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Fride Røe Flobakk

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The Development and Impact of Educational Neuroscience

A Critical Discourse Analysis

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... the human brain is evolved for sociality, for the capacity and necessity of living in groups, for the ability to grasp and respond to the mental states of others: human brains are both shaped by, and shape, their sociality.

Rose & Abi-Rached (2013, p. 22)

Preface and acknowledgements

My aspiration for conducting a doctoral research on educational neuroscience originates from my time as a bachelor student in education, as I found it remarkable how little attention was given to aspects of the brain in concepts related to education and learning. Of the immeasurable body of educational literature we were given over the years, only a brief paragraph of it was dedicated to 'education and the brain' (a paragraph, that is, which was neither accurate nor too optimistic about the prospect of linking education and neuroscience). Since I was, and still am, of the opinion that our brain is crucial for our ability to learn (along with individual cognition and social aspects, of course), I decided to continue the academic path in order to investigate the linkage of education and neuroscience further – or more precisely, to investigate the *inattention* of education and neuroscience within the educational field in Norway. Following this I wrote my master thesis on educational neuroscience in 2011 and, needless to say, submitted my doctoral research on the same topic in 2015.

I would, however, not have come far with my PhD research without certain people. Most importantly, I will give a special thanks to my supervisor, Nina Volckmar. You have believed in me, and my research idea regarding educational neuroscience, since I was a young master student. You have listened, guided, encouraged, and challenged me – always with the aim of improving my work. For that I am forever grateful. I will also thank my co-supervisor, Paul Howard-Jones, who contributed to a significant year as a visiting research student at University of Bristol. Thank you, Paul, for all the great discussions, for your indispensable feedback on my research, and for letting me attend courses and seminars at Centre for Mind and Brain in Educational and Social Contexts (MBESC). I will also thank my colleagues at the Department of Education at NTNU for listening to my ideas and problems and for always giving me valuable advises. Especially have the PhD seminars at the department, initiated and organised by PhD-coordinator Marit Honerød Hoveid, been an important arena for presenting and discussing doctoral research.

Just as important as these work-related contributions are the efforts my friends and family have done in order to drag me *out* of the office every now and then. Thanks to Cecilie, Gro and Eirik, Andreas, Kjersti, Morten, and Emilie for all the weekends, holidays, dinners, trips, and countless laughs we have shared. Thanks to my sister Frøydi for traveling miles just to spend time with me and for always supporting me, thanks to my thoughtful Papa who pays close attention to my work and who always cuts out and sends news articles he thinks I will find relevant, and thanks to my wonderful Mamam for giving me Isak, a crooked little tree in a tiny clay-pot, just to remind me what truly is important in life. Words are powerless to express my gratitude to you.

They say that every researcher should live with someone, but that no one should live with a researcher. In retrospect I understand why, and my biggest thanks, and my heart, goes to my dearest Thomas. You have been there every single step of the way. When I come home late after work you always meet me at the front door just to scoop me up in a big hug, when I had to move to England for a year you left your friends and your work and moved with me, and when I have danced with joy or screamed with frustration you have danced and screamed with me. I would have withered without these everyday signs of encouragement and boundless patience. I would have withered without you. I know it is a small gesture in comparison, Thomas, but to you I dedicate this work.

Fride Røe Flobakk
Trondheim, December 2015

List of contents

Summary

The discourse of educational neuroscience is a complex field of study, encompassing an intricate and interrelated network of discursive structures, relations, and practices within and between different discursive levels. This multifaceted dissemination makes educational neuroscience an interesting topic for research, and in my doctorial study I use a critical discourse analysis in order to investigate the development and impact of educational neuroscience as a *discourse.* Attention is on academic, public, political, and Norwegian levels of the educational neuroscience discourse, as I address the four discourse analytical concepts of emergence, hegemony, recontextualisation over structural boarders, and recontextualisation over scalar boarders.

In the first analytical part historical series of text from the 19th century and to the present day are analysed and discussed in order to elucidate the emergence and development of educational neuroscience as an academic project. I argue that educational neuroscience can be seen as a discipline emerging from a field of prior discourses by way of boundary problematization, transgression, and negotiation where old discursive elements are re-articulated into new discursive facets. The academic level of educational neuroscience is also the focus of attention in the second part, where I consider discursive struggles, hegemonic relations, notions of dominance, marginalisation, and power dimensions. A chief argument herein is that an underlying struggle between the 'robust' neuroscience (viz. natural science) and the 'softer' field of education (viz. social science) can be seen reverberated in hegemonic notions of neuroscientific dominion and marginalisation of educational explanations and educational practices within the field. In the third part attention is shifted from the academic level towards an analysis of how educational neuroscience is recontextualised in public media, in brain-based learning industries, in political documents, and in texts from intergovernmental interest actors. Attention is on the ways in which these different actors represent, appropriate, and have (or *lack*) dialogue with educational neuroscientific research. Also the forth analytical part considers educational neuroscience's recontextualisation, although this time attention is across scalar boarders to the Norwegian level of discourse. My findings do at this level evince that there barely is any academic attention and debate concerning the linkage of education and neuroscience in Norway, this despite the fact that numerous (and often unscientific) traces of educational neuroscience are represented in Norwegian public and political fields.

Overall, my critical discourse analytical findings evince that educational neuroscience is a complex and a continuous changeable discourse. The discourse can be seen manifested at different levels (e.g. the academic, the public, and the political level), it encompasses an intricate set of representations, values, approaches, structures, relations, practices, and actors, and it can additionally be seen to have emerged, and continue to develop, by means of discursive structures and strategic actions (viz. the power *of* discourse and the power *over* discourse). I further argue that certain difficulties arise by reason of educational neuroscience's novelty and complexity. Not only do issues arise due to philosophical, theoretical, methodological, practical, and ethical bridging problems at the academic level, but difficulties do also arise when educational neuroscientific research is recontextualised at the public and political level. Considering that educational neuroscience is still developing as a discourse, I deem that actors working at the interface of education, psychology, and neuroscience − and also at the interface of the academic, public, and political level − have an opportunity to negotiate, re-articulate, and shape the discourse of educational neuroscience. In this construction I claim that much is to be gained by perceiving educational neuroscience as an anti-reductionistic and transdisciplinary endeavour.

Norsk sammendrag

Den pedagogisk nevrovitenskapelige diskursen er et kompleks felt, som favner om et interaktivt nettverk av diskursive strukturer, relasjoner og praksiser både *i* og *mellom* ulike diskursive nivå. Denne kompleksiteten og mangfoldigheten gjør pedagogisk nevrovitenskap til et spennende forskningsobjekt og i mitt doktorgradsstudium tar jeg i bruk et kritisk diskursanalytisk og diskursteoretisk rammeverk for å studere utviklingen og nedslaget av pedagogisk nevrovitenskap som *diskurs.* Fokus ligger på det akademiske-, offentlige-, politiske- og det norske nivået av pedagogisk nevrovitenskap, der jeg videre tar for meg de fire analytiske konseptene 'emergence', 'hegemony', 'recontextualisation over structural boarders', and 'recontextualisation over scalar boarders'.

I den første analysedelen blir historiske tekster fra 1800-tallet og frem til i dag analyser og drøftet, dette for å belyse fremveksten og utviklingen av pedagogisk nevrovitenskap som et akademisk prosjekt. Her argumenterer jeg for å forstå pedagogisk nevrovitenskap som en disiplin som har vokset frem fra et felt av forhenværende diskurser − en utviklingsprosess som har funnet sted ved problematisering, overskridelse og forhandling av tidligere diskursive grenser, der gamle diskursive element har blitt re-artikulert til nye diskursive konsept. Det akademiske nivået ved pedagogisk nevrovitenskap er også i sentrum i den andre analysedelen, der jeg studerer diskursive kamper, hegemoniske relasjoner, forhold av dominans, marginalisering, samt ulike maktdimensjoner. Et sentralt argument her er at en underliggende kamp mellom den 'robuste' nevrovitenskapen (jf. naturvitenskapen) og det 'mykere' pedagogiske feltet (jf. humaniora og samfunnsvitenskapen), har fått utslag i hegemoniske aspekt knyttet til nevrovitenskapelig dominans og marginalisering av pedagogiske forklaringer og pedagogisk praksis i feltet. I den tredje delen er oppmerksomheten flyttet fra det akademiske feltet til en analyse av hvordan pedagogisk nevrovitenskap er rekontekstualisert i media, i den 'hjernebaserte' læringsindustrien, i politiske tekster og i tekster fra internasjonale organisasjoner. Fokus er på hvordan disse ulike aktørene representerer, tilegner seg, og har (eller *mangler*) dialog med pedagogisk nevrovitenskapelig forskning. Også den fjerde analysedelen omhandler rekontekstualiseringen av pedagogisk nevrovitenskap, men her er oppmerksomheten rettet over internasjonale og nasjonale grenser og til Norge. Mine funn viser her at det er liten akademisk oppmerksomhet og debatt rundt pedagogikk og nevrovitenskap i Norge, dette på tross at mange (og ofte uvitenskapelige) fremstillinger av koblingen mellom pedagogikk og nevrovitenskap er representert i det offentlige og det politiske felt i Norge.

Samlet sett viser mine analytiske funn at pedagogisk nevrovitenskap er en kompleks diskurs i kontinuerlig forandring. Diskursen er manifestert i ulike nivå (slik som det akademiske, offentlige og politiske nivå) og den innehar et intrikat sett med relasjoner, verdier, perspektiver, retninger, strukturer, relasjoner, praksiser og aktører. Den har vokst frem, og utviklet seg videre, ved hjelp av strategiske handlinger og diskursive strukturer (dvs. ved hjelp av makten *til* diskursen samt makten *over* diskursen). Jeg argumenterer for at den relativt nyetablerte og komplekse diskursive strukturen til pedagogisk nevrovitenskap fører til visse utfordringer. Ikke bare oppstår utfordringer grunnet filosofiske, teoretiske, metodiske, praktiske og etiske brobyggingsproblematikk mellom feltene, men vanskeligheter oppstår også når pedagogisk nevrovitenskapelig forskning er rekontekstualisert til det offentlige og det politiske felt. Tatt i betraktning at den pedagogisk nevrovitenskapelige diskursen fortsatt er under utvikling, vil jeg hevde at aktører som jobber i møte mellom pedagogikk, psykologi og kognitive nevrovitenskap − samt i møte mellom de akademiske, offentlige og politiske diskursnivåene − har muligheter til å forhandle, re-artikulere, og forme den pedagogisk nevrovitenskapelige diskursen. I denne konstruksjonen vil jeg argumentere for viktigheten av å forstå pedagogisk nevrovitenskap som et anti-reduksjonistisk og transdisiplinært arbeid.

Chapter 1

Introduction

Over recent decades there has been considerable growth and expansion in the academic field which combines education and neuroscience. The concept of *learning* is a central nexus in research projects within this field, and much cross-disciplinary work has appeared at the interface of the disciplines of education, cognitive psychology, and cognitive neuroscience. For instance, many international and collaborative research groups on education and neuroscience have been initiated, annual conferences are held, books and articles are continually being published on the topic, journals on mind, brain, and education have been launched, and numerous master and doctoral programmes at universities such as Harvard and Cambridge have been established. This substantial development has even led to the identification of education and neuroscience as a distinct and novel academic *discipline*. But the linkage of education and neuroscience has not only attracted interest within academia, and one can also find traces of education and neuroscience within policy documents, amongst intergovernmental interest actors such as the OECD and EU, within public media, in pop-scientific books, in so-called 'brain-based' learning programmes, and in marketing of 'smart' drinks, foods, and pills which promise to enhance customer's cognitive abilities. Notions related to learning, education, cognition, and neuroscience can therefore be found *outside* academia as well, as related representations manifest themselves in public and political fields.

The novelty of this academic discipline does, in itself, make the field an interesting topic for study since there is yet much to be explored with respect to connections between education and neuroscience. However, I will also argue that the field's novelty contributes to encumbering the discipline, because it appears that certain disciplinary structures have not yet been firmly established and acknowledged. For instance, there is little coherence in the ways in which the academic project's aim, research approach, values, and disciplinary relations relevant to education and neuroscience, are perceived and understood by actors both inside and outside the field. Ambiguous disciplinary principles and structures are even reflected in the myriad different titles which are used, as names on research initiatives ranging from 'educational neuroscience' (Campbell, 2011; Geake, 2008; Varma, McCanliss, & Schwartz, 2008), 'mind, brain, and education' (Stein & Fischer, 2011), 'neuroeducation' (Ansari, De Smedt, & Grabner, 2012), 'neuroeducational research' (Howard-Jones, 2010), 'neurolearning' (Petitto & Dunbar, 2004), 'pedagogical neuroscience' (Fawcett & Nicolson, 2007), 'neuroscience and education' (Goswami, 2006), 'neuroscience in education' (Della Sala & Anderson, 2012), and 'brain-based education' and 'brain-based learning' (Jensen, 2008). Whereas some of these groups give the impression of being closely related to one another, others on closer examination attach different meanings to the ways in which one can perceive linkages that can and cannot be drawn between the disciplines of cognitive neuroscience, cognitive psychology, and education. The field combining education and neuroscience therefore appears to be growing, wherein one can find a complex web of disciplinary structures, relations, and actors holding different perceptions, principles, and values.

Aim and research questions

Many researchers have already studied practical aspects of education and neuroscience, such as how one can connect brain-scientific knowledge on reading and letter processing with educational interventions. However, little comprehensive research has been done to map out and critically analyse the field *per se*. I will argue that it is essential to focus also on disciplinary and macro-social dimensions, particularly if one considers the inconsistency in perceptions of the nature of the educational neuroscience discipline. My doctoral study will thus focus on the overarching *field* of education and neuroscience, with particular attention to how this field approaches concepts of learning. Consideration will furthermore be given to societal, structural, relational, strategic, and disciplinary dimensions. In line with this, relevant research questions will ask how the professional discipline of educational neuroscience has developed, what 'general' knowledge is accepted within the discipline, which issues and disagreements are negotiated within the profession, which stakeholders and agents are central to the discourse, and how educational neuroscience is recontextualised in other areas such as public and political fields. Accordingly, an appropriate approach for such a study is to consider the field of education and neuroscience as a *discourse*, since this complies with macro-social and critical perspectives on structural and disciplinary aspects of the education and neuroscience field. When using the term 'discourse', I base my definition on Fairclough's theoretical and methodological framework where a discourse is perceived as a set of complex relations and structures which both represent and constitute meaning, meaning-making, and other social entities (Fairclough, 1992, 2010). In line with this, the overall aim of my doctoral study is *to analyse the development and impact of educational neuroscience by using a critical discourse analysis.*

A critical discourse analysis of the educational neuroscience discourse is not a precise enough line of study, and further definition of the overall research aim needs to be made. In order to reach a wide-ranging and comprehensive analysis of the discourse, I have chosen to focus on the four discourse analytical concepts of *emergence, hegemony, recontextualisation over structural boarders,* and *recontextualisation over scalar boarders.* The first analytical part of my research aims to investigate how educational neuroscience has emerged and developed as an academic discipline. The second part builds on this, but focuses on discursive struggles and hegemonic relations found within the discourse − attention is therefore on different narrations, positions, actors, strategies, and power relations that can be found within the academic level of the educational neuroscience discourse. Whereas the first two analytical parts analyse the *academic* level of discourse, the last two research sections aim to investigate the ways in which educational neuroscience is distributed and recontextualised to other societal fields. Accordingly, the third analytical part will focus on how educational neuroscience is recontextualised over *structural* borders and into the field of media, brain-based learning industries, policymakers, and other interest actors such as OECD, whereas the fourth and last section investigates educational neuroscience's recontextualisation over *scalar* borders and into the Norwegian field. Analysis of educational neuroscience in terms of hegemony, emergence, and recontextualisation, can overall provide a copious analysis, as the four concepts together cover an extensive range of discursive facets at different discursive levels. The analytical approach also makes allowance for critical reflection and discussion by combining micro-textual analysis with macro-social perspectives and theories (Wodak & Fairclough, 2010).

Some clarifications ought to be made with respect to the aim of this research. Firstly, a focus on discursive aspects implies that my study will not offer any practical research on ways to link neuroscientific knowledge and education. Secondly, this means that I do not intend to include any specific academic research initiative linking education and neuroscience in the centre of my analysis, since it is the overarching discourse that I am interested in analysing. Thirdly, for the sake of simplicity, I will refer to the overarching academic research project as the discourse of *educational neuroscience*. By using the term ‘educational neuroscience’, I do not suggest that labelling discursive initiatives with the same name is advantageous, nor do I propose that this is the most suitable term for endeavours, studies and aims within this overarching research field. The term ‘educational neuroscience’ is, however, frequently used by authors working at the interface of education, cognitive psychology and neuroscience, and it does seem to imply less relational directives than, for instance ‘neuroscience *in* education’ or ‘brain-based learning’. The fourth aspect to be clarified is that I intend to take a *critical approach* when studying the discourse of educational neuroscience, but this will not be done in a censorial way but rather in the spirit of critical awareness and reflection. I am thus not commencing my doctoral research project with the aim of refuting or promoting educational neuroscientific work, but rather with the aim of analysing, describing, and reflecting upon discursive aspects pertaining to educational neuroscience.

Scientific positioning and research approach

Philosophical positioning

With regard to my philosophical, theoretical, and methodological positioning − and hence the ensuing research approach taken in this doctoral study − detailed accounts are presented in the following chapters. Considering that scientific positioning influences everything from research questions asked, to research design and discussion of findings, it is essential also to clarify these aspects in the introduction. What ought to be mentioned first is that my philosophical positioning has been particularly thought-provoking, because my encounter with educational neuroscience as a research topic has challenged my formerly held philosophical stance. I am an educationalist, and during my years of educational and social studies I have been an adherent of social constructivism, where epistemological questions often take centre stage. When I started studying the discourse of educational neuroscience, however, the introduction of natural scientific aspects into educational matters provoked certain basic philosophical questions, which I did not sufficiently manage to answer within the framework of social constructivism. In short, it can be noted that questions ensued from how I could link my idea of underlying social and discursive structures − in constructivism often perceived as essential social constructs − with the idea that the material world exists *independently* of our thoughts about it. If I, on the one hand, were to take a position of social constructivism, I would find that certain natural scientific premises such as biological aspects of the living brain are inadequately considered, since social constructivism has a preliminary focus on epistemological doctrines of socially construed understandings. If I on the other hand were to focus on ontological realism, I would find that social aspects such as meaning-making and underlying discursive structures are given less consideration than more existential aspects, such as neural biochemical processes in the brain. I therefore did not possess sufficient philosophical grounding, since I found it difficult to use a philosophy of science which does not make allowance for both natural and social aspects *without* giving predominance to either ontological premises (realism) or epistemological premises (relativism).

After searching for literature relevant to scientific philosophical grounding in educational neuroscientific matters, I realised that not much has been published about philosophies of science appropriate to educational neuroscientific research[1]. Lack of explicit philosophical grounding in educational neuroscience nearly made me change the focus of my doctoral study, in order to explore possible philosophies of science applicable to educational neuroscientific research. Although my motivation for doing a critical discourse analysis in the first place was my impression that the novel discipline of educational neuroscience has some essential disciplinary ambiguities, which ought to be investigated − lack of attention to a coherent grounding in a philosophy of science is, in my view, just another example of this. Bearing in mind the limited time and space available for philosophical conundrums if progress were to be made in my critical discourse analysis of educational neuroscience, I have chosen to take a somewhat open and investigational philosophical positioning in my doctoral research. This implies that I am not set in my philosophical positioning, since there still is much to consider with respect to philosophies of science appropriate for educational neuroscientific research. I have, however, taken an approach influenced by *critical realism* (Bhaskar, 1986, 1998, 2008), because this philosophy of science appears to meet some of the philosophical issues ensuing from the linkage of education and neuroscience. Not only does critical realism assert that there is a real world which exists independently of our knowledge of it, but it also acknowledges that the real world is socially constructed − this without

[1] It must be noted that numerous texts are published with regards to other philosophical questions related to linkages of social, behavioural, and neuroscientific aspects such as consciousness, identity, and relations between body and mind, soul and matter (cf. dualism and monism). These questions do, however, tackle philosophical issues at a different level than ontological and epistemological questions adherent to philosophies of science.

reducing ontological questions to epistemic questions, or vice versa (Collier, 1994). A comprehensive account of critical realism and educational neuroscientific research is presented in chapter 2, but for the moment, it can be noted that critical realism appears to function as a *possible,* but not exclusive, philosophical approach for this study, since it allows for answering philosophical issues arising when linking education and neuroscience.

Theoretical and methodological positioning

Despite a somewhat tentative philosophic positioning in critical realism, it is essential that my philosophical approach is compatible with the theoretical and methodological approach chosen for the study. Considering that the research aim is to analyse structures, strategies, and relations in educational neuroscience as a *discourse*, Norman Fairclough's critical discourse analysis (CDA) seems particularly appropriate as a theoretical and analytical framework (Fairclough, 1992, 2010). A general principle in Fairclough's framework is to see textual analysis at a micro-level in relation to societal and sociocultural structures at a macro-level. As a further specification of this, Fairclough focuses on *critical* aspects by also giving emphasis to what he calls "opaque relationships of causality" between discursive texts, events, and practices on the one hand, and wider social and cultural structures, processes, and relations on the other (Fairclough, 2010, p. 93). Furthermore, and this is essential when adopting a consistent approach to my research, Fairclough has, during the course of his later work, taken a critical realist approach to discourse analysis, and focuses much of his later work on creating justifiable bonds between critical discourse analysis (CDA) and critical realism (CR) inspired by Roy Bhaskar (Fairclough, Jessop, & Sayer, 2002).

Besides presenting a theoretical framework of discourse founded in critical realism, Fairclough also offers methodological and analytical perspectives for critically analysing discourse. An essential point in critical discourse analysis is that it is not an analysis of discourse *per se*, but rather an analysis of dialectical *relations* between and within texts, discourse, and other elements of the social (Fairclough, 2010). Identification of such discursive relations is based on the idea that *text* (spoken or written language) must be seen as part of a social event shaped by social agents on the one hand, and by discursive and social structures and practices on the other. Systematic analysis of text is therefore essential because it can reveal i) the network of practices wherein a text is located, ii) relationships between semiosis and other elements within the practice, and iii) the discourse itself (Fairclough, 2003). When it comes to a specific method design, however, critical discourse analysis cannot be seen to offer any 'toolkit' or special forms of micro-analysis of text. Instead it is argued that selection of method for each individual research project depends upon the object of research, the chosen focus of study, and its respective research questions (Fairclough, 2010). Given that I pay attention to emergence, hegemony, and recontextualisation over structural and scalar borders when analysing educational neuroscience, the method and analytical design utilised must be able to sufficiently identify how these four discursive concepts are featured in different dimension of the discourse. Due to different focuses of attention, each concept is treated as a single analytical entity − with its individual research questions, separate selection criteria for literature searches, and thus also individual text material for analysis (corpora). Despite these variances, all four analytical parts follow some general analytical principles, which I consider are applicable to my study. Firstly, texts are selected for the four corpora (each with approximately 30 texts), by following systematic literature search procedures and specific selection criteria, in order to ensure that each corpus represents a justifiable repertoire of texts relevant for the educational neuroscience discourse. Considering that discourse analysis and critical discussion of findings are inevitably dependent on the texts selected for these corpora, systematic and ample search criteria are important for the study's reliability. Secondly, with regard to the specific mode of discourse analysis, all four parts contain a structural analysis and textual analysis with both discursive and linguistic (semiotic) analysis. The extent of these modes of analysis may vary depending on what is expedient for each part, but a general principle is that micro-textual aspects are seen in relation to discursive and social structures, relations, and strategies at a macro-level. Thirdly, all four parts are presented in separate chapters wherein analytical findings are presented and critically discussed in light of a critical discourse theoretical framework. I will argue that this ensures analytical coherence in that the four parts follow the general principles of the same discourse analytical method, as well as ensuring analytical *continuity* since the method makes allowance for studying the concepts of emergence, hegemony, and recontextualisation in different dimensions of the educational neuroscience discourse.

Structure and coherence of the dissertation

Considering my scientific positioning and the approach taken in my doctoral study, I will argue that there is consistency between research questions and my philosophical, theoretical, and methodological approach. Not only can critical realism help as a possible philosophical approach for studying educational neuroscience, but justifiable links can also be drawn between critical realism and critical discourse theories and methodologies (cf. Fairclough, 2010; Fairclough et al., 2002). I will further argue that a focus on emergence, hegemony, and recontextualisation is a purposeful choice for framing a comprehensive analysis covering different levels of educational neuroscience discourse. Additionally, these discourse analytical concepts provide a guiding framework for a coherent method design for analysing educational neuroscience. Based on this research approach, and in order to present my doctoral research in an organised manner, my dissertation is structured as follow:

Ch. 1. Introduction
Ch. 2. Philosophic and scientific positioning – a critical realist approach to educational neuroscience
Ch. 3. Theory – critical discourse theories
Ch. 4. Method – critical discourse analysis
Ch. 5. The emergence of educational neuroscience
Ch. 6. Hegemonic relations in educational neuroscience
Ch. 7. Recontextualisation across structural borders
Ch. 8. Recontextualisation across scalar borders
Ch. 9. Final reflections

Research context and relevance

A few notes are required in order to locate my doctoral project within a larger and already existing field of educational neuroscientific research, and the following research contextualisation is based on insights gained from my systematic literature reviews and discourse analysis of the educational neuroscience field. It is worth mentioning that considerable work has been done on the interface of education and neuroscience, and one can particularly detect an upsurge in such research from the 1980s and onwards, when improved neuroimaging techniques enabled better methods for studying structural and functional aspects of the brain. Many studies related to educational neuroscience promise to enhance our understanding of aspects pertaining to learning, often by combining insights from cognitive neuroscience, neurobiology, cognitive psychology, and/or education. Examples of such studies are Jong and colleagues' (2009) neuroscientific research which indicates the important role of mirror-neurons in our ability to learn from observing others, research on neural circuits and systems exploring human memory (Buzsáki & Moser, 2013), emotional influence on cognition (Patten, 2011), and aspects related to developmental difficulties such as dyslexia, dyscalculia, and ADHD (Fredrickson & Cline, 2009). The focus here is on *practical* aspects of educational neuroscience, as the research is based on structural or functional cognitive neuroscience seen in relation to concepts relevant for education, such as learning, memory, number and letter processing, learning difficulties, emotion, and social interaction. Practical studies like these are often conducted by researchers, or research groups, with profound knowledge of cognitive neuroscience, education, and psychology, who can, therefore, offer valuable insights concerning cross-disciplinary linkages between brain, mind, and education.

Even if much research conducted at the interface of education and neuroscience has focused on practical aspects, my doctoral project takes a different approach to studying educational neuroscience. There are four reasons for this, which I also think add value and relevance to my doctoral project. Firstly, because I am a PhD candidate in the field of *education* – having only taken some minor courses in cognitive psychology, neuroscience, and educational neuroscience – I am not an expert in the fields of neuroscience or cognitive psychology. Rather, my academic background is concerned with macro-social perspectives on education where attention is often on societal perspectives, political aspects, inter-governmental structures, power relations, dominions of knowledge etc. (cf. Bourdieu, 1999; Fairclough, 2010; Foucault, 1970, 1972; Karlsen, 2006). Accordingly, and as a way of ensuring some academic soundness and reliability, my research will reflect this macro-social perspective as I analyse discursive and relational aspects in educational neuroscience.

Secondly, even if I think it is important to link neuroscientific findings, learning and education *per se*, I also think it is essential to carry out research that critically analyses the enterprise, structure, and impact of the educational neuroscientific *discipline.* Educational neuroscience has, as already mentioned, experienced considerable growth both within academia and in other political and public fields, but the discipline does nevertheless give the impression of being shrouded in ambiguity. Despite inconsistency in disciplinary frameworks, so far there have been relatively few *discursive* analyses of educational neuroscience. Some articles, literature reviews, and studies with reference to the discipline of educational neuroscience do indeed exist − such as Beauchamp and Beauchamp (2012; 2013), Koizumi

(2004), Samuels (2009), and Tamara (2012) − although I will argue that my doctoral project offers a more comprehensive and systematic analysis of educational neuroscience. Because many of these studies focus on the academic discipline of educational neuroscience, I aim to take a step further with my discourse analysis by analysing *both* the academic discipline (i.e. educational neuroscience's emergence and hegemony) *and* the broader public and political impact of educational neuroscience (i.e. recontextualisation of educational neuroscience across structural and scalar boarders). At present, such research perspectives are relatively sparse and it is even noted by authors such as Blakemore and Frith (2005a, p. 2) that "despite [a] growing body of knowledge and its relevance to education policy ... few links exist between brain research and education policy and practice". By also focusing on recontextualisation processes in my doctoral research, I hope to contribute to new perspectives and knowledge concerning educational neuroscience's distribution and uptake in public and political fields. Furthermore, my doctoral study can be set apart from other disciplinary analysis in that I take a *critical* approach when analysing the discourse of educational neuroscience. As numerous authors working at the interface of neuroscience and social scientific disciplines have called for more critical studies for this research field (Hruby, 2012; N. Rose & Abi-Rached, 2013), I hope that my critical discourse theoretical framework will offer perspectives that to date have been relatively sparse. In this respect it should be noted that the depth of my critical discourse analysis and discussion is proportionate to the breadth and scope of my research. Since I aim to provide a comprehensive analysis of different levels of educational neuroscience discourse, in this doctoral research I will not be able to provide in-depth accounts explaining discursive changes and developments in light of extensive social, political, and historical contexts. This is because I consider it essential to first provide a comprehensive description and clarification of the manifestation of educational neuroscience discourse, on which further in-depth explanatory accounts can build.

A third aspect which can contribute to the relevance of my doctoral study is that at the outset of my dissertation I problematize certain philosophical issues which can occur in educational neuroscientific research. In order to meet some of the critiques I mention concerning philosophical grounding in educational neuroscientific research, I have employed an open and investigational research approach based on critical realism. As I have not yet found any literature that explores a critical realistic approach for studying educational neuroscience, I believe that my investigational research approach may offer a new perspective on matters related to educational neuroscience's philosophies of science.

The fourth and last reason for choosing a critical discourse analysis of educational neuroscience is because this research approach allows me to analyse the development, dispersion, dissemination and impact of educational neuroscience both at an *international* scale and *national* scale. As I am from Norway, I am particularly interested in analysing educational neuroscience in relation to the Norwegian context. Not only do I consider this important since to date, few, if any, critical studies on educational neuroscience's impact in Norway, have been conducted, but I also believe that a Norwegian analysis is valuable as it can offer insight into the ways in which educational neuroscience is recontextualised into a country which only relatively recently has seen the introduction of this theme. In view of this, I will argue that my critical discourse analysis of educational neuroscience makes an original contribution to knowledge in the field, in that i) it offers a comprehensive and wide-ranging analysis of the *discourse* of educational neuroscience by focusing on emergence, hegemony, and recontextualisation, ii) it offers a *critical* analysis of the discourse, iii) my research approach explores *critical realism* as a possible philosophy of science for education neuroscientific research, and iv) my study also investigates educational neuroscience's impact within a *Norwegian* context.

Chapter 2

Philosophic and scientific positioning

– a critical realist approach to educational neuroscience

What is real? How is one to know?
These are among the most ancient questions not only of philosophical inquiry proper, but of human thought as such.
Berger and Luckmann (1966).

Philosophy of science constitutes a crucial foundation for scientific research by addressing fundamental ontological and epistemological questions of '*what* exists' and 'how we can *know* what exists' (Molander, 2003). Philosophies of science will furthermore often precede other essential research inquiries, such as scientific theories, methodological argumentations for study, and implications of science, since these notions inevitably include certain basic conceptions of the world. Consideration of philosophical positioning is therefore in my view, particularly essential in academic work and research, since both theoretical and methodological perspectives presuppose a set of ontological and epistemological conventions. However, due to my critical discourse theoretical approach, I am of the opinion that philosophical conventions risk becoming unquestioned conceptions since they are often implicitly manifested within disciplinary research paradigms, theories, methodologies, and other scientific assumptions. In other words, different disciplinary traditions are often based on relatively resilient constitutions of a particular set of philosophies and allied theories, methodologies, and methods. Based on critical discourse theories, it can further be argued that a philosophy of science will be strengthened by associated theories and methods, since these build on and, in turn, manifest philosophical representations. This form of resonance in thought can further be reinforced by resonance in discursive and social practice – researchers conduct studies in line with specific philosophical, theoretical, and methodological assumptions, analogous scientific knowledge becomes manifested in articles and books, and related lectures are delivered to new students within the discipline. A set of philosophic knowledge can therefore become institutionalised in an academic discipline if certain representations are manifested in ways of thinking, being, and acting (cf. Fairclough, 2010; Hyland, 2009).

I will argue that manifestation and institutionalisation of thought in a field such as an academic discipline is not problematic *per se*; what is problematic is when particular ways of thinking and 'being in the world' become naturalised. Naturalised perspectives are *unquestioned* perspectives, since these representations are taken for indisputable truths about the world and our place in it (Fairclough, 2010). I will claim that this further implies that research conducted from a foundation of a 'taken for granted' philosophy of science, will be research which uncritically subscribes to certain presumptions. The line of argument in a research study may be completely flawless, but unless the premises a study is based on are reflected over, central aspects are left unaccounted for. Collier (1994) argues along similar lines by noting how certain scientists appear to have an "unconscious philosophy" which they apply in their practice. Also Gramsci (1971) points to similar assessments when he states that:

> Everyone is a philosopher, though in his own way and unconsciously, since even in the slightest manifestation of any intellectual activity whatever, in 'language', there is contained a specific conception of the world … [Thus the questions:] Is it better to take part in a conception of the world mechanically imposed by the external environment, i.e., by one of the many social groups in which everyone is automatically involved from the moment of his entry into the conscious world … Or, on the other hand, is it better to work out consciously and critically one's own conception of the world and thus, in connection with the labours of one's own guide, refusing to accept passively and supinely from outside the moulding of one's personality (Gramsci, 1971, pp. 323-324).

Thus, when it comes to philosophies of science, the crucial point is, in my view, not *which* philosophic or scientific position one is located within. What is important is whether or not one is *aware* of one's position and the set of assumptions that often shadow any given scientific stance. In view of these principles, it has been an elementary endeavour for me to critically contemplate fundamental philosophical conceptions and implicit disciplinary assumptions of which I, as a researcher, am inevitably a part of. Because educational neuro-science is a topic of study that differs somewhat from general research conventions in my disciplinary community, I believe it is even more important to critically reflect on my scientific positioning and the research approach taken in my study. Moreover, in my work with educational neuroscience, I have encountered certain philosophical issues, which have challenged my previously held philosophical ideas. Issues have not only been linked to my experience of philosophical conundrums recognised in educational neuroscience, such as linkages between mind and brain, or soul and matter, but philosophical challenges have also arisen due to personal conflicts concerning research approaches and appropriate philosophies of science for studying linkages between education and neuroscience. Time and scope of my project have not allowed me to investigate philosophical challenges as thoroughly as I would have liked, and I have instead found it necessary to proceed with an open and somewhat investigational philosophy of science inspired by critical realism. The following chapter will elaborate on these philosophical matters, commencing with an account of philosophical conundrums related to educational neuroscience, before presenting critical realism as a *possible*, but not the only, philosophy of science for studying educational neuroscience.

Educational neuroscience and philosophical conundrums

Disciplinary work related to educational neuroscience combines, in one way or another, aspects relevant to neuroscience with those relevant to education. Additionally, and despite often being absent from the discipline's name, insights from cognitive psychology are also frequently included in educational neuroscientific work. Educational neuroscience can therefore be said to have a *transdisciplinary* endeavour at its heart[2], since new disciplinary knowledge is created in the merging of different disciplines (Samuels, 2009). Transdisciplinary undertakings, however, are often complex and challenging − different academic fields often operate with different vocabularies, methods, theories and, indeed, different philosophies of science, and the task of integrating perspectives across different disciplinary boundaries tends to bring certain difficulties to the surface (Stein, Connell, & Gardner, 2009). Educational neuroscience is no exception when it comes to a complex transdisciplinary synthesis. A number of issues in educational neuroscience have philosophical roots, as endeavours linking education, cognitive psychology, and cognitive neuroscience experience both disciplinary and epistemological issues, in addition to old philosophical conundrums related to mind and matter. In the following section, philosophical issues related to educational neuroscience are elaborated on, since these can be considered to be preliminary to questions concerning philosophies of science for this research project.

[2] Samuels (2009) and Beauchamp and Beauchamp (2013) note how there are differences between 'interdisciplinary', 'multidisciplinary', and 'transdisciplinary' endeavours. Personally, I argue that educational neuroscience ought to be perceived as a *transdisciplinary* endeavour (see chapter 9, page 341 for a comprehensive argumentation) and from now on, I will use the label of transdisciplinarity for educational neuroscience.

Different epistemologies and concepts of learning

When it comes to cross-disciplinary endeavors, challenges of an epistemological character are noted as a central source of difficulties. Stein et al. (2009, p. 45) even note that "interdisciplinary syntheses are among the most epistemologically complex endeavours that humans can attempt". The argument for such complexity is that cross-disciplinary projects require that the gap between academic fields is bridged – *but*, the breach between disciplines tends to run deep, due to differences in scientific perspectives, where differences in methods, theories, and philosophies contribute to generate different kinds of 'knowledge' (Stein et al., 2009). Differences in disciplinary premises are thus a central factor for tension in cross-disciplinary projects when the disciplines are influenced by fundamentally different philosophical concepts of the world. Such issues are noticeable in transdisciplinary synthesis of educational neuroscience as well, and philosophical difference can particularly be ascribed to the 'gap' between *educational* endeavours of the social sciences on the one hand, and *neuroscientific* endeavours of the natural sciences on the other. This gap is constituted due to the respective scientific fields' long history of differences in philosophical perspectives, theories, concepts, and methods − dissimilarities which are further manifested in their conceptualisations of knowledge and in their practice.

If one considers epistemologies that are relevant to the discipline of *cognitive neuroscience*, some of the most common epistemologies can be said to be empiricism and realism (Samuels, 2009). Notable in these philosophical stands is that one often considers knowledge to come from what can be perceived. 'Knowledge' in the science of neuroscience is therefore connected to the idea that reality can be observed through empirical investigation, and modes of study are therefore often consistent with experimentation and observation (Samuels, 2009). Epistemological perspective can, moreover, be manifested in the ways that members of the neuroscience discipline understand certain concepts – for instance the concept of *learning*. Paul Howard-Jones (2008, p. 362) elaborates upon this perspective and notes that "in neuroscience, the term 'learning', when used as a noun, is often synonymous with 'memory'". At the same time, learning is often associated with the declarative memory system and with how the hippocampus operates in the process of forming and recalling memories. In addition to declarative memory, other essential concepts related to learning in cognitive neuroscience are working memory, synaptic plasticity, structural changes in the brain, and accompanying functional correlations in, for instance, biological activity.

Neuroscientists therefore mainly consider 'learning' in terms of changes in an individual's biological system (Howard-Jones, 2008, 2010), and methods used in order to acquire knowledge about learning are often related to empirical and technical experiments and analysis of brain structures and brain functions − such as measurements of electrical activity of the brain (e.g. EEG) and metabolic activity in the brain (e.g. PET-scan) (Gazzaniga, Ivry, & Mangun, 2009). In view of this, cognitive neuroscientists can be seen to take a natural science approach − particularly with biological, cognitive, and neuropsychological perspectives − in their conceptualisation of 'learning' (Blakemore & Frith, 2005a; Gazzaniga et al., 2009; Howard-Jones, 2010).

If one considers epistemologies related to the discipline of *education*, these philosophical conceptions can be seen to encompass rather different aspects than those of neuroscience. In education there is a tradition of rationalistic and relativistic epistemologies, where the current and prevalent epistemic stance is said to be that of constructivism (Samuels, 2009, p. 48). Renowned landmarks in line with constructivist perspectives can furthermore be seen to be Berger and Luckmann's book, *The Social Construction of Reality* (1966), in addition to work by Durkheim, Marx, Mead, Nietzsche, and Weber (cf. Alvesson & Sköldberg, 2010; Samuels, 2009). Common conceptualisations of 'knowledge' in the educational discipline are accordingly related to the idea that "reality is socially constructed and that the sociology of knowledge must analyse the process in which this occurs" (Berger & Luckmann, 1966, p. 13) − an epistemological view which indicates that "knowledge comes from what can be thought about" (Samuels, 2009, p. 48). Furthermore, it is reasonable to assume that these epistemological perspectives are manifested in the ways in which educationalists understand research, in their practices, and in how they comprehend and define certain concepts. In this respect, educationalists' understanding of 'learning' is of note. Instead of looking at 'learning' as individual biological changes at a cellular and structural level of the brain (viz. cognitive neuroscience), educational researchers often focus on more social and political aspects of learning, such as social interaction and meaning making, the importance of context, learning with communities and groups, and socio-political influences on education. Educational concepts of learning are therefore more consistent with the view of the "holistic development of the person in the society" (Samuels, 2009, p. 48), where multifaceted approaches are taken − for example, socio-political and intergovernmental approaches (Green, 2006; Rizvi & Lingard, 2006), developmental approaches (e.g. Piaget, 1964), sociological approaches (e.g. Bernstein, 2000; Bourdieu, 1986), or sociocultural approaches (e.g. Vygotsky, 1978). In addition, notions of learning in education also tend to include perspectives on value, justifications, ethical and moral issues, since one is often more inclined to ask 'what learning and education *ought to be'* rather than contemplating 'what learning and education actually *is*'. The discipline of education can, as such, be seen to comprise numerous different social perspectives and theories of learning, and evaluative judgments and reflections are incorporated as an essential part, since education is perceived to be interlinked with questions concerning what kind of citizen and what kind of society is aspired to. In comparison with cognitive neuroscience, it is therefore often said that neuroscience can only say what one *can* do, whereas education can say what one *should* do (Varma et al., 2008).

The discipline of education and that of neuroscience have rather different epistemological views − which in turn are manifested in different frameworks for research, with distinct methods, theories, and even different vocabularies and definitions of concepts like 'learning'. Such dissimilarities are noteworthy in the transdisciplinary endeavour of educational neuroscience − not only can different concepts of 'learning' create considerable misunderstandings and communication problems for members in the interface of education and neuroscience, but differences regarding 'philosophies of learning' also make it "easy to stray beyond the bounds of sense, at least as interpreted by one or both of these communities" (Howard-Jones, 2008, p. 362). When it comes to a 'new philosophy of learning' it must be said that numerous people working at the interface of educational neuroscience – whether educationalists, neuroscientist, psychologists, or philosophers – still argue about these philosophical issues of epistemological differences (Bakhurst, 2009; Changeux & Ricoeur, 2002; Cigman & Davis, 2009; Howard-Jones, 2008; Samuels, 2009; Schrag, 2011). Like many of these authors, I, too, will concede that bridging of the 'disciplinary gap' cannot be done in one easy manoeuvre when either the discipline of education, or that of neuroscience, is reduced to the epistemological constraints of the other. Considering that educational neuroscience can be seen as a *trans*disciplinary endeavour, I will further argue that the discipline is likely to require a new understanding which 'goes beyond' the philosophical perspectives in each of the two respective disciplines. At present, the debate remains unsettled, and issues concerning the philosophical gap are still considered to be a philosophical conundrum. Nevertheless, there is common acknowledgement of the importance of these questions and it has been emphasized that philosophical issues cannot be left ignored by anyone studying aspects relevant to educational neuroscience.

Dilemma of mind and brain

Transdisciplinary projects of educational neuroscience run into another obstacle, which can be clearly seen in terms of basic philosophy – namely the dilemma of mind and brain. This dilemma is interlinked with ancient philosophical conundrums related to 'mind and matter' − a quandary expressed in various forms, for example, the dilemma of 'body and soul', 'dualism versus monism', 'mind-body dichotomy', 'brainism versus personalism', 'the illusion of consciousness', and 'philosophy of mind' (Bakhurst, 2009; Changeux & Ricoeur, 2002; Howard-Jones, 2008; Pribram, 1986; Sawyer, 2001). Despite the different names, the essential nexus of debate concerns questions regarding the *relation* between our mind and our body and brain. Intrinsically, the problem of the mind addresses essential questions regarding what makes us conscious beings able to reason and think − questions which have proven difficult to answer, partly because we cannot observe either our thoughts or our reasoning – but they also leave traces at a more profound philosophic level: If a crucial part of being a conscious human is the ability to think and reason, then where exactly can these capabilities be found? Is it our brain which thinks and reasons, or is it our mind which can be seen to be responsible for such processes? Is our mind a part of matter? Or is it a division between brain and mind, between body and soul? And who are *we*? – are we our mind's drifting thoughts or are we our embodied brain? Over centuries, people have brooded over this connection between mind and matter, and new literature is continually added to archives on the topic. To make matters even more confusing, different authors tend to allocate different names to philosophical groupings and their respective views. For instance, Bunge (2010) argues that there are currently three main concepts of mind, namely 'computerism', 'psychoneural dualism', and 'psychoneural identity thesis'; Bakhurst (2009) focuses his debate on the dispute between 'brainism' and 'personalism'; Sawyer (2001) argues that debates have been polarised between 'identity theorists' on the one stand and 'dualists' on the other, albeit with a stand of 'non-reductive materialists' wedged in-between the two; whilst Howard-Jones (2008) gives an account where 'dualism' is distinguished from 'monism'. Different names notwithstanding, the various views fall under some comparable groups. Accordingly, and since this section will provide a general overview of the mind-brain dilemma and not a profound in-depth argumentation on the topic, an account of the philosophical conundrum will be presented by using the two categories '*dualism'* and '*monism'*, in addition to a third hypothesis suggested by cognitive neuroscientists.

Dualism

Dualism has a long tradition in science, and numerous renowned names can be allocated to this philosophical notion of mind. One of the most prominent philosophers holding a dualistic mind-matter view is perhaps René Descartes – in fact, his ideas have been so influential that the related view is often known as the 'Cartesian mind-body dualism'[3]. Even if there are different variations of dualistic philosophies of mind, a fundamental agreement is that the mind and the brain are *distinct* entities or substances (mind ≠ brain). Dualistic views on mind and matter, body and soul, additionally assert that the nature of conscious intelligence resides in something non-physical – which, in this respect, implies that our *mind* is beyond the scope of sciences such as physics, neurophysiology, and computer sciences (Churchland, 1988). For someone holding a dualistic view of mind, psychological attributes cannot be ascribed to the brain and it therefore makes no sense to state that a brain thinks or remembers, because such things are done by *people* and not by brains (Bakhurst, 2009, p. 57). However, even if the brain is understood as a concept separated from the mind, interaction between the two is not dismissed – although it is firmly emphasized that neither can help explain the other. In other words, the mind has no effect upon the brain; nor has the brain any effect over the mind. Claims made about mind-behaviour relationship without considering the brain (or claims made about brain-behaviour relationship without considering the mind) will therefore be reasonable within a dualistic conception (Howard-Jones, 2008). In line with the same dualistic argument, it is also reasonable to claim that both concepts can exist without the other. This latter idea can further be linked to dualistic relations between the material body on the one hand and the immaterial mind, soul and spirit on the other − an idea which also connects to theological notions, since separation of mind and matter is related to views of the survival of the soul after death (Churchland, 1988).

Despite ancient history in science and common acceptance; dualistic views on the mind-brain relation are met with considerable criticism. Howard-Jones (2008, p. 371), for instance, reminds us "of the practical benefits of avoiding dualist notions, which can be

[3] The Cartesian mind-body dichotomy is, in accordance to Bakhurst (2009) and Bunge (2010), advocated by later philosophers such as Popper, Husserl, Hacker, and Ilyenkow, in addition to some neuroscientists such as Jackson, Bennett, Sherrington, Penfield, Sperry and Eccles. Dualism has, however, lost ground in current scientific and philosophic communities, but variation of these ideas are still evident in classical psychoneural dualism, in psychoanalysis and New Age-ism, in forms of computerism involving hardware/software dualism, and implicit in scientists' work on matter connected with the brain (Bunge, 2010; Howard-Jones, 2008). It is nevertheless said that a dualistic conception still is "the most common theory of mind in the public at large", partly for the reason that it has been the dominant theory of mind for most of Western history and because dualism is entrenched in the most popular religions in the world as a way of "guaranteeing" the immortality of the soul (Bunge, 2010; Churchland, 1988, p. 7).

considered as fundamental hazards of a philosophical nature faced by workers at the interface between neuroscience and education". One reason for this criticism of dualism can be linked to the idea of 'causal power' of mind over brain. Churchland (1988, pp. 8-9) elaborates on the problem, noting that "if 'mind-stuff' is so utterly different from 'matter-stuff' in its nature – different to the point that it has no mass whatever, no shape whatever, and no position anywhere in space – then how is it possible for my mind to have any causal influence on my body at all?". From a scientific perspective, it is problematic to argue for such mind-over-matter causation, because this would violate naturalistic laws of momentum and energy conservation. Moreover, neuroscientific studies have provided new insights into the brain, which makes it difficult to defend dualistic notions of such causations. For instance, it has been shown that damage to certain brain processes (e.g. through trauma) can reduce mental abilities. Firstly, this makes the claim of mind-over-matter causation problematic because, apparently, dysfunctions in the material *brain* can lead to reduction in *mental* abilities. Secondly, this indicates that biological processes in the brain are intimately connected to our cognitive abilities, and thus the concept of a clear mind-brain dichotomy may be difficult to defend (Howard-Jones, 2008, p. 370). It is, however, of note that even if dualism is a concept of mind that continues to lose ground in science, dualistic concepts are still evident in common theories of mind and in philosophical and scientific work connected to philosophy, psychology, education, and cognitive neuroscience.

Monism

Monism is perhaps the philosophy of mind which provides the most contrasting viewpoints to those of dualism. Instead of claiming that the mind and the brain are separate entities, monism argues that the mind and brain are one and the same thing − the two concepts are, in other words, conflated into one, as mind equals brain and brain equals mind (mind = brain). This implies that the mind is nothing more than the biological brain, and herein it is often agreed that a one-to-one correspondence exists between mind and brain. In this viewpoint, mental processes are neural processes where "for every mental process M, there is a process N in a brain system, so that M = N" (Sawyer, 2001, p. 160). The *mind* can thus be described as states of the *brain*. If one further considers the extent of monism within scientific and philosophic communities, it should be noted that monistic conceptions, as with dualism, are common interpretations of the mind-brain relation found amongst numerous contemporary research communities[4].

Monistic accounts have not avoided criticism, though. Howard-Jones (2008, p. 368) notes that a neurocognitive monism makes the mistake of using simplistic mind-brain models, and that such models inappropriately conflate the concepts of mind and brain into one: "Suggesting one-to-one correspondences between connections in the mind and synaptic connections in the brain is typical of the type of folk cognitive neuroscience used to market many commercial 'brain-based' educational programmes"[5]. Sawyer (2001) similarly notes that monistic positions of identity theorists are eliminative and reductionistic, since they claim that mind is nothing more than the biological brain. It is argued that the problem with monism is that complex cognitive processes cannot adequately be explained by mere biological references. Is it helpful to claim that the mind can solely be explained by microbiological concepts at the level of neurons and chemical processes in the brain? Will not social factors, such as upbringing and social environment, influence the way we think, learn and reason? Also Bunge (2010, p. 148) criticise a monistic philosophy of mind, arguing that certain monists maintain the idea that "brain causes mind – which is like stating that legs cause walking, rather than walking being the specific function of legs". Notions of causation are again problematic, due to the fact that monistic perceptions of mind-brain presume certain causal relationships of power between the two. It should be mentioned that several within the disciplines of philosophy, psychology, and neuroscience are well aware of the philosophical problems related to a monistic view, and they are often careful not to conflate mind and brain (Howard-Jones, 2008). However, as with dualism, traces of monism, and/or confusion concerning the mind-brain relationship, appear to be manifested in knowledge and practice within numerous research communities. The question, though, is: how should one understand the mind and the brain when both dualism and monism are often considered to be insufficient accounts?

[4] Bakhurst (2009) notes that monistic ideas are found amongst some philosopher such as Daniel Dennett and John Searle, Sawyer (2001) claims monism is seen in certain traditions and schools such as the position of 'identity theories', whereas Bunge (2010) argue that 'psychoneural monists' of the materialistic kind conflate the mind and the brain.

[5] 'Brain-based' educational programmes are often linked to 'unscientific' programmes where neuroscience is uncritically used as argumentation for certain forms of educational practice. This topic is further elaborated upon in chapter 7.

Complex and bi-directional interrelations between mind and brain

When it comes to philosophies of the mind, significant insights have been suggested in the wake of the cognitive revolution, as novel technologies and new disciplinary knowledge have initiated new ways to approach the mind-brain dilemma. As Karl H. Pribram notes:

> Interest in the relationship between mind and brain has become invigorated by the surge of activity in the neurosciences and in what has come to be called "cognitive science". The time is therefore ripe to take a new look at this age-old problem, but now from the standpoint of the scientists as well as from that of the philosopher. Today, we are in a position not only to re-evaluate major philosophical stances but also to develop more limited and precise theories and models of mind/brain relationships that subsume a restricted database (Pribram, 1986, p. 507).

In particular, the discipline of cognitive neuroscience has suggested new theories relevant to the mind-brain relationship, but work within disciplines such as cognitive psychology, neurobiology, evolutionary biology, and social cognitive neuroscience, has also contributed to significant insights. For instance, new knowledge of the *plastic brain* and *learning* has resulted in a major shift in our understanding of the mind-brain relationship. These concepts will be elaborated on in the following sections, but, to summarize, numerous studies have shown that the brain is able to change throughout the lifespan in response to external stimuli, experience, and learning (Gazzaniga et al., 2009). This insight has provided new knowledge about the mind, the brain, and the relationship between them, but how can cognitive neuroscientific accounts of the mind-brain relationship be positioned in comparison to dualism and monism?

What can firstly be noted is that the majority of those working within the field of cognitive neuroscience appear to be careful *not* to position themselves within either a dualistic or a monistic position because of the issues and critiques already mentioned (Howard-Jones, 2008). Instead, the view often emphasized is that mind and brain must be explained together, that the relationship between mind and brain is not straightforward, and that the mind and brain ought to be understood as concepts under construction (Blakemore & Frith, 2000, 2005a; Morton & Frith, 1995). Causal connections between brain and mind – and also between brain, mind, and behaviour – are therefore often seen as complex interrelations, which can occur *bi-directionally* (Howard-Jones, 2008). This argument is based on cognitive and neuroscientific research, which, for one thing, has shown that biological processes in the brain can alter cognition, which in turn can alter behaviour (brain → mind → behaviour). For instance, this is seen where damage to the brain (e.g. a stroke) can lead to an alteration in cognitive abilities (e.g. memory impairment), which in turn can lead to changes in a person's behaviour. A well-known example is the case of Phineas Gage, who in 1848 was hurt in an explosion where an iron pole pierced part of his brain and damaged vital areas of the orbitofrontal region of his frontal lobe − an area which plays a central role in social decision making, such as identifying which social rules are appropriate in a given situation. Gage miraculously survived the accident, but his behaviour and personality were reported as being drastically changed from a polite and well-liked man to a disrespectful, impatient, and bad-mannered person (Gazzaniga et al., 2009). The brain injury caused by the explosion resulted in brain damage and cognitive change, which in turn altered Gage's personality and behaviour − behavioural changes which were likely to have impacted on his family, friends, and others in his surroundings (environment → brain → mind → behaviour → environment).

Cases such as these have therefore demonstrated causal connections between brain, mind, and behaviour. At the same time, causal connections have also been shown to work the other way (Howard-Jones, 2008). Social, cultural and environmental factors can influence our behaviour, for example, when we decide to join our friends for chess classes. Presentation of this new stimulus can, in turn, influence our mental processes in that we learn how to play chess. This learning can further be assumed to have some neural correlates at a biological and cellular level in the brain, such as the making or strengthening of new synaptic connections, shifts in patterns of activity within larger brain networks, and accompanying changes in biological functions, such as increased blood flow in certain areas of the brain (Gazzaniga et al., 2009). When it comes to the example of chess playing, one can even assert that continual chess practice can produce structural changes in the brain in terms of alterations in the shape and size of its component parts (environment → behaviour → mind → brain). These examples illustrate how there appear to be *bi-directional* relationships between brain, mind, and behaviour (brain ←→ mind ←→ behaviour), and also that environmental and social factors are significant factors of influence in this relationship (Blakemore, Winston, & Frith, 2004; Howard-Jones, 2010).

This insight from cognitive neuroscience and educational neuroscience presents an understanding of the mind-brain relationship incompatible with dualism or monism, because neither the brain, nor the mind, is given explanatory supremacy. It is instead argued that mind and brain must be understood *together,* since there appears to be an intimate relationship – or set of relationships – between the brain, the mind, and behavioural and environmental aspects

(Bakhurst, 2009; Cigman & Davis, 2009; Goswami, 2009; Howard-Jones, 2008). This further conflicts with certain time-honoured hypotheses related to *learning*, like the hypothesis that our brain is fixed at birth and that experience can only fine-tune it, or that our brain is a blank slate at birth and thereafter is totally at the mercy of its environment. In contradiction to these two hypotheses, findings from neuroscientific and educational neuroscientific research provide a third hypothesis concerning the mind, the brain, and aspects of learning, by stating that parts of our brains are plastic and thus the brain changes as it learns, forgets, invents, plans, and makes decisions (Blakemore & Frith, 2005a; Gazzaniga et al., 2009). The hypothesis offered by cognitive neuroscience can therefore neither be consistent with genetic nor with environmental determinism, because theories about the 'plastic brain' cannot solely be attached to either nature-explanations or nurture-explanations. Precisely *how* this relationship or set of relationships between mind, brain, and learning should be understood is still vague, but indications that our brain is influenced by biological factors in interaction with social, contextual, behavioural, cognitive, and environmental factors suggest that the relationship is entrenched in complex and dynamic processes of transformation and change.

Philosophies of science for educational neuroscience

So far, I have shown that there are certain underlying philosophical difficulties related to the enterprise of linking education and neuroscience − both with regard to uncertainty about how the mind-brain relationship ought to be understood, and with issues arising due to disciplinary differences in epistemologies, theories, methods, and definitions of concepts such as 'learning'. Inevitably, such disciplinary differences will lead to challenges, for instance in the attempt to move *from* biological descriptions at microbiological level in the individual brain *to* descriptions of classroom practice at macro-social level (or vice versa) (Howard-Jones, 2008). Educational neuroscience therefore gains some of its complexity from its endeavours to integrate perspectives across different levels of analysis, where these levels of analysis not necessarily are related to one another (Stein et al., 2009). With regard to these discursive dissimilarities, Howard-Jones (2008, p. 362) also notes that "those who attempt to work at the interface of neuroscience and education will find themselves straddling at least two, very different, philosophies about learning, each expounding a very different set of concepts". This is particularly made clear in the notion that cognitive neuroscience can be allocated to realistic philosophies of science, whereas education is more in line with notions of relativistic philosophies such as constructionism (Samuels, 2009). Philosophical issues therefore lie at the very heart of educational neuroscientific work and, following critical discourse theories, one can assume that the ways in which these disciplinary and conceptual relationships are understood, will influence knowledge, research approach, and practice in the discourse. Overall, I will thus argue for the importance of finding a philosophical approach which can be seen to be compatible with addressing the philosophical issues mentioned above, as well as being compatible with education and cognitive neuroscience, but *without* reducing one to the other. In order to address these issues, I present in the following section, three philosophies of science related to educational neuroscience. Two of the philosophical approaches − namely realism and relativism − are associated with neuroscience and education respectively, whereas the third account of critical realism is presented since I consider that it can offer a possible mutual philosophical basis for education and neuroscience.

The problem linking realistic philosophies with educational neuroscience

Different schools of thoughts exist within philosophies of science, and their borders often overlap, since many share similarities, despite being separated by essential nuances. Certain overarching categorisations of philosophical traditions can be drawn, though, and one of these is between *realism* on the one side and *relativism* on the other – or, expressed another way, between 'naturalism' and 'hermeneutics' (Bhaskar, 1998), between 'essentialism' and 'postmodernism' (Alvesson & Sköldberg, 2010), between 'materialism' and 'idealism' (Campbell, 2011), between 'objectivism' and 'subjectivism' (Molander, 2003), between 'empiricism' and 'rationalism' (Samuels, 2009), between 'positivism' and 'constructivism' (Kjørup, 2008). The list is long and "much of the history of the philosophy of the social sciences can thus be seen as a kind of historical see-saw, an oscillation to-and-fro between variants of these basic positions" (Bhaskar, 1998, p. 18)[6]. As well as having different names, what can be seen to separate these scientific positions are ontological and epistemological perceptions, as each tradition has a different understanding of 'what *is*' and 'our *knowledge* about it'. These essential questions have manifested themselves particularly with regard to the

[6] A word of caution is necessary, because this is indeed a crude alignment of scientific positions and one may disagree to such a simple divide. Some will probably argue against grouping these positions at the *same* side of 'the gap'; others may frown upon locating positions at *different* sides. Kjørup (2008), for instance, notes that one can find similarities between positivism and constructivism, and will probably reason against a clear-cut division between the two. I am usually cautious about drawing lines between either *this* or *that*, nevertheless, in order to address central problems related to philosophies of science for educational neuroscience, such rough categorisation of 'the two camps' ought to be made.

essence of natural science and social science, and whether or not the human domain can be studied in the same way as natural sciences. As Roy Bhaskar notes:

> *[T]o what extent can society be studied in the same way as nature?* Without exaggerating, I think one could call this question the primal problem of the philosophy of the social sciences. For the history of that subject has been polarized around a dispute between two traditions, affording rival answers to this conundrum. A naturalist tradition has claimed that the sciences are (actually or ideally) unified in their concordance with *positivist* principles, based in the last instance on the Humean notion of law. In opposition to positivism, an anti-naturalist tradition has posited a cleavage in method between the natural and social sciences, grounded in a differentiation of their subject-matters (Bhaskar, 1998, p. 1).

In this note, Bhaskar pinpoints the same 'gap' as occurs to educational neuroscience. In order to address this gap, and to determine how educational neuroscience can be situated in relation to it, an account of the philosophical tradition of *realism* is appropriate.

What first can be noted with regard to realism is how this tradition underlines the importance of 'the real'. In a sense, every philosophy is some kind of realism[7], but some philosophies will be more realistic than others depending on how the particular philosophy defines 'the real' in contrast to 'the apparent' or 'the known'. Strong realism, for instance, will claim that "what is known would be real whether or not it were known: something may be real without appearing at all" (Collier, 1994, p. 6). In other words, such philosophies of realism will understand something as real, independently of whether or not it is observed. Viewed historically, this tradition of philosophies is represented by classical empiricism and Humean tradition, and is, essentially, based on Hume's claim that "there is nothing outside an individual's perceptions/experience ... the only reality we can legitimately refer to is that which can be experienced" (Patomäki & Wight, 2000, p. 219). Bhaskar elaborates further on this philosophical tradition of realism by noting that:

> According to [...] *classical empiricism,* represented by Hume and his heirs, the ultimate objects of knowledge are atomistic events. Such events constitute given facts and their conjunctions exhaust the objective content of our idea of natural necessity ... As to this conception, science is conceived as a kind of automatic or behavioural response to the stimulus of given facts and their conjunctions ... Thus science becomes a kind of epiphenomenon of nature (Bhaskar, 2008, pp. 24-25).

Realistic ideas and notions from this Humean tradition have influenced later scientific positions, and philosophical stands such as actualism, positivism, naturalism, objectivism, and

[7] For positivists, for instance, sense-experience is real, whilst intersubjectivity or discourse is real for post-positivists. It is therefore said that every philosophical position is realistic; the question is rather what kind of realism one advocates (Collier, 1994; Patomäki & Wight, 2000).

materialism can, to a certain extent, be grouped with philosophies of realism (Bhaskar, 2008; Clegg, 2005; Collier, 1994; Kjørup, 2008).

However, philosophies of realism have met with censure, and criticism is particularly voiced by social scientists. For instance, it is argued that philosophies of realism – with their loyalty to naturalism, objectivism, and empirical observable notion of reality – tend to neglect the importance of social factors. One of the most common arguments against a strong realistic philosophy, such as that of positivism, is therefore that the *observed* reality is not all there is. There may be social factors and underlying structures, which cannot be observed in the positivistic sense, but which may nevertheless influence observable facets of reality (Alvesson & Sköldberg, 2010). Another critique, which builds on this, is that those holding positions based on realistic philosophy are inclined to claim that social factors can be studied in the same way as natural science. Andrew Sayer (2000, p. 4) notes this by criticising a positivistic account of philosophy and especially "its expectation that the social world could be shown to be a composite of a number of behavioural regularities which would eventually be described by social laws akin to those of natural science". Numerous people within academia, and particularly within social sciences, therefore censure strong philosophies of realism by arguing that they do not adequately address social factors.

Another critique of philosophies of realism – particularly those of classical empiricism, actualism, and positivism – is the critical realists' claim that realism commits 'the epistemic fallacy'. In order to exemplify such an epistemic fallacy, we can draw upon an account of actualism. Actualism is, according to Bhaskar, the most common form of realism in empiricist cultures, "for the view which, while asserting the reality of things and/or events and/or states of affairs, denies the existence of underlying structures which determine how things come to have their events, and instead locates the succession of cause and effect at the level of *events*: every time A happens, B happens" (Collier, 1994, p. 7). As with positivism and empiricism, one major problem with this position is its Humean view that "the only reality we can legitimately refer to is that which can be experienced" (Patomäki & Wight, 2000, p. 219). The critical argument is that our experience and perception – no matter how modified and devoid it is of social variables – will be a *social* or *personal* experience. Because is not science, intrinsically, embedded in human knowledge, social structures, and historical understandings? "[Empiricism] does not recognize", as Collier (1994, p. 72) notes, "that what we experience is determined not just by what is there, but by what we have already learnt. Hence it can take experience itself to be an authority above criticism, unaware of the way experience can confirm our prejudices, since we may see what we have been taught to see". In light of this, critical realists argue that human experience, to which much of the realistic philosophies of science are reduced, is bound up in epistemological notions of 'what we can *know*' and not necessarily of 'what there *is'*. Consequently, it is argued that followers of the Humean tradition and classical empiricism fall prey to the error of the epistemic fallacy since by deducing that 'we *know'* equates to 'it *is',* they are deriving ontological arguments from epistemological ones (Patomäki & Wight, 2000).

Realistic philosophies of science can be seen to be related to certain natural scientific disciplines such as neuroscience, although I will argue that issues arise if one links naturalistic, positivistic, and more realistic philosophies of science to the study of *educational neuroscience.* For instance, a positivistic approach to educational neuroscience can be problematic, considering that a common concern is that natural aspects are given more importance than the more social variables in positivism. By addressing educational neuroscience with a positivistic philosophy of science, one can accordingly risk devaluing social variables in favour of natural, biological, and neuroscientific aspects. A note by the critical realist Sayer (2000) on biological reductionism can in this respect be brought forth:

> Biological reductionism is an instance of what we have termed strong essentialism, in that it assumes a one-to-one correspondence between causal powers (including essences), and behaviour, and treats social phenomenon as reducible without residue to a biological substratum. It therefore shifts everything onto the nature side of the society/nature distinction … Strong social constructivism responds to biological reductionism by inverting this reduction, pulling everything onto the social side … There has thus been a shift from criticism of the naturalization of forms of social oppression to what seem to be attempts to write out nature as an extra-social or extra-discursive force altogether (Sayer, 2000, pp. 97-98).

Within the educational neuroscience community, it has been argued that such reductionism is problematic, and it is stressed that "difficulties [arise] from privileging explanations *either* in terms of brain functioning *or* in terms of psychological and social factors" (Cigman & Davis, 2009, p. 76). Acknowledging the importance of taking both neuroscientific *and* educational explanations into consideration in educational neuroscience, has therefore resulted in a common goal: to aspire to reciprocal collaboration between education and cognitive neuroscience (Ansari et al., 2012; Christodoulou & Gaab, 2009; Greenwood, 2009; Howard-Jones, 2008; Mason, 2009; Stein & Fischer, 2011). I will therefore argue that philosophies of realism which favour natural explanations over social explanations *cannot* be seen as compatible with educational neuroscientific research.

The problem in linking relativistic philosophies with educational neuroscience

Realistic ideas flourish in contemporary philosophies of science, but this broad philosophical tradition is often alleged to be a successor of Kant's transcendental idealism (Bhaskar, 2008). In contrast with the Humean tradition of realism, Kant counters Hume's scepticism of an external reality by suggesting *two* worlds – the world of phenomena and the world of noumena (Patomäki & Wight, 2000). The world of *noumena* is the site of reason and morality, whereas the world of *phenomena* is the world we can experience. However, in contrast to Hume, Kant does not consider the phenomenal world to be the 'real world'. This does not mean that Kant denies the existence of a real world; rather, he claims that we can know nothing of it. Kant's idealistic argument is that we cannot know what we cannot experience, and everything we experience is coloured by reason and memory. Hence, if there is definite scientific knowledge of the phenomenal world, then it emanates from our categories of understanding and *not* from the nature of the world itself (Patomäki & Wight, 2000). Kant's idealistic and relativistic philosophical ideas have had a major influence on numerous philosophies of science, and such classical thought has encountered some alteration and modification over the decades. Nevertheless, some broad characteristics can be noted: Relativistic philosophies of science, as opposed to realistic philosophies, can be said to uphold 'an interpretational' notion of science. Relativists are thus inclined to consider everything to be relative, because the world as we understand it, differs in accordance with different perceptions and interpretations, and social, historical, and cultural contextual factors may play a major role in our understanding of reality (Steinmetz, 1998). Epistemological notions of science are therefore at the heart of relativistic philosophies, since the main focus tends to be on aspects concerning 'how we come to have *knowledge* of something' – rather than an ontological focus, which seeks answers to 'what this something *is'*. This does not necessarily mean that every relativistic philosophy rejects an ontological reality, rather, the attention is first and foremost on epistemological notions of science, whilst ontological enquiries are set in brackets (Neumann, 2010). When understood in this sense, then, numerous philosophical approaches connected to the social scientific domain can be allocated to the relativistic stance – some of the most renowned being postmodernism, hermeneutics, idealism, subjectivism, structuralism, constructivism and social constructivism (cf. Alvesson & Sköldberg, 2010; Bhaskar, 2008; Campbell, 2011; Collier, 1994; Kjørup, 2008; Molander, 2003).

Even with relativism's strong foothold in contemporary philosophies of social sciences, this tradition has not avoided censure and criticism. Positions connected to relativism have, first and foremost, met with persistent critiques from more realistic and naturalistic positions, and much of this censure is due to relativism's neglect of ontological aspects. Idealism, for instance, has been criticised for its assertion that reality, or reality as we know it, is fundamentally a mental construct – it is argued that ontological aspects of the world are thus either trivialised or neglected in idealistic accounts (Collier, 1994).

> [W]hile many might readily accept that the physical world is independent of our knowledge of it, the idea that the phenomena studied by social science exist independently of our knowledge seems implausible, indeed as is particularly clear in subjects like the study of education and management, the researchers are likely to encounter the influence of their own theories *within* their object of study. It is therefore tempting to reject the realist position and argue that since social phenomena are concept-dependent, since they include social science itself, and since theories can influence social practice as well as respond to it, then the social world cannot be independent of our knowledge of it (Sayer, 2000, p. 33).

Similarly, relativistic positions relying on strong notions of discourse have been problematized. The heart of the difficulty is, again, the ontological aspect of such social structures, because "ontologically, if discourse do construct their own objects, then what constructed the discourse themselves?" (Patomäki & Wight, 2000, p. 217). Social-constructionism does not escape censure, and also constructivists' notions are considered to be inadequate due to their complete neglect of or, at best, their inattention to, ontological aspects. John Cromby (2004), for instance, criticises social-constructivism for not adequately addressing the embodiment of subjectivity. The material body tends to be omitted from constructionism, he argues, as the focus instead is on discursive forms and processes whereby a subject is displayed. Cromby (2004) argues that constructivism, by downplaying embodied materialism, conceals a Cartesian dualism since it implies that our world consists of nothing other than discourse. Yet again the critique seems to arise from a tendency to neglect ontology at the expense of epistemology.

Bhaskar also suggests that a critique of relativism could be achieved by designating issues to 'the epistemic fallacy'. Philosophies of relativism often claim that the only reality we can know is the reality which we can experience, but experience will inevitably emanate from categories of understanding and not from the 'real' world itself. The problem with this, critical realists argue, is that deductions are drawn from 'what we *know*' to 'it *is'* (Bhaskar, 2008; Collier, 1994). Epistemology and ontology are, in other words, tied together, because "what is known is what can be experienced and/or observed and what "is" is what can be known" (Patomäki & Wight, 2000, p. 217). In relativism, the real world 'out there' is, therefore, perceived to be intimately entangled with the world 'in here', which is considered to be problematic since ontology has been conflated with epistemology.

Relativistic philosophies of science can thus be seen as related to social sciences, and in particular, constructivism, which has a strong foothold within the educational discipline (Samuels, 2009). I will, however, argue that one is likely to encounter certain difficulties when linking the philosophical tradition of relativism to the study of educational neuroscience. It is particularly challenging to position aspects related to *neuroscience* within a philosophical frame of social-constructionism. "At first glance, any synthesis of constructionism and neuroscience appears to flounder upon a fundamental incompatibility" Cromby (2004, p. 801) notes, "which, in large part, derives from the common understanding of social constructionism's emphasis on discourse, its denials that reality is accessible in direct and unmediated ways, and its consequent focus upon the social processes whereby knowledge is generated, legitimated and circulated". In view of this, social-constructionism cannot be said to offer an advantageous philosophical framework for studying educational neuroscience, because it appears to favour epistemological aspects of reality at the expense of ontological ones, by denying that reality is accessible in direct ways. A tendency to give more weight to epistemological aspects is evident in social sciences, and numerous ideas, theories, and methodological procedures incorporate such constructionist ideas. For instance, the following statement explains how many constructionists understand embodied subjectivity and materiality.

> Many constructionists simply do not theorize or study subjectivity, focusing instead on the discursive forms and processes whereby it is displayed, managed and made to serve functional goals ... [E]ven where subjectivity is theorized, it is often somewhat disembodied, in that the particularities of the body are disregarded, downplayed, added in later, or made adjunctive to other supposed mental-linguistic entities or processes. Hence the body tends either to be omitted from constructionism, or only to appear as surface of inscription, metaphor or text – rather than as a fleshy organ bearing both enablements and constraints (Cromby, 2004, p. 798).

With regard to the discipline of educational neuroscience, I will argue that downgrading the embodied materiality of human existence to mere language and discourse constitutes a significant problem. This is because educational neuroscience addresses issues at the borderline between mind and body, and between the social and the natural (biological). Both natural and social explanations should be considered relevant, and emphasis on the discursive-social at the expense of the embodied-material will indeed impede reciprocal collaboration between the two disciplines of education and neuroscience. Furthermore, as noted by Cromby (2004), social constructionism *conceals*, rather than addresses, Cartesian dualism, since it consistently conflates discourse and materiality. Drawing parallels with what has previously been noted concerning the error of conducting epistemic fallacies, in addition to the drawbacks of holding on to a Cartesian mind-body dualism, relativistic philosophical traditions, such as constructionism, can indeed be considered to be inadequate when studying aspects pertaining to educational neuroscience.

Overall, I will argue that realistic and relativistic philosophies of science are insufficient frameworks to ground research in the interface of education and neuroscience. By taking a position of social constructivism, certain natural scientific premises such as biological aspects of the living brain, are inadequately considered, because social constructivism tends to have its preliminary focus on epistemological doctrines of socially construed understanding. If, on the other hand, one uses a philosophical position of realism, social aspects, such as meaning-making and underlying discursive structures, are liable to be given less consideration than more existential aspects such as neural biochemical processes in the brain. The general argument is, in simple terms, that neuroscience will call for naturalistic approaches, just as society must be described in terms of social categories. I will furthermore argue that a philosophy of science compatible with studying educational neuroscience must go beyond the two disciplines and their respective philosophies of science, because transdisciplinary educational neuroscientific research attempts to *combine* both naturalistic and social scientific aspects of study. Social, cognitive, and biological accounts are therefore important, and one must endeavour to achieve a common philosophy which neither reduces education, nor neuroscience. A similar note is stressed by Samuels;

> Because both science and education have relied on different epistemologies, it might be expected that efforts to bridge the fields would necessitate understanding these epistemic differences. A simple bridge between two epistemologies is not likely to be sufficient, however. Increasingly, traditional conceptualizations of knowledge are being questioned ... The question of what knowledge is, what "the

> mind" is, and what relation the brain has to these elements are questions beyond the realm of any one discipline and promise to be contentious and exciting for many years to come … Assuming that everyone shares the same epistemology is unrealistic and treating the differences as if they do not matter is either naïve or arrogant (Samuels, 2009, p. 49).

In view of this note, I am tempted to ask if perhaps critical realism holds perspectives which include, but go beyond, traditional conceptualisations of epistemology and ontology, and thus may suggest a philosophical foundation for educational neuroscience.

Critical realism and educational neuroscience

In my doctoral study of educational neuroscience, I consider it essential to take a philosophical and scientific approach which makes allowances for, without giving predominance to, i) neuroscientific ideas, wherein existence of real objects is essential, and ii) central educational and social scientific premises, wherein, for instance, the idea of underlying social and discursive structures is essential. In view of this, it appears that *critical realism* presents a possible framework for a critical discourse analysis of educational neuroscience. Furthermore, there is another motive behind this task of problematizing current philosophical accounts, and my attempts at investigating an appropriate philosophy of science connected to educational neuroscience research. Within the discipline of educational neuroscience, there is a general agreement that the 'gap' between education and neuroscience creates difficulties at a practical, theoretical, and philosophical level (Varma et al., 2008). Advocates for educational neuroscience do, accordingly, endeavour "to bridge the gap" by reciprocal collaboration, voicing possible solutions to the difficulties encountered in this attempt. However, it appears that much work to date has addressed theoretical and practical levels − what seem to be absent, though, are accounts of explicit philosophies of science that can provide possible philosophical grounding for educational neuroscience research. It is as if practical and theoretical explanations are easier to sustain, in contrast to philosophical support for bridging the gap between natural and social sciences. However, and in my view, a philosophical account for a bridge between the two domains of natural and social sciences is crucial. Because on what philosophical ground can the discipline of educational neuroscience base its theories and practices upon, if it is a philosophical cast-off in both social sciences and in natural sciences?

Again, it must be stressed that this chapter is meant to be an open and investigative approach to a philosophy of science appropriate for studying educational neuroscience. Thus, although I am inspired by critical realism in my critical discourse analysis on educational neuroscience, this does *not* imply that I would consider critical realism to be *the ultimate* philosophical 'bridge' that could be built between domains of education, cognitive psychology, and neuroscience. That said, critical realism seems to provide an alternative way of perceiving ontological and epistemological questions as opposed to that of many realistic and relativistic philosophies of science. The following chapter thus presents an account of the critical realistic philosophy of science, before I go on to relate this to educational neuroscience.

Critical realism

Critical realism, the philosophy of science suggested by Roy Bhaskar, has increased its prominence in academia, during recent decades, and its augmented recognition is particularly evident in the human and social sciences. "It is a recurring theme in Bhaskar's work that the human sciences have been misled by a positivist misunderstanding of the natural sciences; and this has been the basis of several valuable interventions of transcendental realism in the work of the human sciences" (Collier, 1994, p. 102). Increased interest in critical realism has continued, as numerous academics take on board Bhaskar's ideas and elaborate on them with regard to their own disciplines – in economics (Fleetwood, 1999; Lawson, 1997), in law (Norrie, 2010), in social studies regarding human reflexivity and social mobility (Archer, 1995), in sociology (Sayer, 2000), in geography (Pratt, 1995), in historical sociology (Steinmetz, 1998), in organisation theory (Tsang & Kwan, 1999), in information systems (Mingers, 2004), and in critical discourse analysis (Fairclough, 2010; Fairclough et al., 2002). One reason for this acknowledgment can be that critical realism is seen as a philosophy of science that offers an alternative to social-constructionism (Alvesson & Sköldberg, 2010). Another reason is that it proposes a viable alternative to positivism and post-modernism (Bhaskar, 1998). Collier points to similar notions:

> Bhaskar's account of social scientific work can be highlighted by contrast with the two main rivals, positivism and hermeneutics … Like hermeneutic theorists but unlike positivists, he holds that the study of any social practice must start with the agents' conception of it. But unlike the hermeneuticist and like the positivist, he holds that social science can go on to refute these conceptions. He holds social

> explanation to be both causal (as does the positivist) and interpretive (as does the hermeneuticist), denying their shared premiss that these two notions will not cohabit. And he rejects their shared acceptance of a Humean account of causality (Collier, 1994, p. 167).

In brief, the philosophical position of critical realism can be located in-between the relativistic stance (viz. hermeneutics, constructivism, and idealism) and the realistic stance (viz. positivism, empiricism, and naturalism). It neither completely refutes its neighbour's ideas, nor fully agrees with them. In this respect, it should also be mentioned that Bhaskar's critical realism is not necessarily unique in its criticism of realism and relativism, and it can thus be seen as one approach in a larger philosophic and scientific movement. When it comes to the questions of *which* alternative views critical realists are actually proposing, the following sections will present accounts of some of the critical realistic concepts.

The epistemic fallacy

It is appropriate to start with an account of what Bhaskar calls '*the epistemic fallacy*', since this is a central nexus, from which critical realism's overarching critique against strong realistic and relativistic philosophies follows. Under the headline 'the status of ontology and its dissolution in classical philosophy', Bhaskar (2008, p. 36) notes that "the 'epistemic fallacy' … consists in the view that statements about being can be reduced to or analysed in terms of statements about knowledge; i.e. that ontological questions can always be transposed into epistemological terms". In other words, it is argued that certain issues arise when one makes epistemic questions *prior* to ontological ones, because one will commit a logical misjudgement deducing from 'what we *know'* to 'what there *is'*. Critical realists thus claim that epistemic questions are, in a sense, secondary to ontological ones. The argument for this claim is, as Collier (1994, p. 137) summarises, because "knowledge exists as an aspect of our being in the world, and before we can know what we know, we need to have some idea how we interact with that world in such a way as to acquire knowledge of it".

According to critical realists, the epistemic fallacy has been committed in the philosophy of science for decades and "since Descartes, it has been customary first to ask how we can know, and only afterwards what it is that we can know" (Collier, 1994, p. 137). As Collier further argues, the problem is that this Cartesian ordering of reality has had significant influence on western philosophies and thus contributed to the prevalence of the epistemic fallacy. The tendency of letting questions concerning 'how we can *know'* determine our concept of 'what there *is'* have therefore become a recurring feature in philosophies.

> In fact the epistemic fallacy pervades not only classical empiricism, where it originates (though Descartes must take much of the blame for setting philosophy off in this direction), but also Kant, the absolute idealist, Schopenhauer, Nietzsche, pragmatism, logical positivism, linguistic philosophy, poststructuralism, and, in a rather different form, phenomenology and existentialism (Collier, 1994, p. 76).

By asserting that the majority of western philosophers have subscribed to the epistemic fallacy, Bhaskar justifiably stresses that these great philosophers have not deliberately committed what critical realists see as logical misjudgements. The problem is rather that this scientific error of concluding from 'we *know'* to 'it *is'* has to date dwelled *un*recognised in academia. Collier stresses this, by noting that "[t]his shift is so common in the philosophy of the last three centuries that it often goes unnoticed, and it is an important achievement of Bhaskars's philosophy to pick it out, name it, and (I think) refute it" (Collier, 1994, p. 76).

Bhaskar argues that the epistemic fallacy is a significant error committed by many of the western philosophies of science, and that one should therefore avoid deducing from 'we *know*' to 'it *is*'. An alternative way to avoid subscribing to this common fallacy is, as Bhaskar (2008) further asserts, to be clear about the distinction between 'experience' and 'existence', and thus open up the possibility of a law-governed world *in*dependent of man.

> *[T]ranscendental realism*[8]... regards the objects of knowledge as the structures and mechanisms that generate phenomena; and the knowledge as produced in the social activity of science. These objects are neither phenomena (empiricism) nor human constructs imposed upon the phenomena (idealism), but real structures which endure and operate independently of our knowledge, our experience and the conditions which allow us access to them. Against empiricism, the objects of knowledge are structures, not events; against idealism, they are intransitive (in the sense defined) ... According to this view, both knowledge and the world are structured, both are differentiated and changing ... On this view, science is not an epiphenomenon of nature, nor is nature a product of man ... Only transcendental realism, I will argue, can sustain the idea of a law-governed world independent of man (Bhaskar, 2008, pp. 25-26 [my footnote]).

In order to further explain his philosophical idea, Bhaskar promotes the concepts of *transitive* and *intransitive objects,* the notion of *mechanisms*, the idea that both nature and science are *stratified,* and the notions of *causal powers* operating at different levels.

[8] Transcendental realism is Bhaskar's term for his general philosophy of science. This idea, in addition to his concept of 'critical naturalism' – his philosophical concept of the human sciences – make up the overarching concept of 'critical realism'.

Transitive and intransitive objects

Critical realists understand "objects of knowledge" as structures and mechanisms existing *in*dependently of man. As such, it is argued that an ontological aspect is maintained without reducing aspects of reality to i) our experiments or our perceptions (as with empiricism and positivism), nor reducing it to ii) epistemological notions of thoughts (as with ontological constructivism and idealism) (Bhaskar, 2008). Therefore, in agreement with critical realism, a tree is a tree which will continue to exist in this world *regardless* of there being humans who either i) *observe/experience* this tree, or ii) *think* about this green leafy thing. To define and clarify this philosophic notion, critical realists use the terms intransitive and transitive objects. *Intransitive objects* are objects which exist independently of science and of man. Intransitive objects can, as such, be seen as an ontological notion of existence. *Transitive objects*, on the other hand, are embedded in philosophical sociology and epistemological notions of existence, as these objects are related to human thinking and perceptions (Bhaskar, 2008).

> '[T]ransitive object' refers to the state of scientific knowledge at any time, and the 'intransitive object' to the object which exists independently of science, which the science is about ... However much science deepens its knowledge of its *intransitive object,* its product remains a transitive object. This last point enables Bhaskar to allow quite a lot of scope for 'the sociology of knowledge', explanations of scientific results as produced by mechanisms quite extraneous to the project of our deepening our knowledge of nature. But it saves his theory from the ontological relativism that is often inferred from such social studies of science. Rival scientific theories necessarily have different transitive objects, or they would not be different, but they are not about different worlds (Collier, 1994, pp. 51-52).

Distinctions between transitive objects and intransitive objects are thus essential concepts in critical realism, as they allow for ontological accounts of reality independent of man, in addition to epistemological notions pertaining to social factors and human knowledge in science.

Mechanism

Another prominent aspect in critical realism, closely related to transitive and intransitive objects, is *mechanism*. According to Bhaskar (2008), reality can be understood in three domains – the domain of 'empirical', 'actual', and 'real'. The 'domain of empirical' comprises only experiences, 'the actual' also includes events, whereas the 'domain of real' additionally encompasses mechanisms. By separating 'the world' into these three categorisations, critical realists argue that they avoid condensing ontology into experience and thus prevent a foundation vulnerable to the epistemic fallacy (Bhaskar, 2008; Clegg, 2005).

	Domain of Real	Domain of Actual	Domain of Empirical
Mechanisms	√		
Events	√	√	
Experiences	√	√	√

Table 2.1: The three domains of the real, after Bhaskar (2008).

The 'domain of real' can be seen to encompass experiences, events, and mechanism, and mechanism used in this sense refers to 'mechanism generating an event'. It is not necessarily an indication of a mechanical mechanism, rather, it "is that to which a law refers" (Collier, 1994, p. 43). Furthermore, what separates critical realism from numerous structuralist philosophies is that mechanisms are understood as *real entities*. This implies that mechanisms – being an animal instinct, an economic tendency, or a syntactic structure – are *not* understood as mere 'theories' or 'logical constructs'; mechanisms are instead alleged to be real. By emphasising mechanisms and their causal criteria of reality, critical realists argue that they once again avoid the fallacy committed by numerous empiricists.

> Theories which relegate mechanisms to a lower ontological league, as 'theoretical entities', 'logical constructs', etc., are refusing to allow causal criteria for reality – i.e. they will only let something through the ontological customs office if it is a possible object of experience. Yet *within* the level of the Actual we are employing causal criteria all the time, and would never get out the Empirical if we did not: when we find the garden muddy in the morning, we assume a real rainstorm, though we slept through it; a murder-victim implies a murderer, even though one might never be identified. Rainstorms and murderers are possible objects of experience, but their existence is in these cases asserted on causal criteria only, since they are not 'experiences' in the sense of perceived. Why should we not likewise allow that mechanisms are real, though unperceived? (Collier, 1994, p. 44).

As indicated earlier, the point is that numerous philosophies of science tend to let human perception, experience, or language and thoughts determine what *exists*. By introducing the concepts of the three domains, the idea of mechanism as real entities, and the terms transitive and intransitive objects, Bhaskar makes an attempt to break with common epistemic and ontological assumptions held by dominant philosophies of science.

Nature as an open and stratified system

Two critical realistic concepts which also ought to be elaborated on are Bhaskar's idea that nature is an 'open system' and, furthermore, that it is 'stratified'. Nature being an open system refers to the concept that one cannot perceive natural settings as 'closed', where only one mechanism alone operates (Bhaskar, 2008). In other words, a closed system is one where a genuine causal mechanism is isolated and where one therefore finds occurrences where 'every time A occurs, B follows', as in Humean causality. It is argued that open systems exist almost everywhere outside meticulous laboratory setups and experimental conditions, and here one cannot find Humean causalities because ordinary observable events are not invariably preceded by any other constantly connected event (Collier, 1994). Dark skies are not always followed by rain, and excessive amounts of reading homework for a child are not always followed by improved learning, because nature is a messy and complex system where numerous mechanisms occur simultaneously. This is important to consider in research.

Notions of nature as an 'open system' in addition to the concept of 'mechanism' have led critical realists to the argument that nature consists of *multiple strata.* In this respect it is essential to remember that it is *mechanisms*, not things or events, that are stratified.

> [T]here is a multiplicity of mechanisms in nature. If there were a single mechanism only, there would be a naturally closed system, and passive observation would be enough to establish laws (or *the* law) of nature ... [T]hese mechanisms are, so to speak, *layers* of nature, and are *ordered*, not just jumbled up together ... It appears that the material universe existed before there were organic life, and that living organisms can only exist as composed of and surrounded by matter. In this sense, matter may be said to be more 'basic' than life; life in turn may be said to be more basic than rationality (in the sense that we are rational animals), and hence than human society and its history. This suggests that the sciences that explain a more basic layer may have some explanatory primacy over those explaining a less basic layer (Collier, 1994, pp. 45-46).

The philosophy of critical realism thus implies that different aspects of nature, and their related sciences, can be ordered in accordance with 'levels of strata'. As a consequence, critical realism has often been criticised for its realistic and naturalistic emphasises. It has even been claimed that Bhaskar's philosophy is in danger of committing the same error as positivists did – namely mistakes of *reductionism*. The accusation is understandable, because Bhaskar's logic could readily be considered as an argument where, for instance, a biological stratum is perceived to be more 'basic' and thus has 'some explanatory primacy' over less basic strata, such as education. However, and this is noteworthy, critical realism should not be considered as a reductive philosophy of science, because it has been repeatedly stressed that it is "impossible to reduce social to natural, or indeed social to psychological or psychological to social, or either to biological, or biological to physical, and so on" (Collier, 1994, p. 242). Lower generative mechanisms can therefore explain *without* replacing the higher level such as the level of the societal.

With regard to levels of strata, in addition to the view of different domains of the empirical, the actual, and the real, it is essential to elaborate more on the relationship between such strata. How do critical realists perceive the relationship between, for instance, human agency, causal power, and change? If the level of the natural can explain the societal, when the social is not reduced to natural explanations, then what kind of power do social aspects and human actors possess?

> Society is an emergent stratum – societies are governed by social laws not natural ones, and may to a degree control by their organization the mechanisms presupposed and the forces generated by social existence ... [A]s individual agents we have powers which are not reducible to, but emerge from, biological and social ones (Collier, 1994, p. 120).

As a response to this, Patomäki and Wight (2000, p. 230) further note how "every social act, event, or phenomenon is only possible insofar as the conditions for action exist as well as the agents which act; conditions which, we argue, are real and not reducible to the discourse and/or experience of the agents". Such an argument implies that discourse, for instance, ought not to be reduced to 'nothing more than a discourse' since, at least in part, the discourse is dealing with something real. Acknowledging that social structures are real social factors such as ideas, political paradigms, and ways of thinking, can also be seen to produce *change* (Sayer, 2000). This is noteworthy, as critical realism thus stresses the powers of structures and agencies.

Causation

The last concept to be elaborated on is the critical realists' concept of *causation*. As we have seen, critical realism assumes a stratified ontology where a distinction is drawn between the 'real', the 'actual', and the 'empirical', and this in turn can be linked to causal powers.

> [T]he 'real' is the domain of structures and their associated 'causal powers'; the 'actual' is the domain of events and processes; the 'empirical' is the part of the real and the actual that is experienced by social actors. The 'actual' does not in any simple or straightforward way reflect the 'real': the extent to which

> and ways in which the particular causal powers are activated to affect actual events is contingent on the complex interaction of different structures and causal powers in the causing of events. Causal powers, moreover, are now exclusively the properties of structures: social agents also have causal powers which affect the actual (Fairclough, 2010, p. 355).

Critical realists thus interpret 'causation' as being a complex phenomenon which operates at different levels. This implies that when an event occurs, critical realists perceive it as being a result of a complex interplay between different causal factors. At the same time, complex relationships between causal factors make it difficult to understand the relationship between *cause* and *effect*. Since causes are interlinked, they will arguably be difficult to isolate without distorting and reducing the real world's complex nature. It is therefore essential to be careful when deducing effects from certain causal factors, since causality in the open and stratified reality is a complex phenomenon. Critical realists thus argue that one can *substantiate* that something will happen as a result of certain causal factors, but one cannot *predict* it with a hundred per cent certainty (Kleven, Hjardemaal, & Tveit, 2011). By asserting this, critical realism differentiates itself from standard Humean cause-and-effect deduction. "One of the most distinctive feature of realism is its analysis of causation, which rejects the standard Humean 'successionist' view that it involves regularities among sequences of events" (Sayer, 2000, p. 13). Humean regular conjunction of cause events and effect events is seen to be valid only in controlled and closed experimental setups, since a researcher under such circumstances is able to say that 'every time A occurs, B follows'. The problem, however, is that such closed systems rarely occur in natural settings. Critical realism thus discards the Humean law of causality, on the grounds that it does not adequately address natural occurrences in the open and stratified reality.

> Causation is about what produces change (the activation of causal powers) not about (whether observers have registered) a regular conjunction of cause events and effect events. Hence, regularities are not necessary for explanation, whether of physical or social phenomena. Even where we do find regularities they still have to be explained in terms of what produces them. Thus critical realism rejects the Humean, constant conjunction view of causation (Fairclough, 2010, p. 205).

With regard to critical realists' perception of causality, it should also be noted that critical realism views "objects as structured and as having particular causal powers or liabilities" (Fairclough, 2010, p. 204). This implies that objects are able to act in certain ways or go through certain changes. Arguably, these powers often exist in dormant form, but they can be triggered in certain situations. Furthermore, it is stressed that if and when these powers are activated, the effects depend on the *context* (Fairclough, 2010). Again, critical realists refer to the complex nature of reality as open and stratified, asserting that cause and effect cannot readily be predicted based on a simple 'A thus B' causation.

The critical realistic account of a philosophy of science is both encompassing in its themes and complicated in its argumentation. To explain the entire philosophy in more depth as well as reviewing criticism of the position of critical realism, would be beyond the scope of this dissertation[9]. Nonetheless, some aspects will be further explained in the following section, where an attempt is made to link critical realism to the discipline of educational neuroscience.

Critical realism as a possible philosophy of science for educational neuroscience

As previously noted, the discipline of educational neuroscience encounters difficulties with regard to 'the gap' between education on the one side and neuroscience on the other (Campbell, 2011; Goswami, 2009; Howard-Jones, 2008; Samuels, 2009). Attention is therefore given to bridging the practical and theoretical aspects of this cross-disciplinary endeavour, but crafting an explicit philosophical bridge seems to have been slightly neglected. In order to address this issue, I will suggest the philosophy of critical realism as a possible philosophical foundation for educational neuroscience research. First of all, I propose this link between critical realism and educational neuroscience because I think critical realism addresses some philosophical conundrums at the very heart of my doctoral project − and thus perhaps other projects at the interface of education, cognitive psychology, and neuroscience as well. Secondly, I argue for this link because I think the discipline of educational neuroscience lacks a profound philosophical foundation for its transdisciplinary work. I am suggesting critical realism only as a possible framework, and do not consider it to be the only viable philosophical position which can make strong links between education and neuro-science.

What can first be noted in this respect is that a connection between social studies and critical realism is not a new idea and several disciplines within the social sciences have

[9] For more copious literature on critical realism see Bhaskar's original work (1986, 1998, 2008), Collier's (1994) introduction to Bhaskar's work, Sayer (2000) on critical realism and social science, and Fairclough (2010) on critical realism and critical discourse analysis.

already been linked to a critical realistic philosophy of science[10]. Education is no exception and Brad Shipway (2011), in particular, notes the potential and uptake of critical realism in education:

> [C]ritical realism 'appears to have gained momentum in social theory, its fortunes seemingly inversely related to the demise of postmodernism' (...) With the turn of the millennium, the 'uptake' of critical realist perspectives in education has grown rapidly, with some authors deliberately deploying Bhaskar's concepts while others indicate a more latent, or tacit use of critical realism as they go about their work across education's various domains (Shipway, 2011, p. 2).

Critical realism's advance within the educational field notwithstanding, not much has been written about the possible connection between critical realism and the discipline of *educational neuroscience*[11]. I will therefore draw attention to what I consider to be possible connections between the two.

One argument for suggesting a critical realistic foundation for educational neuroscience follows from critical realism's repeated censure of 'the epistemic fallacy'. By stressing the importance of not falling for the epistemic fallacy − i.e. deducing from 'we *know'* to 'it *is'* − critical realism has positioned itself as a philosophy of science that is careful *not* to conflate ontology into epistemology. With reference to the discipline of educational neuroscience, I will argue that this is essential in that it can aid educational neuroscientists arguing for the importance of considering cognitive neuroscientific aspects in educational matters. This is because by taking a critical realistic perspective, one will be careful not to overly emphasize social and educational variables (epistemology) at the expense of more embodied and material aspects such as neurobiological processes in the brain (ontology). This implies, for instance, that researchers studying the social and interacting child, who develops and learns within an educational and socio-cultural discourse, must also remember that our development and learning are influenced by neurobiological processes such as changes in synaptic strength in neural networks which, in turn, may be impaired by chronic high stress[12]. Natural and biological aspects within the brain can therefore be seen to be interlinked with social aspects such as prolonged stressful environments (environment → brain), but

[10] This can, as previously noted, be seen in the work by Archer (1995, 2000); Fairclough (2010); Fleetwood (1999); Mingers (2004); Norrie (2010); Pratt (1995); Steinmetz (1998); Tsang and Kwan (1999).

[11] Personally, I have not come across any literature or references concerning this explicit linkage between educational neuroscience and critical realism.

[12] Neuroscientific research has shown that both physical and psychological stress triggers the release of cortisol which, in turn, can activate glucocorticoid receptors in the CA1 region in the hippocampus – a region in the brain important in the consolidation of episodic memory. It has further been shown that cortisol in small quantities can increase attentiveness and aid learning. Chronic high stress, however, has disadvantageous effects on cognitive functions such as impairment of episodic memory (Gazzaniga et al., 2009).

impairment of cognitive functions such as memory can also be seen to influence an individual's ability to learn and interact in educational settings (brain → mind → behaviour → environment). A focus on such complex and bi-directional relationships between environments, behaviour, mind, and brain is essential within the educational neuroscientific community, and I will suggest that critical realism can help to craft a philosophical argument for attentiveness to both ontology *and* epistemology in these matters.

Distinguishing epistemological notions from ontological ones does *not* imply that critical realists consider biological factors to be more important than more social explanations. As previously noted, critical realism asserts that the world can be seen as 'stratified', since different mechanisms are ordered in different 'layers of nature'. Furthermore, even if critical realism suggests that more basic layers have some explanatory importance over less basic layers, it stresses that a layer can *never* be reduced to another layer. Lower generative mechanisms, such as biology, can therefore provide explanations without replacing higher levels, such as societal levels (Collier, 1994). In my view, critical realistic perspectives on different natural and scientific strata are essential with regard to the discipline of educational neuroscience as well as their emphasis on *non*-reductionism. A frequent criticism of educational neuroscientists is that they subsume educational aspects under the regime of neuroscience (cf. Varma et al., 2008). Such criticisms of reductionism can, however, be considered to be unwarranted. An emphasis on educational and social explanations is evident in the work of educational neuroscience, and even within the neuroscientific branch, as research pertaining to social cognitive neuroscience plays a significant role in the attempt to understand the relationship between the social and the neurobiological (Blakemore et al., 2004). Condemnation of reductionism can therefore be seen as a misunderstanding because a central goal in the educational neuroscience community appears to be the crafting of reciprocal collaboration where *neither* education *nor* neuroscience is reduced under the influence of the other (Ansari et al., 2012; Christodoulou & Gaab, 2009; Greenwood, 2009; Howard-Jones, 2010; Mason, 2009; Stein & Fischer, 2011). In this respect, once again I will argue that educational neuroscientists can find answers in critical realistic philosophies of science. Not only does critical realism provide arguments for *why* neuroscientific explanations are important in the educational domain, but it also argues for a *non-reductive* perspective on science in its focus on stratified nature and its mechanisms.

Moreover, critical realism asserts that different levels of 'strata' – such as those of education and of neuroscience – should be studied in different ways:

> Laws of human behaviour and of social processes will be distinct, and it will not be possible to reduce one to or predict one from the other. Each level is autonomous in the sense of having its own irreducible set of mechanisms, and distinct sciences using different concepts and discovering different laws will be required to study them (Collier, 1994, p. 117).

With the claim that the world is complex and stratified, and where each layer is irreducible albeit grounded in more basic layers, critical realists emphasise the uniqueness and complexity of each research object. Scepticism is therefore uttered about 'cookbook' prescriptions of method and one does instead argue that methods ought to be shaped around the object of study (Sayer, 2000). Different research objects will therefore require different modes of study, and transdisciplinary methods that follow different perspective of the natural and social world are thus claimed to be appropriate. A critical realistic perspective on educational neuroscience will therefore underline the importance of *not* using naturalistic methods to study the social – and not using social methods to study the natural. The critical realistic argument that different levels of strata require different methodological approaches, therefore seems to support educational neuroscientists' emphasis on attentiveness to the different levels of analysis which exist between the disciplines of education and cognitive neuroscience (Ansari & Coch, 2006; Berninger & Corina, 1998; Varma et al., 2008). These non-reductive perspectives therefore seem to be suggested in both the educational neuro-science discipline *and* in critical realism's philosophy of science.

In order to exemplify how critical realistic ideas about non-reductive levels of nature and science can help work within educational neuroscience, consider for instance the computer game *The Number Race* suggested by Wilson, Dehaene and colleagues (2006). This computer game is further elaborated upon in chapter 6, but to summarize, the game is based upon cognitive neuroscientific theories of number sense and symbolic representations, in order to help children with mathematical learning difficulties. In the design process, the research group made use of game design theories, data simulation, and learning algorithms in order to estimate how children would respond to the computer game. Not until the final stage were a small group of children introduced to the game − with the result that they found it boring, too easy, and unengaging (Howard-Jones, 2010; Wilson et al., 2006). One essential flaw in this project was that usage, views, and opinions from the children – for whom the computer game was ultimately designed − were not included in the essential stages of the research, and the computer game was thus programmed solely on the basis of game design theories and cognitive neuroscientific concepts. Moreover, I will also argue that use of this computer game was not analysed in a social and educational setting, such as a complex classroom situation. Unfortunately, this example is not unique as one can find numerous examples where educational, social, cognitive psychological, or neuroscientific aspects − practical or theoretical − have been neglected in research on education and neuroscience. Further elaboration of such instances will be presented later in the dissertation, but for now my argument is that a critical realistic approach to educational neuroscientific research would have helped prevent such neglect. This is because critical realism stresses that nature is stratified, and since each level has its own irreducible set of mechanism, distinct sciences with distinct concepts and laws will be required in order to study them (Collier, 1994). With respect to the example above − and to educational neuroscience research in general − this implies that neuroscience, with its relationship to biology, must be perceived as a more 'basic' layer than cognition, human behaviour, and social processes. Individual cognition (viz. psychology) must, by the same token, be distinguished from the social, as we also here are concerned with two distinct strata. This distinction is also noted by Collier (1994, p. 147) when he claims that "people are not relations, societies are not conscious agents. Different strata, as we have seen, are characterized by different kinds of *mechanism*". What this implies overall is that research on education and neuroscience such as *The Number Race* project, must recognise that it is likely to encompass numerous variables at different levels of strata − and that these variables should be studied using different research methods. Neuroscientific concepts on number processing, game design theories, and computerised learning algorithms may contribute to valuable insight into how to *design* a software learning game for children with mathematical learning difficulties, but unless psychological, educational, and social modes of studies are also included one cannot acquire knowledge of how such computer games can be used, and how they might be perceived outside laboratory settings.

When it comes to critical realism's argument regarding the ordering of nature in different strata, certain notions should also be mentioned concerning a critical realistic approach to the mind-brain problem. Critical realists assume that matter is more 'basic' than life, and that life in turn is more basic than rationality, and so on up to the level of human society (Collier, 1994). In this respect, critical realists often use the term *emergence* when referring to relationships between higher-level and lower-level mechanisms, implying that higher-level mechanisms are rooted in, and emergent from, more basic levels.

> Emergence theories [such as Bhaskar's] are those that, while recognizing that the more complex aspects of reality (e.g. life, mind) presuppose the less complex (matter), also insist that they have features which are irreducible, i.e. cannot be thought in concepts appropriate to the less complex levels − and that not because of any subjective constraints on our thought, but because of the inherent nature of the emergent strata (Collier, 1994, p. 110).

A critical realistic approach to the mind-matter relationship, and hence also to the mind-brain problem, will therefore perceive matter and brain to be of a more 'basic' level than cognitive aspects such as rationality. The mind will, nevertheless, have features which are irreducible to the level of the brain. For the sake of comparison, one can therefore say that in contrast to dualism (viz. mind ≠ brain), critical realists do not understand the mind as being completely independent of the brain, because more complex aspects of the mind will emerge from and thus presuppose more 'basic' aspects of the brain. In contrast to monism (viz. mind = brain), critical realists will emphasize that the mind cannot be thought of or fully explained by using concepts appropriate to the brain, because the complexity of the mind cannot be reduced to more 'basic' levels such as the brain. In view of this, I will again argue that critical realism can offer a philosophy of science compatible with numerous ideas in the educational neuroscience community, and supports the view that the mind-brain relation is a complex and non-reductive interrelationship which cannot be explained either by monistic or dualistic philosophies (cf. Blakemore & Frith, 2000).

Overall, I will argue that critical realism can provide a valuable philosophical foundation for work conducted at the interface of educational neuroscience. Not only does critical realism provide an alternative to realistic and relativistic philosophies, it is also a philosophy of science that emphasizes both biological concepts (viz. ontology) and more societal and educational concepts (viz. epistemology), but *without* reducing one to the other. By the same token, critical realism also provides a philosophical perspective that emphasizes different levels of analysis, highlights the complexity in mind-brain relationships, and acknowledges transdisciplinary and reciprocal collaboration between disciplines such as education, cognitive psychology, and neuroscience − issues which lie at the very heart of many educational neuroscientific endeavours.

Chapter summary

There is a 'philosophical gap' between the disciplines of education, cognitive psychology, and cognitive neuroscience. This 'gap' and the disciplinary dissimilarities which follow from it, can lead to difficulties for anyone conducting work at the interface of education and neuroscience. My doctoral research has been a similar experience, as I, too, have encountered philosophical issues in my study of the educational neuroscience discourse. Philosophical issues, on the one hand, arise due to the 'philosophical problems' that can occur at the interface of education and neuroscience − such as epistemic differences, and issues related to the mind-brain relationship. More importantly, on the other hand, philosophical issues arise due to difficulties in finding an adequate philosophy of science for studying educational neuroscience. In short, it can be said that this is related to more fundamental philosophical enquiries, as I have encountered problems in linking research on educational neuroscience to either realistic or relativistic philosophies of science. Despite the existence of much literature on educational neuroscience, I have, to date, found little work that explicitly addresses and suggests potential philosophies of science for educational neuroscience research. Indeed, philosophical issues such as epistemic differences and the mind-brain problem are commonly documented. However, more fundamental questions and suggestions for a common philosophical grounding for education, cognitive psychology, and neuroscience are seldom elaborated. Despite having limited time and scope to adequately address such fundamental questions of philosophy of science, I have attempted to propose a possible philosophical approach for studying educational neuroscience.

Finding a research framework for my doctoral study where there is agreement amongst philosophical, theoretical, and methodological perspectives, in addition to complying with the object of study itself, has been a difficult task. Nevertheless, I consider that a critical realistic perspective may provide an appropriate foundation for such work. Firstly, I will argue that critical realism addresses certain essential philosophical problems for educational neuro-scientific work in that it proposes a philosophy of science which acknowledges the importance of both ontological and epistemological notions. By making allowances for social aspects attached to education, cognitive psychological aspects attached to individual cognition, *and* natural aspects attached to neuroscience – this *without* conducting errors of reductionism – the perspective of critical realism appears to be a viable philosophical framework for research relevant to educational neuroscience. Secondly, I will argue that critical realism is also in agreement with the views held by many working at the interface of education and cognitive neuroscience, regarding philosophical problems related to transdisciplinary collaboration (viz. epistemic, theoretical, and methodological differences) and the mind-brain dilemma. Again, this emphasises the notion that critical realism can be seen as a possible philosophy of science for educational neuroscience research. My third argument for using a philosophical approach inspired by critical realism is that it also helps to establish a coherent research approach in my own critical discourse analysis of educational neuroscience, since theories and methodologies adherent to Fairclough's later perspectives are consistent with a critical realistic philosophy of science.

Chapter 3

Theory – critical discourse theories

This chapter aims to explain the theoretical framework used in my PhD research. Numerous theoretical approaches can be applied to a study on *educational neuroscience* – each may be related to different research questions and each can suggest a different angle of examination. A researcher within cognitive neuroscience may, for instance, be interested in conducting a memory study and thus make use of neurobiological and cognitive theories of learning. An educationalist interested in pedagogical aspects, on the other hand, may be engrossed in more practical issues related to transformation of neuroscientific findings into classroom practices – in this respect, teaching theories on a more pedagogical level can be appropriate. In contrast to cognitive neuroscience and practical pedagogy, however, my field of study examines *macro-social* perspectives on *education*. This distinction indicates that my perspective is more closely related to structural perspectives on societies, political aspects, power relations, dominions of knowledge, historical concepts, relationships between text and context etc. The theoretical connections in my branch of study are therefore social and political work from Fairclough, Bourdieu, Habermas, Bernstein, and Foucault, rather than more pedagogical related theories such as Marcia and Bowlby, or neuroscientific theories such as those of Hodgkin and Huxley[13].

As a consequence of my inclination toward macro-social perspectives, the theoretical framework I have chosen for this PhD study is drawn from the *critical discourse analytical tradition* – particularly the branch rooted in the work of Norman Fairclough. This is a tradition where examination of opaque 'structures' within discourse are central, as one seeks to expose discursive and social dimensions within, and between, different discourses. If one relates this critical discourse analytical framework to the study of educational neuroscience as a *discourse*, relevant research questions can be: 'how did the academic discipline of

[13] Both J. Marcia's identity theory and J. Bowlby's attachment theory are often referred to in pedagogical studies, whereas the Hodgkin-Huxley model of the Na^+ and K^+ conductance change is a mathematical model related to the mechanisms of action potential in the brain.

educational neuroscience emerge?', 'what are the common representations and narrations suggested by actors in the discourse?', 'can one find any hegemonic relationships within the academic level of educational neuroscience?', 'how is this academic discipline recontextualised to other fields, such as the public and political field?' and 'how can educational neuroscience be seen to be distributed across scalar borders and into Norway?' In order to address these questions comprehensively, a theoretical and methodological foundation must be established. Chapter 3 will therefore present this research's *theoretical* discursive framework, whereas chapter 4 gives an account of the method used in my study. As "theory and methodology are far from being mutually exclusive" in the critical discourse tradition (Fairclough, 2010, p. 164), these two chapters should be seen in relationship to one another. Chapter 3 will commence with an account of, and an argument for, the specific theoretical framework I have chosen – namely a critical discourse analysis conducted from the work of Fairclough. I will then further define the scope by expounding on some central aspects pertaining to this critical discourse tradition, before elaborating on the analytical concepts of emergence, hegemony, and recontextualisation across structural and scalar borders[14]. Overall, the theory chapter is set out in order to provide a theoretical grounding for the analysis of the educational neuroscience discourse.

Fairclough's critical discourse theoretical framework

The tradition of critical discourse analysis is often associated with studies of language and text. Indeed, one of Fairclough's latest books, a collection of twenty-three of his papers on critical discourse analysis, is even entitled *'Critical discourse analysis; the critical study of language'* (2010). Language and text are undoubtedly essential but, and as numerous critical discourse analysts have pointed out, critical studies of discourse cannot be reduced to studies of language and text *per se*. There is a crucial distinction between the linguistic study of *text* and a critical study of *discourse*. To understand this subtle, albeit highly crucial, distinction, one needs to return to the beginning of critical discourse analysis[15]. Critical discourse analysis

[14] Delimitations have to be made as regards which theoretical aspects are explained. There are significant numbers of different theories and definitions one can reflect upon – each with references to significant amounts of literature arguing whether or not one should write 'discourse' with miniscule or capital 'D', or what the differences is between 'field' and 'sphere'. I have chosen not to embark upon such a task, but will rather focus on critical discourse concepts of particular interest in this research on educational neuroscience.
[15] There are different schools within the discourse tradition, and even within the *critical* discourse tradition, which is often associated with the work of Foucault. The distinction between these perspectives can be confusing and Fairclough (2003, p.

(CDA) – that is, the school of analysis particularly associated with Norman Fairclough – developed as a result of the disciplinary divide between linguistics and other areas of social science (Fairclough, 2010, p. 417). On the one hand there is the discipline of linguistics, which has a long tradition of micro-analysing text, including patterns in talk and in writing. On the other hand there is social science, such as sociology, which has expertise in examining macro-sociological issues such as social change and social practice. What tends to be problematic with the former, when challenged by the critical discourse tradition, is that linguists do not adequately address sociological issues of a discursive nature such as social change. The problem with the latter, though, is that claims about discourses made by sociologists tend to lack a firm grounding in the actual empirical analysis of language (Fairclough, 2010, p. 418). In order to address these challenges, the tradition of critical discourse analysis explores macro-aspects of social relationships and processes as exposed in micro-aspects of text and language.

> In contrast with many branches of linguistics which define their research questions within their own discipline, CDA typically takes up social scientific questions and claims about social or institutional change, and explores how these changes may be taking place at the micro level of texts and interactive events. Or, to put the point in more general terms: CDA explores how discourse figures in relation to other social elements in processes of social or institutional change (Fairclough, 2010, p. 418).

The linking of micro-analysis of text with macro-sociological theories, further explains the close relationship between method and theory within critical discourse analysis. Interlinking these two, however, is done by "conceptualise[ing] the more sociological concepts of discourse … in terms which can be explored empirically through repertoires of linguistic (in conjunction with non-linguistic) analysis" (Fairclough, 2010, p. 418).

When it comes to the connection between micro and macro analysis of text and the social, another distinctive facet of critical discourse analysis should be explained – that is, the notion of *transdisciplinarity.* The transdisciplinary nature of critical discourse analysis is closely linked to its objective – namely, to analyse relationships and structures *within* and *between* discourses. In Fairclough's own words, the aim of the study is "*not* analysis of discourse 'in itself' as one might take it to be, but analysis of dialectical *relations between* discourses and other objects, elements or moments, as well as analysis of the 'internal

124) even notes how "Foucault's work has been taken up in many different theories and disciplines, producing a rather bewildering range of overlapping and contrasting theorizations and analysis of 'discourse'". Fairclough's approach to discourse studies, though, can be allocated to the larger *critical* discourse tradition and it has, confusingly enough, taken on the name *critical discourse analysis.* Even if Fairclough's analytical approach is often known under the abbreviation CDA, I will continue to use its full name throughout the dissertation.

relations' of discourse" (Fairclough, 2010, p. 4). As critical discourse analysts aim to cut across discursive boundaries in their search for structural relations, they often characterise the mode of study as *transdisciplinary* work. This transdisciplinary form of analysis also affects the theoretical frame used in a study, since crossing of discursive boundaries often leads to crossing of conventional boundaries between *disciplines* (Fairclough, 2010). For instance, if one seeks to analyse a particular educational discourse, then investigation of structural relations between the educational discourse and the political discourse may be of value. Consequently, theoretical aspects from disciplines such as politics, economy, sociology, and linguistics, are appropriate for the analysis of discourse. The argument for applying such cross-disciplinary frameworks is that terms extracted from macro-sociological theories can be translated into discourse-analytical concepts. "What I mean by that is that … the logic of one theory can be put to work within (the logic of) another without the one being reduced to the other" (Fairclough, 2010, p. 398). This is shown throughout the critical discourse analytic tradition, as social and political thoughts relevant to the social theory of language – such as the work of Althusser, Foucault, Giddens, Gramsci, and Habermas – are often used to enrich and supplement the theoretical framework within the analysis of discourse (Fairclough, 2010). Critical discourse analysis is thus an encompassing theoretical and methodological framework since it does not restrict itself to certain disciplinary confines, but instead attempts to create constructive dialogue between social theories and research.

Despite the notion that critical discourse analysts endeavour to combine micro aspects of text with macro-sociological theories in a transdisciplinary way, there is yet another aspect that should be addressed – an aspect which also makes it distinctive from other discourse traditions. In contrast with other discourse studies, critical discourse analysis seeks to go 'beyond' what is said and done in a discourse; attempting, as such, to examine unclear structural relations between aspects such as language, discourse, knowledge, ideology, and power. Accordingly, its approach to the analytical subject of attention is, indeed, *critical*.

> By 'critical' discourse analysis I mean discourse analysis which aims to systematically explore often opaque relationships of causality and determination between (a) discursive practices, events and texts, and (b) wider social and cultural structures, relations and processes; to investigate how such practices, events and texts arise out of and are ideologically shaped by relations of power and struggles over power; and to explore how the opacity of these relationships between discourse and society is itself a factor securing power and hegemony (Fairclough, 2010, p. 93).

Because critical discourse analysis has the central goal of critically questioning discursive structures, its analytical work is *normative* and *explanatory* rather than a mere *descriptive* commentary on discourses. Fairclough (2010) elaborates on this distinction, noting that whilst descriptive work tends to be less interested in the more extensive *effects* of discourse, critical discourse analysis has an explicit explanatory endeavour. In other words, it seeks to address and evaluate 'social wrongs' in their opaque discursive disguise[16]. Taken together, critical discourse analysis can thus be said to be a transdisciplinary theoretical and methodological framework of study, which aims to critically explain and evaluate discursive structures and relations.

Critical discourse theories and critical realism

Fairclough's methodological and theoretical framework can be distinguished in his early and later work, since his philosophical stand has been altered in the course of his academic carrier. Fairclough himself stresses this development by documenting how, over recent years, he has started "working with a realist and specifically critical realist ontology" in numerous papers related to critical discourse analysis (Fairclough, 2010, p. 164; Fairclough et al., 2002). As previously mentioned, the theoretical, methodological and, indeed, philosophical stance I use in this doctoral research will resemble Fairclough's *later* work, as this work draws attention to critical realistic arguments. Seeing that chapter 2 already has expounded on critical realism as a scientific philosophical anchoring for this dissertation, only a brief account concerning a critical realist approach to critical discourse analysis will be presented here.

Understanding the shift in Fairclough's critical discourse tradition brings us back to an observation about philosophies of science. Numerous authors within the discourse analytical tradition – in addition to those involved with Fairclough's original critical discourse analysis – tend to conduct their work in line with a socio-constructivist, post-structuralist, or post-modernist school of thought. This assemblage of philosophies of science is not surprising, considering the linguistic turn, the notion of structuralism, and the Foucaldian tradition's emphasis on social construction of thought – all philosophies of science emphasize an epistemological focus of study (Fairclough, 2010). Iver Neumann (2010, p. 14 [my translation]) also stresses this philosophical position in the discourse tradition by stating that

[16] See page 69 for further explanation on opaque discursive structure.

“it is for the discourse analysts … a basis of conception that the world appears to us as more or less changeable – in flux. It is meaningless to say that the world consists of either this or that without specifying how it became this way, how this world is maintained and how it is challenged by other possibilities”. On this note, Neumann continues by arguing that discourse analysts are not primarily interested in the real, but rather in the transpired, that is, how and why things become known as they do. “It is for this reason epistemological questions – how we can possess knowledge about the world – are the centre of attention in discourse analysis, whilst ontological questions are pushed to the background” (Neumann, 2010, p. 14).

Contrary to this, and what becomes apparent when reading Fairclough’s later work, is that Fairclough gives the impression of being sceptical about focusing on epistemology at the expense of ontology. He thus takes a critical stance against some prominent tendencies within the study of discourse, particularly those studies that adopt “postmodernist and extreme social constructivist positions” (Fairclough, 2010, p. 348). In order to address these issues, Fairclough bases his later work on a realist social ontology, in addition to a critical realism particularly inspired by the work of Roy Bhaskar. In a paper concerning critical discourse analysis of organisations Fairclough expresses this change to the point:

> I shall argue instead for a critical realist position which is moderately socially constructive but rejects the tendency for the study of organisation to be reduced to the study of discourse, locating the analysis of discourse instead within an analytically dualist epistemology which gives primacy to researching relations between agency (process, and events…) and structure on the basis of a realist social ontology (Fairclough, 2010, p. 348).

Fairclough’s philosophical shift is further argued by noting how critical realism accentuates ontological aspects *without* reducing epistemological aspects. In this way, the tradition of critical discourse analysis can recognise ontological aspects, while simultaneously avoiding a collapse of deep-rooted and prominent discourse theories, which are seen to constitute a foundation of Fairclough’s critical discourse tradition. Fairclough is able to preserve his traditional theoretical approach with only a minor alteration, because “critical realism is a philosophy of (social) science, not a (social) theory, and a critical realist approach is consistent with diverse social scientific theories which CDA might productively enter dialogue with” (Fairclough, 2010, p. 361). By relating critical realism to the concept of discourse, a majority of social theories applied in the critical discourse tradition are maintained – albeit anchored by a slightly different philosophical argument, which also acknowledges the existence of a real world. Nevertheless, some notions of the critical realistic approach to critical discourse analysis should be accentuated. To start with, it is essential to distinguish between the concept of *discourse* and that of *reality*. This distinction follows from the argument that the natural world (the real) and the social world (e.g. concepts of discourse) abide by a different set of rules where the former, but not the latter, exists independently of human action.

> [C]ritical realist ontology … asserts that there is a real world which exists independently of our (always limited) knowledge of it and of whether or how we represent it, rejects versions of discourse theory which collapse the distinction between reality and discourse, yet also assert that the real world is socially and discursively constructed (Fairclough, 2010, p. 164).

A critical realistic approach to discourse analysis thus recognises that the natural and the social world are different, and that neither can be reduced to the other. It is furthermore stressed that concrete social events (such as text) and abstract social structures (such as semiotic systems, viz. language) are understood as part of social reality (Fairclough, 2010; Sayer, 2000).

Another and related aspect relevant to discourse theories is critical realism and its understanding of causation, as critical realists show how a distinction can be drawn between the 'real', the 'actual', and the 'empirical', and causal powers found herein. 'Causation' is thus perceived as a complex phenomenon, which operates at different levels. This is important because critical realism is seen to explain *how* semiosis can have effects on and produce change in social practice, social institutions, and the social order more generally (Fairclough et al., 2002). In particular, three concepts connected to critical realism are elaborated when arguing for its relevance to critical discourse studies and causation. It is stressed firstly that "critical realists distinguish the real from the actual and the empirical", secondly that "critical realism views objects as structured and as having particular causal powers or liabilities", and thirdly that "critical realists argue that reasons can operate as causes, that is, can be responsible for producing change" (Fairclough, 2010, pp. 204-205). In connection with causal powers related to semiosis, it is further noted how social events (e.g. texts) may be shaped by two forms of power: Social events (and texts) are, on the one hand, shaped by social agents, and on the other hand, by social practices (e.g. order of discourse) and social structures (e.g. semiotic systems and language) (Fairclough, 2010). Emphasis is additionally put on *context,* as it is asserted that language studied in isolation will lead to incomplete and reductionistic accounts of social causation[17].

> Realist discourse analysis in this view is based in a dialectic-relational social ontology which sees objects, entities, persons, discourses, organisations and so on as socially produced 'permanences' which arise out of processes and relations (...) and which constitute a pre-structured reality with which we are confronted, and sets of affordances and limitations on processes. The concern in research is with the relationship and tension between pre-constructed social structures, practice, identities, orders of discourse, organisations on the one hand, and processes, actions, events on the other (Fairclough, 2010, pp. 356-357).

A critical realist perspective on discourse theories can generally be seen to repudiate much of the critique that discourse theories have encountered, concerning relativistic problems connected to post-modernism and social-constructionism. This is particularly due to the assertion that there is a real world which exists independently of our knowledge of it, to rejection of discourse theory which denies the distinction between reality and discourse, and the related assertion that the real world is socially and discursively constructed. Subsequently, Fairclough notes that critical discourse analysis can now – with its new and critical realistic anchoring – be seen as a "'moderate' or 'contingent' form of social constructivism" (Fairclough, 2010, p. 5)[18]. The forthcoming enquiry related to this chapter, however, is what these critical realistic discourse theories suggest: what do the discourse theories on structures, relations, language, power, ideologies and change actually encompass? Furthermore, what is the theoretical backdrop of critical discourse analysis used in this study?

Central discourse theoretical concepts in this research

The following sections present central discourse-theoretical concepts for this critical discourse analytical study on educational neuroscience. This includes discursive notions of text, representation and discourse, intertextuality and interdiscursivity, and social events, practices and structures. Concepts of knowledge, ideology and power, discourse and social change, as well as opaque discursive structures and relations are also elaborated.

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[17] For a more through argumentation for a critical realist approach to discourse analysis, see for instance Fairclough et al. (2002), Sayer (2000), in addition to chapter 8, 9 and 13 in Fairclough (2010).

[18] The critical discourse theoretical framework presented in this chapter is in concordance with Fairclough's later work that is suggestive of a critical realistic approach to critical discourse analysis. If not explicitly stated, my theoretical framework will from now on forth simply be called *critical discourse analysis,* since this is in accordance with the term (the late) Fairclough himself used.

Text, representations, and discourse

As already noted, text is a central aspect of critical discourse analysis – but what precisely does this concept comprise? A basic element in the discourse tradition is that 'text' is understood as something more than just written text. As Fairclough (2010, p. 233) notes: "Texts are to be understood in an inclusive sense, not only written texts but also conversations and interviews, as well as the 'multi-modal' texts (mixing language and visual images) of television and the internet". The discourse tradition thus operates with an inclusive definition of 'text'. Moreover, when it comes to this concept, it is emphasized that a text should not be understood in isolation. The argument is that a text cannot exist in a vacuum; someone must have created it and it will therefore be allocated time and/or space. A text – be it a written document, a spoken conversation, or news coverage on the internet – will therefore, inevitably and undoubtedly, be part of a larger historical, social, and cultural context. In line with this argument, critical discourse studies of text are rarely utilized as merely linguistic and grammatical analyses of documents. "Insofar as semiosis has been studied in isolation from its context," Fairclough, Jessop and Sayer (2002, p. 2) notes, "this is bound to lead to an incomplete account of social causation and therefore risks committing one or more kinds of reductionism". Since texts are seen as intertwined aspects of the contextual in the critical discourse analytical tradition, emphasis is put on complex relationships between the micro-textual and the macro-sociological.

This notion of text alone cannot fully illuminate the analytical value attributed to it by critical discourse analysts. Yet another aspect should be assigned to the term, namely the concept of *representation*. 'Representation' is an abstract term, defined as the 'concept of appearance', which lies between the physical reality and our perception of this reality. The argument is that our perception of the world is not unmediated – in our effort to understand the world around us, we make use of language, categories, and other social models of conception[19]. However, these social models are not – and never can be – neutral 'reading glasses', which reflect the reality without a socially biased perspective (Neumann, 2010). In other words: *how* we present the world will, to some extent, be attributable to the historical, social, and cultural context surrounding us. We can therefore never present the world as it is –

[19] Fairclough (2010) has in his later work used the term *semiosis* when referring to "meaning-making as an element of the social process" (p. 230). In some of his paper 'semiosis' is also referred to as 'language' and 'discourse', because semiosis is seen to encompass more than (verbal) language, in addition to offering a less confusing term than 'discourse' used as abstract nouns (p. 220). In my dissertation, however, I will make use of 'language' and 'discourse', because I consider these terms to be clearer and more comprehensible for readers without a background in critical discourse studies.

what we can do is *re-present* it. Understood in this manner, text – that is, our representation of the world – will be influenced by the *discourse* in which we, and the text, are immersed.

In critical discourse analysis, the concept of *text*, as the previous paragraph indicates, must be seen in conjunction with the concept of *representation* – which in turn must be understood in conjunction with the concept of *discourse.* Before continuing, a more thorough definition of *discourse* is thus appropriate, although, defining the concept of discourse is not easy due to its imprecise nature. What has contributed to the vagueness of this concept are the many and different definitions of discourse formulated by various disciplinary and theoretical perspectives (Fairclough, 1992). In order to clarify this multi-defined concept, it is helpful to refer to Toews (2004), as he divides the term into two different meanings: discourse understood as *text* and discourse understood as *structural dimensions*. The first meaning is concerned with systems of categorization and codes in a communicative process – in other words, it is chiefly concerned with linguistic aspects. Language and other forms of text are relevant to the second meaning as well, albeit the focal point here is analysis of the underlying dimensions of discourses. As Toews (2004, p. 8917) notes, it is the "discourse as the historical *a priori* of thought, speech, and action" which researchers attempt to analyse. In this latter part, discourse is thus seen to encompass a dialogical conception of text and the social context. Considering what has previously been said regarding Fairclough's tradition – and particularly concerning concepts of text and representation – it is not surprising that Fairclough has been signalling a social-theoretical concept of discourse in line with the latter discursive approach.

In respect of the social-theoretical and structural approach a discourse can, generally speaking, be understood as "a specific way to talk about and perceive the world" (Jørgensen & Phillips, 1999, p. 9 [my translation]), although the simplicity of this account does not adequately identify the intricate nature of a discourse. Another definition, suggested by Fairclough himself, states that "[d]iscourse is an element of all social processes, events and practices, though they are not simply discourse" (Fairclough, 2010, p. 503). Even if this definition is more adequate than the first one, it is nevertheless not particular clarifying. Precisely this, though, is the difficult core of critical discourse analysis and its theoretical framework – the concept of discourse cannot easily be explained in one single sentence. Discourse is a complex concept, because it connects with a particular aspect of study and then branches out, attempting to reach everything from macro-social processes, events and practices, to micro-linguistic aspects in text and language. To make things more complicated, the nexus of a discourse can be located either *here* or *there* depending on the research question and the aim of a particular study. The concept of discourse must therefore be seen as a variable analytical dimension rather than a fixed social concept. In other words, with the concept of discourse, one attempts to conduct an abstract delimitation of a vast and non-restricted social concept or phenomenon.

The analytical notion of 'discourse' can be a somewhat 'all-inclusive' concept, given that the intention is to cover both micro-textual and macro-social aspects of a particular topic. What is essential to emphasise, however, is the variety of different analytical aspects a discourse can therefore encompass. As already stated, 'text' is one aspect that is included in discourse, but 'subjects' is also a part of discourses. The same goes for 'knowledge', 'social practices' and 'events', as well as more material aspects such as 'organisations' and 'institutions'. With regard to the two latter aspects, these can actually be seen as both material constructions and as programmes, which systematize thought and practices (Neumann, 2010). An educational institution, for instance, can be perceived as a concrete school building, but also as an organisational system where certain knowledge and practices are institutionalized in ways of being and behaving within the educational domain. In view of this all-encompassing notion of discourse, one can say that "*discourse* is a particular way of representing certain parts or aspects of the (physical, social, psychological) world" (Fairclough, 2010, p. 358). One can, for instance, find discourses which represent social groups and social relationships in different ways. What is of further importance is that these discursive aspects are understood to be in a *dialectical relation* to one another – that is, they are seen to influence, and be influenced, by each other. Moreover, it is argued that a discourse cannot be reduced to its components and, simultaneously, that these aspects cannot be understood as simply discourse (Fairclough, 2010). In view of this, the concept of discourse is multi-layered and complex and, indeed, a concept which can be difficult to grasp. As Fairclough (2010, p. 3) notes; "Discourse is not simply an entity we can define independently: we can only arrive at an understanding of it by analysing sets of relations". Thus, to fully understand the concept of 'discourse' as an analytical notion of study, it may be easier to draw on different theories related to the structures and relations one can allocate to discourses. These discursive structures can be conceived as a web, which is embedded within and between discourses – a network of potential relations of a social, political, historical, cultural, and textual nature.

Intertextuality and interdiscursivity

One term which has been suggested in order to address textual discursive relationships is *intertextuality*; a term which indicates that one text will be affected by, and in turn affect, other texts. Intertextuality is thus a term referring to relationships *between* different texts, as each linguistic and semiotic aspect will carry 'luggage' with it from its meeting with other textual fragments (Neumann, 2010). Similarly, the concept of *interdiscursivity* indicates relationships *between* discourses, signifying how one discourse can both affect and be affected by other discourses (Fairclough, 1992). The concept of interdiscursivity thus contributes towards conveying the idea that "different discourses are intimately entangled with each other and together form the giant milling mass of overall societal discourse" (Jäger & Maier, 2009, p. 35). Interdiscursivity can be further related to the Foucauldian term 'order of discourse', albeit that this latter term has a somewhat different meaning. What this term suggests is that relationships *between* discourses are not necessarily *neutral*; rather, discourses are often arranged in a hierarchic 'order' where some hold more 'dominant' positions than others. "An order of discourse can more specifically be seen as a particular combination of different discourses, different genres and different styles, which are articulated together in a distinctive way" (Fairclough, 2010, p. 358). Taken together, intertextuality, interdiscursivity, and order of discourse refer to discursive structures and relationships, which can be found between texts and between discourses. These links are indeed central, since critical discourse studies aim to analyse and illuminate the entwined discursive web.

Social events, practices, and structures

The relationship between social structures, social practices, and social events is also of note within a critical realistic approach to critical discourse studies, where language and semiosis are seen as elements in all the social levels. Schematically this is illustrated by Fairclough (2003, p. 24) as follows:

- Social structures: language
- Social practices: orders of discourse
- Social events: texts

Social structures are seen as very abstract entities, which are further understood to define a potential or a set of possibilities − such as an economic structure, a social class or kinship system. Additionally, language is understood as an abstract social structure, for instance in how certain ways of combining linguistic elements are possible whereas others are not (e.g. ‘the brain’ is possible in English, whereas ‘brain the’ is not). Yet even if social structures such as language define certain possibilities and exclude others, the relationship between what is structurally possible (i.e. structures) and what actually happens (i.e. events) is very complex (Fairclough, 2003).

What this implies is that a concrete event, such as a text, is not in any direct or simple way the effect of potentials defined by abstract social structures such as language. Within the critical discourse tradition, relationships between social structures and social events are understood as *mediated,* and a level of intermediate organisational elements called ‘social practices’ is thus located between structures and events. Social practices are further seen as ways of controlling the selection and maintenance of certain structural possibilities in particular areas of social life. Additionally, social practices are understood as being networked together in particular and shifting ways. Examples of social practice are practices of teaching and practices of management in educational institutions, which, in turn, can also be seen to have undergone a shift during recent decades as they have become networked together with practices of management (cf. ‘marketization’ of education; Fairclough, 2003). If we also look at the semiotic and language dimensions of social practices, these are seen to be ‘order of discourse’. Elements of order of discourse are not elements of linguistic structures such as nouns or sentences, but rather particular social ordering of the relationship between different ways of acting, representing, and being in particular areas of social life (Fairclough, 2003). The important point to note is how this intermediate level of social practice articulates discourses (hence language) with other non-discursal social elements. This is also in line with the notion that as we move from abstract structures (e.g. language), through social practices (e.g. order of discourse), and towards more concrete events (e.g. text), it becomes increasingly difficult to separate language from other social elements (Fairclough, 2003). Overall, it can therefore be said that a social process can be seen as the interplay between the three levels of social structures, practices, and events.

Knowledge, ideology, and power

When it comes to discursive structures embedded within a discourse, aspects such as knowledge, ideology, and power are essential[20]. With regard to notions of *knowledge*, the concept of representations ought to be brought forth. As previously stated, representations are the series of categories, metaphors, and other social models of conception, which we turn to when trying to make sense of the world. Our representations are seldom neutral, and texts should therefore be understood as being culturally encumbered (Neumann, 2010). The argument that follows from this perception of language and text is that *how* we express certain 'truths' about our perceived reality, is also culturally laden and attributable to certain discourses. This implies that our *knowledge* of the world is influenced by discourses and what is understood as certainties will therefore vary depending on contextual factors such as time, place, and culture. However, this relationship between discourses and knowledge must not be seen as a one-directional influence where discourses solely affect our knowledge; the relationship is somewhat dialectical, because knowledge and language may shape social practices and material objects, which, in turn, may change discourses. This is a central aspect and it is emphasized that "discourses exert power because they transport knowledge on which collective and individual consciousness feeds. This knowledge is the basis for individual and collective, discursive and non-discursive action, which in turn shapes reality" (Jäger & Maier, 2009, p. 39). In view of a critical realistic approach to discourse theories, knowledge about the world must therefore be understood as 'truths', which are related to certain discourses (Fairclough, 2010). In other words: our knowledge about the world is socially constructed and can be suggested, challenged, and even discarded since our concepts of certainties are changeable.

Aspects of socially construed and changeable knowledge bring forth crucial questions for critical discourse analysts: *which* truths are acknowledged in certain discourses, *why* is this knowledge suggested, and *who* has the power to craft these truths? Relating knowledge to certain views of preference directs our attention to the concept of *ideology.* In Fairclough's account of ideology – an account which partly builds on Althusser's and Thompson's theorization – ideologies are understood "to be 'meaning in the service of power'" (Thompson 1984 in Fairclough, 2010, p. 8). This notion implies that ideology functions as a means of representing aspects of the world in particular ways – it being operationalized in

[20] Seeing that discourses are related to one another (cf. interdiscursivity and order of discourse), structures which can be found *within* a discourse can also be seen as somewhat interlinked *between* discourses.

identities or in ways of acting – and these representations contribute towards establishing or sustaining relationships of supremacy. The concept of ideologies can, as such, be utilized to address relationships of discourse and power, but ideologies are also vulnerable to criticism since they represent or explain aspects of the world inadequately (Fairclough, 2010). Moreover, relationships between discourse and ideologies are of interest due to the entwined network of relationships between discursive aspects, such as knowledge, subjects, social practices, and institutions. As Fairclough notes:

> Institutional frame includes formulations and symbolisations of a particular set of ideological representations: particular ways of talking are based upon particular 'ways of seeing' … in the process of acquiring the ways of talking which are normatively associated with a subject position, one necessarily acquires also its ways of seeing, or ideological norms. And just as one is typically unaware of one's ways of talking unless for some reason they are subjected to conscious scrutiny, so also is one typically unaware of what ways of seeing, what ideological representations, underline one's talk (Fairclough, 2010, pp. 41-42).

Construction of knowledge and suggesting certain 'ideological truths' at the expense of others is further linked to notions of *power*. When considering the notion of power and discourse, it must be stressed that the term 'power' has a somewhat changeable meaning which should not be generalised – the notion of power will vary from discourse to discourse, and between different discursive dimensions. Jäger and Maier (2009, p. 37) elaborate on this and divide the connection between power and discourse into two dimensions: on the one hand one can have power *over* discourse, whilst on the other hand there is the power *of* discourse. Firstly, the power *over* discourse indicates that the different individuals and groups in a discourse have different chances of influence. These agents or groups can be said to have more power over discourse than others, "for example because they have privileged access to the media or greater financial resources" (Jäger & Maier, 2009, p. 39). Furthermore, these individuals have power in being able to suggest certain truths, representations, or views of the world. Construction and maintaining of *doxa* – that is, knowledge which at that time is considered to be the accepted truth – is power consuming because it demands continuous articulation of a certain representation, in addition to the continuous task of holding at bay conflicting representations. In other words, it takes excessive discursive work to 'freeze meaning' in a world where knowledge and truths are in constant fluctuation (Neumann, 2010). However, even if individuals and groups have power *over* discourse, none can be said to control discourses per se. "Discourses are supra-individual. Everybody is co-producing discourse, but no single individual or group controls discourse or has precisely intended its final result" (Jäger & Maier, 2009, p. 38).

This concept leads us to the second notion of power – the power *of* discourse − where power bias is seen to lie within the discourse itself. The argument is that discourses exercise power since they regulate and institutionalise how subjects think, talk, and act, *albeit* this 'order of things' appears as normal and consequently remains relatively unchallenged by individuals within the discourse (Neumann, 2010). This implies that people sometimes abide by an 'imperceptible power' – a power, that is, which is manifested and embedded in the discourse. There is neither one person nor a group of people who hold this supremacy; the power is instead in the discourse itself. Discourses can therefore be seen to exert power over their individuals as they make certain things appear to be true and beyond all doubt, even if this not necessarily is the case (Jørgensen & Phillips, 1999). Jäger and Maier elaborate on how discourses can exert power over their subjects simply due to their construction, by noting how one can distinguish between two different effects of discourse:

> Firstly, discourses form individual and mass consciousness and thereby constitute individual and collective subjects. Secondly, since consciousness determines action, discourses determine action. This human action creates materializations. Discourses thus guide the individual and collective creation of reality (Jäger & Maier, 2009, p. 37).

The argument that discourses exercise power in a society by regulating and institutionalizing ways of thinking, talking, and acting, can further be linked to the term *discursive regularity*. The argument is that discourse exists due to a set of regularities between representations of reality, values, and institutions (Neumann, 2010). Expressed more precisely: when representations are reflected in social practices, one can say that the discourse is preserved in a state of *status quo*. In turn, social practices contribute to shaping materialized institutions and symbolized systems that regulate individuals, actions, and thoughts. As such, the power of discourse can be seen as a closed feedback-loop where discursive aspects reflect and affect each other. A discourse with a resilient discursive regularity between these aspects will be a system of self-maintenance. In other words, such powerful discourses can be said to hold a *hegemonic* and dominant position in that their representations appear to be stable and thus remain unchallenged (Neumann, 2010).

When analyzing states of hegemonic dominion and the power effects of discourse, it is, furthermore, of importance to distinguish between *discourse* on the one hand and its *aspects* on the other, because there is a difference between the effects of a singular discursive aspect such as a text, and those of a discourse. “A single text has minimal effects, which are hardly noticeable and almost impossible to prove. In contrast, a discourse, with its recurring contents, symbols and strategies, leads to the emergence and solidification of ‘knowledge’ and therefore has sustained effects” as Jäger and Maier (2009, p. 38) note, before continuing; “What is important is not the single text … but the constant repetition of statements”.

Discourse and social change

One certainly receives the impression that discourses are somewhat profound and rigid structures with a firm set of relationships both within and between discursive orders. Furthermore, with regard to executions of power, it can appear that individuals are subject to certain deterministic constraints of their discourse or other agents. Numerous authors have argued about this, debating whether or not subjects can be credited with an active role in the discursive matrix. Althusser, for instance, sees people as passive subjects deprived of the opportunity for ideological resistance and action (Jørgensen & Phillips, 1999). Fairclough (1992; 2010) and numerous authors (Jäger & Maier, 2009; Jørgensen & Phillips, 1999; Neumann, 2010) take another approach, claiming that one *can* oppose power. “The nature of conflicting elements holds the seed to resistance, since elements which challenge dominant representations provide people with resources to make resistance. Hegemony is therefore never stable, but changing and unfinished” (Jørgensen & Phillips, 1999, p. 88). Subsequently, this means that discursive dominance can cease to exist, hegemonic power can falter and change can occur. Critical discourse analysts therefore perceive individuals as *active* subjects, and understand discourse as a system liable to *change,* because even if there are issues of power ‘over’ and ‘of’ discourse, there will always be the possibility of resistance and revolution. This implies that the feedback-loop between discursive regularities – such as those between representations, values, social practice, and institutions – can be broken (Neumann, 2010). Moreover, change does not appear only *within* discourses, change can also occur *between* discourses. The next question is thus how change in discourses can occur?

In his book ‘*Discourse and social change’*, Fairclough (1992) elaborates on the fragile line separating hegemonic dominion from discursive change. One of the crucial factors that can tip the scale in one direction or another – either towards continuance of hegemony or in favour of discursive alteration – is, indeed, voices of *disagreement* uttered from individuals holding alternative representations. “The immediate origins and motivations of change in the discursive event lie in the problematization of conventions … Such problematizations have their bases in contradictions” (Fairclough, 1992, p. 96). When it comes to confrontation with discursive representations, values, social practices, or institutions, it is further argued that resistance is most likely to be expressed by individuals from *other* discourses, because their external positioning provides them with resources to resist (Fairclough, 2010, p. 27). This suggests that subjects outside a discourse may not be as willing to accept certain representations and ‘ways of being and acting’, simply because they are not as institution-alised within that particular discursive matrix as others. Consequently, people from outside are more likely to resist to discursive boundaries, which determine what can and cannot be said and done within a discourse. However, to state that people outside are more likely to challenge a discourse does not mean that individuals within the discourse will not be critical – on the contrary. With regard to how subjects react to hegemonic representations, one can draw on Hirschman’s theorisation of the different choices of action at individual level (Hirschman 1970, in Neumann, 2010). Firstly, it is noted that individuals accept the dominant representation and the ‘way of being’ presented by a discourse; one is, in other words, *loyal* to the discourse and willingly identifies oneself with the subject position presented by a discourse. The second option is labelled *voice,* meaning that one protests about the discourse. Resistance by ‘voice’ can also be labelled *contra-identification*, as in this type of resistance the subject opposes a discourse by choosing a position diametrically opposed, and exclusively contradictory, to the dominant subject position. “In this mode of resistance, the subject position one inhabits will still be a pre-made position, even if it is negative, because it is simply a variation of the dominant subject position” (Neumann, 2010, p. 171). Another, and more radical, mode of action is the third position, namely *exit,* where one chooses to leave the discourse altogether. Exit can also be seen as a type of dis-identification, because one locates oneself in a subject position which is not entirely encumbered by the discourse. Dis-identification can thus be seen to be “every strategy which presents new ways of being in the world” (Neumann, 2010).

Resistance can furthermore be seen as a struggle over representations and ways of being and acting. Such discursive tussles have also been characterised as *hegemonic struggles*. “Hegemony is a focus of constant struggle around points of greatest instability between classes and blocs, to construct or sustain or fracture alliances and relations of domination/ subordination, which take economic, political and ideological forms” as

Fairclough (1992, p. 92) notes, before continuing; “Hegemonic struggle takes place on a broad front, which includes the institutions of civil society (education, trade, unions, family), with possible unevenness between different levels of domains”. Hegemonic struggles can be seen to be played out both within discourses and between them, as boundaries between discursive elements can contain significant amounts of tension. Such battles over discursive confines are noteworthy, since these boundaries represent what can and cannot be said and done within a discourse. Resistance in the form of exit or dis-identification will therefore not only imply questioning of these borderlines, but also *transgression* of them.

> Change involves forms of transgression, crossing boundaries, such as putting together existing conversion in new combinations, or drawing upon conventions in situations which usually preclude them … As producers and interpreters combine discursive conventions, codes and elements in new ways in innovatory discursive events, they are of course cumulatively producing structural changes in orders of discourse: they are disarticulating existing orders of discourse, and rearticulating new orders of discourse, new discursive hegemonies. Such structural changes may affect only the ‘local’ order of discourse of an institution, or they may transcend institutions and affect the societal order of discourse (Fairclough, 1992, pp. 96-97).

Discursive struggles and resistance can therefore be seen as struggles over discourses and over representations’ value of truth. Hegemonic struggles in a discourse can furthermore facilitate change, because boundaries are crossed and different discourses are being linked. Changes in one discourse can affect other discourses as well, and intertextual and interdiscursive aspects are therefore prominent in processes of change. Critical discourse analysis even stresses this, by claiming that “high levels of interdiscursive connections coincide with change, while few interdiscursive connections indicate reproduction of status quo” (Jørgensen & Phillips, 1999, p. 94). When it comes to the shaping and changing of discourse, it must be stressed that *new* discourses and *new* representations will also be liable to change. The ‘milling mass’ of discourses, and the network of structures and relations entwined within them, must therefore be understood as concepts which are in *constant* adaption. A discourse is not a set entity, and representation of knowledge, ideologies, power relations, dominance, hegemonic struggles, and resistance are therefore enduring processes.

Opaque discursive structures and relations

Critical discourse theories are generally about relationships, dimensions, and structures within or between discourses − these being notions of representations, social resonance, regularities, power, dominance, hegemony, struggle, social practices, orders of discourse etc. What is of note concerning such discursive relationships, and what is particularly stressed within the *critical* discourse tradition, is that these dimensions are not necessarily explicit. On the contrary, discursive dimensions tend to be subtly embedded and are thus often ‘taken for granted’ or are even ‘unknown’ by people within the discourse (Neumann, 2010). These are the structures in our social reality which we obey, simply because they have become so compatible with our way of ‘being in the world’ that we do not question them. As these opaque discursive structures contribute towards shaping how we think and act − and hence influence our knowledge, social practices, and institutions − it is argued that it is of analytical value to highlight them. Indeed, critical discourse analysis emphasizes this by noting how “[t]hese relations require analysis, because there are no societies whose logic and dynamic, including how semiosis figures within them, are fully transparent to all: the forms in which they appear to people are often partial and in part misleading” (Fairclough, 2010, p. 231). This demonstrates a resemblance to the Foucaldian discourse tradition, as the importance of identifying *what* is acknowledged as truths, in addition to discovering *who* has the power to create these truths, implies a profound and critical insight into a discourse. The question that follows from this, however, is: how one can examine structural and abstract aspects embedded in a discourse?

> The analysis of thought is always *allegorical* in relation to the discourse that it employs. Its question is unfailingly: what was being said in what was said? The analysis of the discursive field is orientated in a quite different way; we must grasp the statement in the exact specificity of its occurrence; determine its conditions of existence, fix at least its limits, establish its correlations with other statements that may be connected with it, and show what other forms of statement it excludes. We do not seek below what is manifest the half silent murmur of another discourse; we must show why it could not be other than it was, in what respect it is exclusive of any other, how it assumes, in the midst of others and in relation to them, a place that no other could occupy. The question proper to such an analysis might be formulated in this way: what is this specific existence that emerges from what is said and nowhere else? (Foucault, 1972, pp. 30-31).

In other, perhaps more comprehensible, words; “Critical discourse analysis aims to question and criticize discourses … It reveals the contradictions within and between discourses, the limits of what can be said and done, and the means by which discourse makes particular statements seem rational and beyond all doubt, even though they are only valid at a certain time and place” (Jäger & Maier, 2009, p. 36). Through this statement, the theoretical frame of the critical discourse tradition, which primarily accentuates different discursive structures, is justified and complemented by its more methodological and analytical approach, where attention is paid to the actual *study* and *exposure* of these discursive structures.

Emergence, hegemony, and recontextualisation

This last sub-section will present a brief account of a specific set of discursive concepts which constitutes a central analytical foundation for this research – namely *emergence, hegemony,* and *recontextualisation across structural and scalar borders.* This sequence of concepts is suggested by Fairclough (2010)[21] as an analytical agenda in accordance with a critical realistic approach to discourse studies – an agenda, that is, which particularly emphasizes the analysis of dialectical relations between discourse and social elements, in addition to highlighting other discursive aspects such as hegemonies, struggles, and relationships of power. Moreover, these concepts accentuate the role of *active* subjects, as they encompass a focus on potential *strategies*. As Fairclough notes:

> CDA oscillates between a focus on *structures* and a focus on the *strategies* of social agents, i.e., the ways in which they try to achieve outcomes or objectives within existing structures and practices, or to change them in particular ways. This includes a focus on shifts in the structuring of semiotic difference (i.e., shifts in orders of discourse) which constitute a part of social change, and how social agents pursue their strategies semiotically in text (Fairclough, 2010, p. 233).

Overall, the analytical agenda comprising emergence, hegemony and recontextualisation can be an abundant methodological frame for critically analysing the discourse of educational neuroscience, and consequently it is used as the main analytical framework in this study. As the next chapter covers the specific analytical research procedure, this section will present the theoretical account of emergence, hegemony, and recontextualisation over structural and scalar borders.

Emergence

The concept of emergence is, in brief, concerned with *emergence of discourse*. Underlying this concept is the notion that 'nothing comes out of nothing' – discourses are not crafted in a

[21] The concept of *operationalization* can be added to this analytical agenda, where analytical focus is on processes where aspects of abstract discursive structures are 'put into practice' in more realistic and material settings (Fairclough, 2010). However, my critical discourse analytical study of educational neuroscience will not encompass this latter concept, since an additional operationalization analysis would have exceeded my research project's time and scope margins. See also 'suggestions for further research' in chapter 9.

vacuum, but instead "emerge through 'reweaving' relations between existing discourses" (Fairclough, 2010, p. 367). What this implies is that discourses can be perceived to build upon already existing discourses, and developmental processes occur through a 'reweaving' of elements within and between the fields of available discourses. Furthermore, the emergence process can include problematisation, negotiation, and transgression of discursive boundaries, a de-articulation of 'the old' and, subsequently, a re-articulation of the new discursive elements. Emergence of discourse will therefore encompass notions of *change* − not only in discursive boundaries and in articulations, but also in discursive and social relationships, in structures, social practice, social agents, in organisations etc. (Fairclough, 2010). Emergence of discourse can, as such, be seen as an intrinsic notion *within* the discourse, as well as emergence *between* discourses, if, for instance, it becomes institutionalized within a changed order of discourse. However, even if emergence of discourse can be analysed at different levels, emergence must also be seen as a process associated with the use of 'successful' *strategies.* "[W]hile problems of emergence can be researched through analysing change in social processes, social interaction and text, including chains and series of interconnected texts over time and across organisational space, they also require reference to these structural, strategic and other factors" (Fairclough, 2010, pp. 367-368). Addressing the notion of appearance and development of discourse thus implies an identification of the range of emerging discourses, in addition to an account of the emerging strategies that have been used.

Hegemony

The concept of hegemony is valuable when illuminating aspects of change since it addresses relationships of dialogue, conflict, struggles, and dominance between discourses. Fairclough (2010, p. 19) notes this by stressing that hegemony "[s]how how particular discourses gain prominence or become marginalised over time, and how particular discourses emerge as dominant or hegemonic". One basic principle underpinning the hegemony concept is the idea that discursive 'truths' and regularities will constitute a natural centre for struggle and change (Fairclough, 2010). This implies that discourse is not a fixed entity set once and for all and that a discourse's narrations, practices, values, institutions, and other discursive aspects can therefore be seen as negotiable. This is where notions of *power* and *hegemony* come into play, because negotiations of discursive aspects will often bring into play different actors' intentions and strategies for shaping a discourse in a certain way.

> Hegemony is a focus of constant struggle around points of greatest instability between classes and blocs, to construct or sustain or fracture alliances and relations of domination/subordination, which takes economic, political and ideological forms ... [Hegemonic struggle] contributes in varying degrees to the reproduction or transformation not only of the existing order of discourse ... but also through that of existing social and power relations (Fairclough, 1992, pp. 92-93).

In this respect it must be mentioned that preservation of a certain discursive way of thinking, being, and acting in the world can become a less power-consuming task if there is strong resonance between discursive regularities. As previously mentioned, this implies that the discourse settles into a feedback-loop between discursive representations, values, and institutions (Neumann, 2010). The stronger the resonance is between discursive regularities, the more closed the feedback-loop will become; and the more closed and self-sustaining a discourse is, the more difficult it will be to break its (seemingly) naturalised hegemonic dominion. Such aspects of discursive regularities are important to note, because they bring into focus an essential point: discursive change must be seen as interplay between individual actors/groups *and* discursive structures. While individual actors and groups undoubtedly enter into negotiations and struggle over different discursive 'truths', no one can be seen to control discourse or to precisely have intended its final 'result' (Jäger & Maier, 2009). Constitutions of hegemonic relationships must therefore be seen to be brought into play by actors *and* by discursive structures, since both subjects' power *over* discourse and the power *of* discourse contribute to changes in discourse. By critically analysing hegemony as a discursive aspect, one can therefore provide insights into the struggles between different strategies for transforming society in different directions, identifying and explaining the success of certain strategies and the failures of others, in addition to illuminating tensions, conflicts and struggles within and between discourses.

Recontextualisation

The concept of recontextualisation is adopted from the sociological term suggested by Bernstein in his sociology of pedagogy, and is further operationalized as a category in Fairclough's critical discourse analytical tradition. Recontextualisation as a concept addresses the ways in which a discourse can be distributed to other fields or discursive levels, as noted by Fairclough in the following:

> The sociological concept of 'recontextualisation' (Bernstein, 1990) has therefore been operationalized in CDA in order to explore the potentially distinctive recontextualising principles associated with

> different fields or networks of practices (governmental, academic, public sphere etc.) which affect, at the concrete level, how one type of text or event is transformed into others in flows along chains and through networks. These flows are not simply unidirectional – there are flows into 'practical' events from governmental and theoretical fields, as well as flows in the other direction (Fairclough, 2010, p. 422).

In other words, whereas the concept of hegemony shows how particular discourses become dominant and hegemonic, the concept of recontextualisation addresses how a discourse is disseminated, re-articulated, and internalised to other fields. Fairclough (2010) further distinguishes between recontextualisation across *structural* borders and *scalar* borders. The former pay attention to how a discourse becomes distributed over the structural boundaries found between different social fields, such as the academic, public, and political field, whereas recontextualisation over scalar boundaries focuses on how a discourse is disseminated at international, national, and/or local level.

Recontextualisation bears further resemblance to concepts of intertextuality, interdiscursivity, and to the notion that there is always a continuous flow of influences within and between discourses, since a discourse will inevitably affect – and be affected by – other discourses. Here, some of the same principles used in emergence analysis are applied, although 'the table is turned' as one is now examining how a discourse can be seen to cross discursive borders into other contexts. Accordingly, the analytical focus, for instance, will be on how elements of the educational neuroscience discourse are re-articulated and put into relation with the discursive elements that already exist within these new contexts (cf. Fairclough, 2010). Another central concern is how particular fields can have their own distinctive ways of internalising an external discourse. In this respect Chouliaraki and Fairclough (1999) note that recontextualisation includes a *colonisation-appropriation dialectic* where the recontextualisation process can be seen as i) the 'colonisation' of one field or institution by another, but also as ii) the 'appropriation' of external discourses in the way in which the field actively incorporates a discourse into strategies pursued by particular groups or social agents within the recontextualising field. For example, the discourse of educational neuroscience appears to have become recontextualised into the public field (e.g. by media and by business persons in 'brain-based' learning programmes) and into the political field (e.g. by policymakers), but educational neuroscience may have become incorporated differently into the strategies of mass media, business managers, or government officials. The concept of recontextualisation thus acknowledges the active and diverse strategies of central actors pertaining to educational neuroscience, as well as recognising how the discourse itself can be seen to have had an impact on different fields and at different discursive levels. When it comes to the study of educational neuroscience, the concept of recontextualisation can be of great value, since it directs attention away from the academic level of discourse and instead investigates how educational neuroscience has become *re*-contextualised within other societal fields − both internationally and nationally.

Chapter summary

This chapter has attempted to provide a theoretical backdrop for this doctoral study on educational neuroscience. As I intend to use critical discourse analysis as a methodological framework – a mode of study where theory and method are highly interlinked and, indeed, where the resulting discussion of the topic is chiefly based on critical discourse theories – substantial space has been allocated to the clarification of central theoretical concepts. Discursive aspects such as text, representation, knowledge, ideology, power, hegemony, subject positions, social practice, and events have been explained, and the web of relationships one can find within and between discourses has been emphasized. One of the chief arguments throughout the chapter is therefore that discourses constitute a set of relationships and structures which contribute towards shaping our knowledge, practices, and institutions, and that these aspects in turn shape discourse. In other words, there is a dialectical relation within and between different discourses and their aspects. Another central argument is that such discursive relationships tend to be opaque and unknown to people within the discourse, as these discursive dimensions are often accepted as a natural part of discourses. Connected to this, critical discourse analysis, due to it being *critical*, aims to uncover and evaluate elusive discursive dimensions. Accordingly, and in regard to this doctoral study, the following method chapter will explain in more detail how these discursive structures and the theoretical concepts of emergence, hegemony, and recontextualisation can be linked to an analysis of the educational neuroscience discourse.

Chapter 4

Method – critical discourse analysis

Critical discourse analysis is a multidisciplinary and multimodal theoretical and methodical framework, where macro-sociological theories are interlinked with micro-analysis of text. This implies that critical discourse analysis does not consist of *one* particular theory, nor can it be said to offer *one* specific method design. When Fairclough refers to critical discourse analysis, he therefore often defines his account of it as a 'methodology' rather than a 'method'. The distinction is essential, as *method* implies particular analytical procedures, whereas *methodology* has a theoretical character because it justifies the use of particular research methods (Fairclough, 2010, p. 164). In a critical discourse study, the method used has a complex and research-unique design, which inevitably depends on the object of research and its relevant theoretical framework. Conducting critical discourse analysis is therefore not simply a matter of 'applying methods' in the conventional way (Fairclough, 2010; Jäger & Maier, 2009).

> CDA is not a toolkit for analysing text and talk … which can be evaluated against competing toolkits. CDA does not offer special forms of 'micro' analysis; it is a way of framing any choice of modes of 'micro' analysis. It is a resource for tracing relations between the processes and relations and patterns one can discern in text and talk, and wider social (economic, political, legal etc.) relations and processes and practices and structures (Fairclough, 2010, p. 419).

Lack of a coherent method design has led to the criticism that critical discourse analysis is a rather 'imprecise' and 'vague' mode of study. However, even if critical discourse analysis lacks a detailed and universal method procedure, it has an abundance of methodological accounts of critical discourse studies. Furthermore, flexible methods that allow researchers to tailor analytical designs to their own object of research will require careful theoretical and methodological consideration of one's own research project – this can therefore be seen as a strength rather than a weakness of critical discourse analysis.

Researchers using critical discourse analysis must evaluate potential method designs with the aim of formulating method procedures that will benefit the research. In order to provide transparency in my research process, I will in the following chapter present considerations and clarifications regarding method design for this doctoral project. I will first elaborate on the general methodology of critical discourse analysis, before presenting the method procedures for my critical discourse analysis of educational neuroscience. This latter account includes a presentation of research questions, a definition of discursive boundaries, an account of literature searches, and the presentation of general text analytical designs. Subsequently, I will elaborate on the specific clarifications of the four analytical parts of emergence, hegemony, recontextualisation over structural borders, and recontextualisation over scalar borders, before considering certain limitations regarding the method design.

General methodology of critical discourse analysis

Numerous perspectives are offered concerning critical discourse methodology and analytical designs for how one can strongly link macro-social theories with micro-textual analysis of language. To start with, some basic principles are suggested by Fairclough, in order to distinguish critical discourse analysis from other forms of research. Essentially, Fairclough (2010, pp. 10-11) suggests "that research and analysis counts as CDA in so far as it has all of the following characteristics:

1. It is not just analysis of discourse (or more concretely, texts), it is part of some form of systematic transdisciplinary analysis of relations between discourse and other elements of the social process.
2. It is not just general commentary on discourse, it includes some form of systematic analysis of text.
3. It is not just descriptive, it is also normative. It addresses social wrongs in their discursive aspects and possible ways of righting or mitigating them".

Critical study of discourse offers a transdisciplinary mode of research where the goal is to analyse dialectical relations *between* discourses and other social aspects, in addition to analysing internal relations *within* discourse. This goal reflects the general objective of critical discourse analysis, as it aims "to systematically explore often opaque relationships of causality and determination between (a) discursive practices, events and texts, and (b) wider social and cultural structures, relations and processes" (Fairclough, 2010, p. 93). In view of this, an analysis of discourse will also suggest transgression of disciplinary boundaries, as social, political, and linguistic theories may be put to use (Fairclough, 2010). It is important in this respect that linguistic analyses are not reduced to social theories – nor the other way around. This is noteworthy, as Fairclough aims to transcend the division between social and linguistic studies of discourse by focusing on dialogical relationships between text *and* context.

> So, text analysis is an essential part of discourse analysis, but discourse analysis is not merely the linguistic analysis of text. I see discourse analysis as 'oscillating' between a focus on specific analysis of text and a focus on what I call the 'order of discourse', the relatively durable social structuring of language which is itself one element of the relatively durable structuring and networking of social practices. Critical discourse analysis is concerned with continuity and change at this more abstract, more structural, level, as well as with what happens in particular texts (Fairclough, 2003, p. 3).

This transdisciplinary concept of text and context – the linking of micro-textual analysis with macro-social theories – reflects what Fairclough calls "a relational view of texts, and a relational approach to text analysis" (2003, p. 35). Analytically speaking, this draws attention to certain concerns about 'levels' of analysis and, notably, attention to the relationship between such 'levels'. In order to distinguish these levels of text analysis, this can be arranged schematically as follows (cf. Fairclough, 2003):

- *The level of the social*: 'external' relations of texts, i.e. the text's social context.
- *The level of discourse*: interdiscursive relations, i.e. a mediating level.
- *The level of text*: 'internal' relations of texts, i.e. the text *per se*.

The 'level of text' encompasses language text, spoken or written, and is concerned with the text *per se*. Level of text can accordingly be associated with an analysis of 'internal' relationships of texts, as it includes descriptive and linguistic text analysis (Fairclough, 2003). Methodologically speaking, the argument for such a mode of study is that detailed and systematic analyses of text will reveal how discourse is manifested textually. Essentially this assumes that language is an interconnected and irreducible part of the social, and that there will always be a textual moment in work in the production of social practice and in social life. Fairclough (2003, p. 203) emphasizes this by noting that "[w]ithout detailed analysis, one cannot really *show* that language is doing the work one may theoretically ascribe to it". Numerous analytical tools can assist in the task of revealing ways in which texts represent and construct certain perspectives of the world, social identities, practices, and relationships. However, critical discourse analysis does not initially provide all the analytical modes of study necessary for conducting detailed text analysis, and many analytical strategies come from Michael Halliday's tradition of 'Systemic Functional Linguistics' (Fairclough, 2003;

Halliday, 2002). Other methods of text and language analysis − for instance, perspectives from conversation analysis, linguistic pragmatics, or corpus linguistics − can also be applied to discourse studies (Fairclough, 2003; Wetherell, Taylor, & Yates, 2009). Linguistic modes of analysis therefore cover a variety of textual aspects, ranging from interactional control to metaphors, as well as semantic, grammatical, vocabulary, and phonological relationships.

Moving on to the middle dimension – the 'level of discourse' – this section involves discursive aspects such as discursive practice and processes of production, distribution, and consumption of text. The focus of attention is thus on how texts are articulated and represented, and how they can resemble other texts and other discourses. Accordingly, intertextual and interdiscursive relationships are central to how the relations between genres, discourse, and styles are examined and analysed. These latter aspects can also be found in both 'level of text' and 'level of the societal': In 'level of texts', genres, discourse, and styles can be organised into interdiscursive relationships, as these elements may be articulated, mixed and textured together; whereas, at the 'level of the societal' they can be articulated together through variations in the order of discourse. Since the elements appear in texts and the social, the level of discourse constitutes "a mediating level between the text *per se* and its social context" (Fairclough, 2003, p. 37). In view of the importance of text–context relationship in critical discourse studies, the intermediate level of discourse is a key-element.

At the level of the social, the focus is on analysis of 'external' relationships of texts, as here one is analysing their relationship to other elements of social events and, more abstractly, social practices (such as order of discourse) and social structures (such as language) (Fairclough, 2003). What the three-dimensional model further emphasises is that the level of text and the level of discourse must be interrelated with the social elements of which they are part. Analytically, this may imply an uncovering of relationships between discursive practices, the social, and the order of discourse on which these practices draw. In addition to focusing on the order of discourse, researchers can also examine the social matrix of discourse, scrutinize how practices are regulated and distributed, focus on the ideological and political effects of discourse, study traces of discursive and social change, or examine hegemonic relations (Fairclough, 1992). Considering these broader social traits, this level connects the level of text, discourse, and the societal by means of social analysis. Consequently, researchers will often draw their final conclusions, results, and evaluations when analysing this last level, since this stage addresses issues of, for instance, power, ideological consequences, or social change. Engagement in such issues makes the study political and critical (Jørgensen & Phillips, 1999).

Regarding the actual analysis in critical discourse studies, researchers may wish to code a complete body of text in general terms or analyse a smaller number of samples in more detail. Researchers can also choose various analytical perspectives when analysing texts, as one can code textual data in broad terms, code it in terms of topics, summarize the discourse, scan text material for particular features or formulations, or examine texts with respect to certain types of questions (Fairclough, 1992, p. 230). Furthermore, text analyses may also comprise various modes of linguistic analysis, modes of categorization of texts, and other qualitative text analytical procedures (Wetherell et al., 2009). Bearing in mind that critical discourse analysis emphasizes dialogical and relational aspects of discourse, the levels of text, discourse, and the social will not be analysed separately, but will rather be considered as interlinked. Investigations therefore do not only focus on linguistic analysis, but also include interdiscursive analyses and analysis of social contexts. Taken together, this model of critical discourse analysis can help describe, interpret, and explain the discursive concepts. Another consideration worth mentioning is that the three-dimensional outline illustrates relational dimensions of discourse and how these discursive dimensions should be considered when combining micro-textual analysis with macro-social aspects. It is therefore a *methodological* diagram rather than a specific method design for analysing discourse. Different research projects will have different foci and thus require different method designs. Furthermore, not every research project will find it necessary to cover each level of analysis in the same depth, and again it is the object of research that will determine which delimitations should be made.

Method procedure for this research on educational neuroscience

The method used for the critical discourse analysis in this doctoral project is anchored in Fairclough's critical discourse tradition. In order to present an account of the general method procedure for my analysis of the educational neuroscience discourse, I will in the following sections present more detailed accounts of the research questions, the definition of discursive boundaries, selection criteria for texts, and general text analytical design.

Research theme and research questions

The overarching theme for my doctoral study is the discipline of *educational neuroscience* – that is, as briefly mentioned in the introduction, the rather novel discipline which combines insights from disciplines such as cognitive neuroscience, neurobiology, psychology, and education. Within this cross-disciplinary field one can find different research perspectives, as some researchers or research groups are interested in the concepts of emotions whereas others give their attention to learning difficulties such as dyslexia or dyscalculia. The focus of my study, however, is the overarching *field* linking education and cognitive neuroscience, where I focus more specifically on how one approaches the concept of *learning*. This is because the concept of 'learning' is essential in the fields of education, cognitive psychology and neuroscience (albeit that different meanings are often denoted to the phenomenon, as shown in chapter 2), and the concept of learning can also be shown to be related to other relevant concepts in educational neuroscience, such as emotions and learning difficulties. Furthermore, as my academic background is particularly oriented towards macro-social perspectives on education, I have chosen to align my research approach accordingly. The focus in my doctoral study will therefore be on societal, structural, and relational dimensions of educational neuroscience as a *discourse,* and the overall aim is:

> *to analyse the development and impact of educational neuroscience by using a critical discourse analysis.*

In view of this, relevant research questions are: how the professional discipline of educational neuroscience developed, what 'general' knowledge is accepted within the discipline, which issues and disagreements are negotiated within the discipline, which stakeholders and agents are central to the discourse, and how educational neuroscience is recontextualised into other areas such as public and political fields. In this respect, four discursive concepts for investigation can be of particular value − namely *emergence, hegemony, recontextualisation across structural borders,* and *recontextualisation across scalar borders.* These research aspects are also appropriate since they are consistent with a critical realist approach to critical discourse analysis (Fairclough, 2010; Fairclough et al., 2002). As these concepts further define my critical discourse analysis, four corresponding research questions are defined:

- How and where did the discourse of educational neuroscience *emerge* and develop?
- What are the processes of discursive struggles related to the discourse of educational neuroscience and which associated narratives and relations of *hegemony* can be identified?

- How, where and how extensive has the discourse of educational neuroscience been *recontextualised* across structural borders and into public and political fields?
- How, where and how extensive has the discourse of educational neuroscience been *recontextualised* across scalar borders and into the Norwegian level?

Investigating educational neuroscience in terms of hegemony, emergence, and recontext-ualisation can help in a thorough analysis of the discourse, since together they comprise an analytical approach which combines micro-textual analysis with macro-social perspectives. This approach will also be in line with principles associated with Fairclough's three dimensional concepts of discourse and discourse analysis, because an analysis that combines aspects of emergence, hegemony, and recontextualisation makes allowance for dialogical relationships between text, discourse, and social factors (Wodak & Fairclough, 2010). It should further be noted that certain concept-specific aspects will set these topics and their respective research questions apart, and that the four discursive concepts will therefore be addressed as distinct parts. Specific concept-dependent aspects notwithstanding, the methods for analysing emergence, hegemony, and recontextualisation over structural and scalar borders will share numerous similarities, such as the principles for defining discursive boundaries, the procedure for finding texts to the corpora, in addition to general analytical designs.

Definition of discursive boundaries

Any discourse analysis should encompass a clarification of the discursive lines that are drawn by the researcher in order to delimit the discourse in question. The reason for this is that discourse is neither a concrete nor a constant concept; a discourse can instead be seen as an abstract delineation used to analyse and clarify particular parts of the world. More specifically it is noted by Fairclough that:

> 'Discourse' is widely used in social theory and analysis ... to refer to different ways of structuring areas of knowledge and social practice ... Discourses do not just reflect or represent social entities and relations, they construct or 'constitute' them; different discourses constitute key entities (be they 'mental illness', 'citizenship' or 'literacy') in different ways, and position people in different ways as social subjects (e.g. as doctors or patients) (Fairclough, 1992, pp. 3-4).

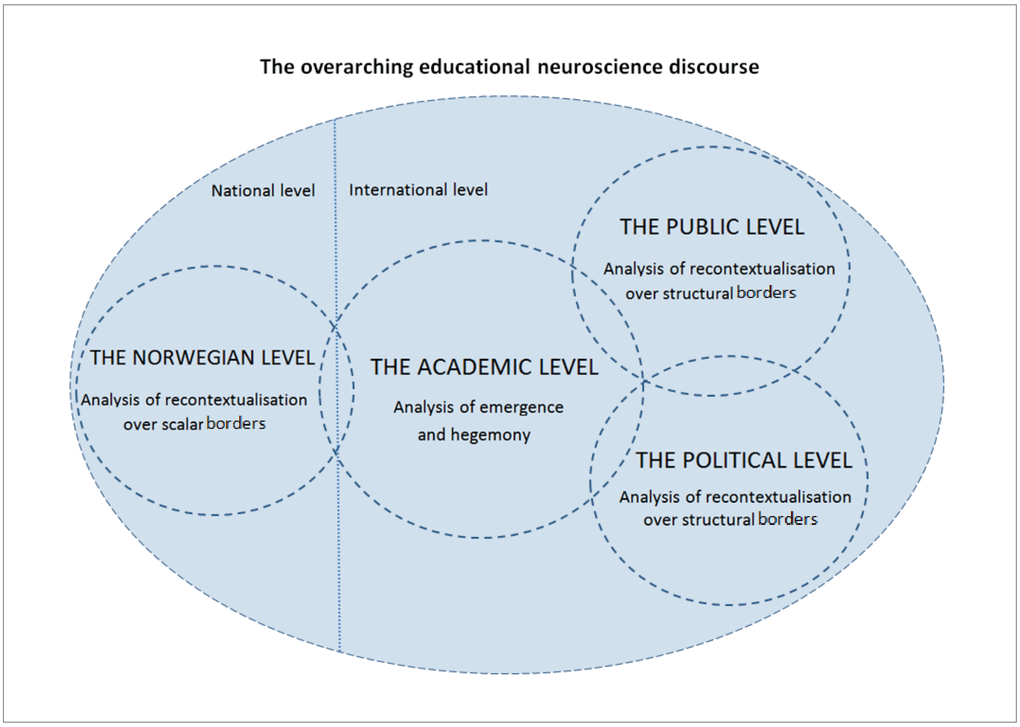
Based on this, one can talk about the 'discourse of education', for instance, or the 'discourse of neuroscience', but one can also talk about a 'social scientific discourse', a 'natural scientific discourse', or an overarching 'academic discourse'. Moreover, an 'academic discourse' can be seen to be in contrast to a 'political discourse' or a 'public discourse' − although aspects of politics and the public cannot be entirely separated from an academic discourse since they are highly interwoven in society. This suggests that discursive boundaries are neither prearranged nor constant, and a discourse cannot be entirely separated from other discourses (Hyland, 2009; Neumann, 2010). The 'borderlines' which separate one discourse from another are, therefore, vague and should be perceived more as analytical delineations of a concept, rather than concepts signifying actual discursive boundaries[22]. Accordingly, it is essential that the discourse analyst clarifies where discursive lines are drawn in a research study, since these boundaries will define and restrict the research in hand.

As this doctoral project's overarching research aim is to analyse educational neuroscience in terms of the discursive aspects of emergence, hegemony, and recontext-ualisation over structural and scalar borders, one can assume that the discourse under study will be similar − namely the *discourse of educational neuroscience.* However, I will argue that the lines defining educational neuroscience as a discourse are far from clear. For instance, is the educational neuroscience *discourse* the same as the academic *discipline* of educational neuroscience? If so, can this discipline be seen to embrace only academics who hold shared perspectives, aims and aspirations? And what about the analysis of the emergence of educational neuroscience − this must surely imply an analytical scope that also encompasses *prior* discourses and disciplines, since the aim here is to scrutinise the historical context of educational neuroscience *before* it was established as a distinct discipline. Moreover, by drawing educational neuroscience's discursive boundaries entirely with academic confines in mind, then what about political and public aspects which also appear to influence, and in turn be influenced by, aspects pertaining to educational neuroscience? For instance, should popular scientific narrations presented in media be excluded from the analysis, since such texts cannot fully be considered under the *academic* domain? With these issues in mind, I have been careful when defining the educational neuroscience discourse. Not only must the discursive boundaries defined make allowance for complex relationships within and between different levels of the educational neuroscience discourse and other related discourses, but definitions of discursive boundaries must also make it possible to analyse particular levels of the discourse without becoming overwhelmed by its complexity.

[22] The concepts of intertextuality and interdiscursivity are used in critical discourse studies as a means to incorporate aspects of discursive 'entanglement', by indicating that any discursive or textual aspect will carry certain 'luggage' from other texts and other discourses.

In order to define certain discursive borders in a field with complex and continually changing borderlines, I have chosen to mark out the analytical field, based on the concepts of emergence, hegemony, and recontextualisation over structural and scalar borders. They are all related to what can be seen as an overarching discourse of *educational neuroscience,* albeit that they can also be seen to represent what Fairclough (2010) calls 'different levels of discourse' in that they focus on somewhat different structural, social, and relational aspects of educational neuroscience. Different levels of the educational neuroscience discourse relevant to this study are illustrated in model 4.1. However, it must be noted that the overarching educational neuroscience discourse can be seen to encompass other discursive levels than the ones I have illustrated here. One should also bear in mind that there is a complex set of relationships within and between these different levels of discourse, because each level can influence, and in turn be influenced by, other levels both within and outwith the overarching educational neuroscience discourse. I have attempted to illustrate the complex set of relations with the dotted lines, which also indicate that these outlines are abstract and unfixed borders.

Model 4.1: Different levels of the educational neuroscience discourse relevant in this study.



In my research I have chosen to differentiate between four levels of the educational neuroscience discourse − namely the academic, public, political, and Norwegian level. I have further placed the academic level in a central position, since educational neuroscience first and foremost can be seen to have emerged and developed as an academic project. The outline of *the academic level* of the discourse is further augmented by reference to educational neuro-scientific aspects which are related to academic structures, practices, and events. As such, the academic level of the educational neuroscience discourse will be relatively similar to the academic *discipline* of educational neuroscience. I further understand the academic level of educational neuroscience to be somewhat different from the public and political levels, in that it can be seen as an entity revolving around specific areas of knowledge and social practice which, in turn, are closely interlinked with, and influenced by, structures, practices, and events from a larger academic discourse. For instance, this can be seen in how knowledge is constructed and structured around the relationship between the brain, mind, and education, and in how practices such as research, publishing of articles, and use of academic language also evolve around this. Furthermore, it appears that certain discursive positions and social roles are more prominent at this discursive level than others, such as relationships between researchers, teachers, and students in education, cognitive psychology, and neuroscience. In view of this, it is the analytical concepts of *emergence* and *hegemony* that are essential at the academic level of the educational neuroscience discourse. Specific clarification of these two concepts is presented later in this chapter, but for the moment, it can be noted that the emergence analysis will focus on how educational neuroscience has emerged and developed as an academic project, whereas the hegemony analysis will investigate hegemonic relationships within and between academic structures, narratives, and practices related to educational neuroscience.

Even if educational neuroscience can be seen to have its origins in academia, it can also be seen to influence, and in turn be influenced by, public and political aspects. In order to encompass these aspects in my critical discourse analysis, I have also outlined the educational neuroscience discourse in terms of *a public level* and *a political level*. The public and political levels can be seen to encompass a range of different structures, practices, and events, and can partly be set apart from the academic level in that they do not follow the same discursive structures as the academic level. The public level can be seen as the part of educational neuroscience discourse most accessible to the public community, since, for instance, it encompasses popular scientific texts and media articles on educational neuroscience, in addition to events linked to the so-called 'brain-based' learning industry. The political level, on the other hand, is more related to policymakers and international interest actors and the ways in which they use educational neuroscience and incorporate it into political discourse. It is the analytical concept of *recontextualisation across structural borders* that is apposite in this respect, since it addresses how educational neuroscience has become distributed to the public and political fields. Outlines for the recontextualisation analysis are therefore *not* drawn with the main focus on academic discipline, as with the emergence and hegemony analyses; instead they focus on fields with internalised aspects of educational neuroscience. Particularly of interest is the consideration of how educational neuroscience is presented in media (in news articles and popular scientific literature), how a single 'branch' of so-called 'brain-based' learning industry as arisen, and also how educational neuroscience appears to have been picked up by policymakers and other significant actors within international organisations and institutions.

The last level of interest in the educational neuroscience discourse is the level of Norway. Just as educational neuroscience can be seen to be recontextualised across structural borders, so can it be seen to be recontextualised across *scalar* borders which lie between the international and the national. I have chosen Norway as a level of particular interest, principally due to my Norwegian nationality. However, I will also argue that Norway is an interesting level of analysis as the country appears to be in its initial stages of introducing educational neuroscience, and it can thus act as a valuable case of analytical study. In this respect one can ask how educational neuroscience has been received by academics in Norway, how media presents this topic, if there are any examples of brain-based learning industries, and how educational neuroscience is represented in political documents. In order to investigate these aspects of the Norwegian level of educational neuroscience, discursive outlines will be drawn with the main focus on capturing the reach of educational neuroscience in Norway, with an additional focus on the Norwegian academic, public, and political fields[23].

Finding texts

After describing a set of research questions for the analysis and outlining the boundaries for the discourse, the next step in critical discourse analysis is consideration of the text material, or *corpus*, for analysis. This is essential, since my understanding of the *discourse* of

[23] Further clarifications on different discursive levels and relevant analytical concepts will be presented in page 99-118.

educational neuroscience will emerge through an analysis of the manifestation of the discourse in *texts*. However, available text material relevant to a discourse is usually too massive to examine in full. Consequently, the task of constructing a manageable body of texts appropriate for analysis is essential (cf. Krippendorff, 2004). In this respect, one has to decide on the size of the corpus, procedures for a literature search, which search tools to use, and criteria for which texts to include and exclude from the corpora. The following sections describe these procedures by elaborating on guiding principles for the research corpora, literature searches used in this study, inclusion and exclusion criteria, and presentation of the final texts selected for corpora. As text data selected in a critical discourse study is the basis for analysis, the following account is also presented in order to provide research transparency.

Guiding principles for the research corpus

As my research topic is the discipline of educational neuroscience, seen in relationship to the concepts of emergence, hegemony, and recontextualisation over structural and scalar borders, my corpus must inevitably reflect this line of study. Furthermore, it has been emphasized that samples for the corpus will depend upon researchers' knowledge of the relevant 'archive' (Neumann, 2010). With regard to background knowledge, it must be stressed that as a preliminary to this doctoral research, I conducted a master project where I surveyed the field of educational neuroscience. I can therefore modestly say that the discourse of educational neuroscience – and the archive related to this discourse – is rather familiar to me. Such familiarity was helpful when selecting corpora, although, it must be stressed that further insight into the field and relevant archives also arose throughout the research.

Another factor, which defines a research corpus, is whether or not the intention is to examine small sets of texts or larger quantities of data. In this respect, one ought to acknowledge that there are strengths and weaknesses associated with both methods. Using a large-scale corpus, for instance, has been criticised, because with this method it is not feasible to include more detailed and qualitative samples of texts, whereas research using smaller sets of data has met with criticism, since "attempting to answer research questions from a limited set of data introduces the spectre of sampling bias" (Krippendorff, 2004, p. 111). In order to avoid some of this criticism, my discourse study on educational neuroscience will draw on a rather large set of data, using both large-scale and detailed approaches to text analysis. I also believe that using a large-scale research corpus will be beneficial, since I intend to select texts from the academic, public, political, and Norwegian level of the educational neuroscience discourse. In order to choose a profitable research corpus which encompasses relevant texts for each discursive level and their respective analytical concepts, I will refer to four distinct corpora for the analytical parts of emergence, hegemony, and recontextualisation over structural and scalar borders. This implies that each of the four analytical parts is based on a body of text that corresponds to the specific research questions and discursive level in question. As I intend to use structural and interactional analysis of larger discursive structures and changes in relationships within and between discourses, rather than a detailed linguistic text analysis of just two or three texts, I have further decided that each of the four corpora will refer to approximately 25-30 texts.

Even if this critical discourse study consists of four corpora, certain general criteria will be followed. The research corpora will mainly consist of *written* texts – these being articles, book chapters, media reports, and collections of political documents written in English or Norwegian − since this will help to narrow down the quantity of relevant data. Literature searches for the research corpora will also be conducted in order to detect so-called 'monument texts' or 'cruces' in the educational neuroscience discourse. A monument text can be seen as a key text for the discourse, and cruces are further defined as 'moments of crisis' in the discourse as they draw attention to conflicting opinions, changes, problematisation of practices, and other points of difficulty (Fairclough, 1992, p. 230; Neumann, 2010). Monument text and cruces in a discourse can be of analytical value and it is therefore beneficial for critical discourse analysts to find such texts in literature searches. Regarding selection of a body of texts, Fairclough (1992, p. 228) also stresses that "the corpus should be seen not as constituted once and for all before one starts the analysis, but as open to ongoing enhancement in response to questions which arise in analysis". The collection process for the corpus will therefore be open to alteration, and incorporation of supplementary text materials at later search stages is thus a possibility.

Literature searches and search tools

As I aim to analyse educational neuroscience at different discursive levels, and to focus on different discursive concepts, the scope for potential text material relevant to my research could be massive. In order to achieve validity and soundness of procedures for collecting texts, I will try to ensure that my literature searches are precise in their targeting, and systematic in their screening of texts. I will therefore follow a set of designated search procedures, since this can support ordered literature searches and consistent evaluation procedures for texts. As the approach of 'systematic literature review' is a generally accepted method for literature searches with a defined systematic search approach, I have chosen to adapt certain parts of this method to my literature search. The following process is based on the procedure for a systematic literature review by Jesson, Matheson, and Lacey (2011, p. 12), but I have adjusted it to make it compatible with my critical discourse analysis of the educational neuroscience discourse:

1. Define research questions for analysing a particular concept (i.e. emergence, hegemony, or recontextualisation over structural/scalar borders) of educational neuroscience.
2. Identify a range of information sources to discover where key information is available.
3. Develop online searches by identifying key words and creating complex searches.
4. Define inclusion and exclusion criteria for the corpora.
5. Search online databases, follow up citations, and keep a record of results.
6. Screen titles and abstract.
7. Reduce the data, generate categories, and produce final interpretation criteria.

The first step has been covered in the previous section and thus the other key points will be elaborated on in the following section − starting with the identification of relevant information sources. As the discipline of educational neuroscience is relatively 'new', I can expect to find the majority of relevant texts on the internet − or at least find them listed in internet databases and/or library catalogues. Internet searches are therefore a sound gateway to finding relevant text materials for the four research corpora, but this method also generates certain difficulties when it comes to the vast *amount* of data resulting from searches. In order to ensure a comprehensive search procedure, I intend, when possible, to use web-based search engines which provide *systematic* literature searches. In this respect, certain criteria must be fulfilled. For example, the search engine must present results in chronological order, in addition to being able to detect older references, which are often 'hidden' from general web searches, since they may be listed in web based library catalogues. Moreover, it is important that the search databases used are accurate, up to date, suitable for comprehensive literature searches and refer to texts with quality information. The search engines used must additionally present correct quantities of information, so that a particular article reference only appears once instead of turning up numerous times in a result set. It is also essential that search engines used for systematic literature examinations provide ample tools such as key word search, reference search, author search, search within a specific timespan, and other valuable search options[24]. Based on these criteria, I have chosen to use search engines such as web-based library catalogues from the library of Bristol University and the Norwegian University of Science and Technology, in addition to the online database *'Web of Science'*. Thomson Reuters' Web of Science (formerly known as ISI Web of Knowledge) is an international database and online index for peer-reviewed academic journal articles[25] dating from the present back to the 19th century. Web of Science is a comprehensive search engine providing numerous search tools for systematic and targeted literature searches. The database is also appropriate for my research since it is not restricted to topic searches in specific areas such as 'education' or 'neuroscience', instead providing *combined* searches over numerous databases such as those which cover 'the sciences', 'social sciences', and 'arts and humanities'. It should further be noted that Web of Science has a database of more than 54 million records in over 12,000 different journals which, indeed, is a substantial number of texts accessible through automatic searches[26] (Web of Science, 2014). This is of note because extensive and combined searches are essential to my search procedure, where the cross-disciplinary topic of educational neuroscience necessitates access to an interdisciplinary literature.

It must be noted, however, that Web of Science may not be able to detect all texts relevant to the different levels of educational neuroscience. The search engine's failure to find some texts can be due to their format, where it is published (e.g. a conference synopsis not listed as a peer reviewed journal article), or the fact that it is not recorded in any of the databases used in Web of Science. Moreover, Web of Science does not refer to policy documents, book articles, or public texts, unless they are part of a reference list in an article. To compensate for this limitation, every reference list of relevant texts listed by Web of Science has been examined with the aim of finding monument texts frequently referred to − these being other journal articles, policy reports, conference or meeting synopses, public texts, or articles in books. In this way, texts which are significant for the discourse, but fail to

[24] Needless to say, neither *Google* nor *Google Scholar* provides systematic literature searches, as these engines are limited in their capacity to order search results chronologically, to detect texts in library catalogues, to show only journal articles, and to utilise un-biased search without being affected by previous searches (i.e. use of 'cookies' in internet searches).
[25] The concept of peer reviews is based on confidence in the reliability of the peer review process. However, there are some limitations in this process, since "being judged by experts who have established perspectives and paradigms can act as a barrier to publishing new and unconventional ideas ... "The result is that there is less likely to be what is known as a paradigm shift, or a fresh movement away from accepted thinking towards a new direction" (Jesson et al., 2011, pp. 20-21). This underlines the importance of also using grey literature throughout my critical discourse analysis in this research.
[26] These journal records are from numerous disciplines, both within social sciences and natural sciences and, of course, many of these fields are not relevant for linking education and neuroscience.

appear in Web of Science, may be detected, examined and, if relevant, included in the corpus for further analysis. What this implies is that Web of Science must be seen only as a search *tool* for guiding my literature search, and *not* as the only gateway to finding relevant texts.

After identifying search engines and literature databases, one should develop online searches by identifying key words and combining these to enable complex searches. What can first be noted with regard to general key word searches is that certain 'natural language' key words can be identified in the search topic itself − in this case it will be *education* and *neuroscience*. Additionally, it is important to identify a 'controlled vocabulary' for key word searches, which includes similar and related words such as synonyms, variants of words[27], and broader or narrower terms of the topic's natural language (Jesson et al., 2011). In the case of this critical discourse study, controlled vocabulary can be *learning*, *cognition*, and *brain*. These key words can further be used to initiate complex searches in the databases, where different combinations, different database-topics, and different time-spans can be selected. To assist key word combinations, Boolean operators, such as and/or/not, can be utilized in order to improve target-specific searches (Jesson et al., 2011). Accordingly, the general search used in my four target-specific literature searches will include the following:

- Searches with different key words and different combination of key words (such as education* neuroscience* learning* brain*).
- Searches with different criteria (timespan, most cited, specific journals, different Boolean operators, etc.)
- Searching additional and relevant texts by cues given in citations and reference lists.
- Searching additional 'grey literature' by cues given in citations and reference lists.

The two last points have been added in order to widen my search beyond the narrow confines of online literature databases, so that 'grey literature'[28] and non-electronic literature such as conference summaries, meeting reports, and books can also be detected. Manual literature searches in library catalogues, examination of printed journals, and other literature searches outside online search-engines are therefore also essential to ensure that I access important articles and monument texts that would not appear in my web-based key word search[29].

[27] The Web of Science database uses the asterisk symbol * when searching for variants for words, such as different endings. Searching for education* will therefore denote a search for education, educate, educational, educative, educationalists, etc.
[28] Grey literature is literature that is *not* academic and/or peer-reviewed texts.
[29] Finding literature besides that of peer-reviewed journal articles is also important as a means to include 'un-biased' published articles in the literature search. Jesson and colleagues (2011, p. 114) note this by stating that "publication bias occurs where journals have a tendency to promote a given approach and reject papers which make a negative stance or produce inconclusive findings." This is also an important point in critical discourse analysis, since it also aims to include and analyse 'less dominant' voices in the discourse (cf. Fairclough, 2010).

In accordance with what is noted in both critical discourse analysis (Fairclough, 2010) and literature reviews (Jesson et al., 2011), I will consider my literature search to be near completion as soon as the same key texts keep appearing when accessing different information sources and trying several complex key word searches[30]. Before finishing my search, I intend to cross-reference my research record with the following checklist from Jesson et al. (2011, p. 30) to ensure that I have undertaken a thorough search:

- Have I searched all the appropriate resources?
- Are there any gaps in the information sources searched?
- Have I used complex search statements as required by individual databases?
- Could any improvements be made to the searches?
- Have I identified all the relevant references?
- Have I used both full-text and bibliographic databases?

Even if this checklist is extracted from a classic literature review, and even if I have adapted numerous procedures from a systematic literature review in order to ensure an ordered and systematic literature search and data examination, I must stress that my research is a critical discourse analysis. This distinction is important to note because, besides from parts of the literature search itself, there are significant differences between a systematic literature review and a critical discourse analysis. Firstly, where a systematic review follows a structured approach and has a rigorous method for searching the literature, a critical discourse analysis is more inclined to also find literature outwith a set of search criteria defined in advance. The reason for searching outwith a specified set of search criteria is because critical discourse analysis also aims to find 'hidden voices' in a discourse, and a rigid schedule for search criteria may not always allow this. Secondly, a systematic literature review usually ends up with a synthesis or meta-analysis, which follows a prescribed form, whereas a critical discourse analysis does not follow a fixed model for its presentation of findings. Thirdly, whereas a systematic literature review aims to show research which has been completed and potential knowledge gaps in a field, critical discourse studies take the analysis to a more critical level as texts are reflected on in a broader societal context. My research must therefore be viewed as a critical discourse analysis, which utilizes a systematic literature approach when searching for relevant texts for the corpora, and not as a systematic literature review per se.

[30] It must be noted that a critical discourse analyst often works with flexible and interactive research stages. New texts and new understanding of the discourse might emerge during the work, and one must therefore be able to incorporate new aspects throughout the research. This implies that new texts can be included in the final corpora even after the general work with the systematic literature search has ended.

Inclusion and exclusion criteria for the corpora

During work pertaining to literature searches, one will often scan a substantial number of texts and one should therefore screen texts successively in accordance with inclusion and exclusion criteria. In order to narrow the four bodies of text down to a manageable size of around 25-30 texts each, and additionally to ensure that all texts are systematically evaluated and selected on the same criteria, I have designed a four-step selection procedure. The pre-set inclusion and exclusion criteria used in the evaluation steps are based on my research questions, critical discourse concepts pertaining to emergence, hegemony, or recontext-ualisation over structural or scalar borders (Fairclough, 2010), and general criteria often used in classic and systematic literature studies (Hart, 2001; Jesson et al., 2011). The general structure for selection procedures is identical for each of the four analytical parts, albeit that each literature search will also have specifically designed inclusion and exclusion criteria corresponding to its respective discursive topics (specific clarification for each analytical part is presented later in this chapter).

The first stage in the screening process for selecting texts for the corpora, encompasses quite broad inclusion and exclusion criteria, since the aim here is to collect as many relevant documents as possible. The title and abstract of texts from internet and e-library searches and from references followed up manually, will therefore be selected in accordance with the following general inclusion and exclusion criteria:

- Texts relevant to educational neuroscience
- Texts relevant to the academic, public, political, or Norwegian level of the discourse
- Texts relevant to emergence, hegemony, or recontextualisation over structural- or Norwegian borders
- Written texts mainly
- Texts in English or Norwegian (the latter for the Norwegian analysis)
- Focus on monument text and cruces in the discourse

After screening texts by using these broad criteria, I am still likely to have relatively large bodies of text relevant to the four research corpora. To narrow the text material down further, three succeeding stages have been designed in order to assess texts with progressively more subject-specific inclusion and exclusion criteria. Each stage also involves a more thorough reading of the texts. The second stage, for instance, aims to select texts in accordance with their potential in scope, and general aspects of each text will therefore be noted. The same procedure is applied in the third and fourth steps, as this involves a more focused reading of the abstract and/or full text, with evaluation criteria closer to the overarching research questions on emergence, hegemony, and recontextualisation over structural and scalar borders. Inclusion and exclusion criteria at these latter stages include, for example, identifying how a text relates to the connection between education and neuroscience, how the relationship between education and neuroscience is presented, if the text shows any particular traces of emergence/hegemony/recontextualisation, if there are any notable intertextual references, or if the text is suggestive of any boundary conflicts or transgressions.

By systematically evaluating texts through a four-step examination plan, my intention is to avoid exclusion of relevant texts due to general and superficial search criteria. In addition, I have also designed these four comprehensive review stages − each with more focused readings and more targeted inclusion and exclusion criteria − as a means to obtain an overview of the available data. In turn, this can aid in the selection of four useful corpora for my critical discourse analysis of educational neuroscience. It should also be mentioned that a record is kept for each text evaluated, where key points from the criteria above are recorded and evaluative remarks regarding either inclusion or exclusion criteria are given. The final texts in the four different corpora will therefore contain an extensive record of key elements which can be used in the final critical discourse analysis.

Table 4.2: Search report table for the four analytical parts.

	Emergence	*Hegemony*	*Recontext. over structural borders*	*Recontext. over scalar borders*
Approx. number of hits resulting from the literature searches[31]	121 115 texts	2 082 texts	364 740 739 texts	452 849 texts
1st stage: scanned in e-library databases and grey literature	6 495 texts	1 146 texts	1 979 texts	3 716 texts
2nd stage: interesting and potential in scope	131 texts	107 texts	127 texts	203 texts
3rd stage: relevant in topic after reading	79 texts	65 texts	77 texts	108 texts
4th stage: data in final corpus	24 texts	29 texts	27 texts	31 texts

[31] These amounts may not be accurate, since some texts can be presented in numerous complex key word searches.

The search report table and number of relevant articles after each round of literature screening is reported in table 4.2, and complete evaluation lists for inclusion or exclusion of a text in each of the four stages of the four corpora can be found in appendix B. The first corpus consists of 24 texts and is selected with the intention of analysing the *emergence* of educational neuroscience, whereas the second corpus encompasses 29 texts and is selected with the purpose of analysing educational neuroscience's *hegemonic relation.* The corpus for analysing educational neuroscience's *recontextualisation over structural borders* and into the public and political level, comprises 27 texts, and the last corpus for analysing educational neuroscience's *recontextualisation over scalar borders* and into the Norwegian level, encompasses 31 texts. Full reference lists for the corpora are presented in appendix C.

General text analytical design

As previously noted, an understanding of the discourse of educational neuroscience will emerge through an analysis of texts, because discursive relationships, structures and other discursive aspects will inevitably be manifested in a discourse's text. In Fairclough's critical discourse analytical tradition, a chief endeavour is to combine textually oriented discourse analysis with non-textual discourse analysis (for example, approaches associated with Michael Foucault). Fairclough's approach can therefore be seen to move between linguistic analysis of specific texts and interdiscursive analysis of order of discourse (Fairclough, 2003). Regarding linguistic analysis of text, researchers within the critical discourse tradition tend to refer to 'systemic functional linguistics' (SFL).

> My main point of reference within existing literature on text analysis is Systemic Functional Linguistics (SFL), a linguistic theory and associated analytical methods particularly associated with Michael Halliday. In contrast with the more influential Chomskyan tradition within Linguistics, SFL is profoundly concerned with the relationship between language and other elements and aspects of social life, and its approaches to the linguistic analysis of text is always oriented to the social character of text ... This makes it a valuable resource for critical discourse analysis (Fairclough, 2003, p. 5).

The combination of critical discourse analysis and systemic functional linguistics is highlighted by numerous researchers within the two respective fields, since the two approaches share several major commonalities (Fairclough, 2003; Halliday, 2002). Young and Harrison (2004) expand on these commonalities, noting in particular three shared aspects: their emphasis on the role of language in society, their view of a dialectical relationship between language and discourse, and their shared emphasis on cultural and historical aspects of meaning. However, there are some differences between the two traditions worth mentioning: firstly, whilst systemic functional linguistics uses highly specialised linguistic terms, discourse analysts try to use simpler terms when analysing text; secondly, critical discourse analysis is more trans-disciplinary than systemic functional linguistics as it attempts to combine linguistic analysis with various social theories (Fairclough, 2003). Considering its lack of references to social theories and analysis, systemic functional linguistics should be seen as a supplementary text analytical tool within the critical discourse analytical tradition.

In line with these arguments, in my critical discourse analysis I will make use of systemic functional linguistics as an *additional* framework for detailed text analysis. Examination will be based on textual analysis and interpretation of a series of texts pertaining to educational neuroscience. Each text will be studied using interactional text analysis and structural analysis, whereby an attempt is made to categorise the underlying meaning of a text and interpret it in accordance with a pre-set list of terms. The pre-set lists in each of the four analytical parts are designed in accordance with the analytical discourse concept and the related set of research questions (see appendix D). Additionally, to enable a more qualitative path of analysis, smaller samples within the corpora will be selected for more detailed analysis, as these can illustrate certain qualities of the educational neuroscience discourse (cf. Jørgensen & Philips, 1999). For every text analysed, a data extraction sheet will be completed, on which, for instance, traces of discursive boundary problematisation, detection of representations, de-articulation, re-articulation, changes in relationships and narrations are noted (cf. Fairclough, 2003, 2010; Hitching & Veum, 2011). Identification and interpretation of these aspects is essential in critical discourse analysis since we after "discussion of terms, models, narrations and categorisations will get a clearer picture of the discursive field we are attempting to map" (Hitching & Veum, 2011, p. 129). Moreover, because each text in a corpus is analysed with the same key concepts, an overarching critical discourse analysis and interpretation of discursive concepts and an assessment of the level of discourse at hand will be available. The four analyses can, in turn, be seen in relationship to one another, as they illuminate different levels of discourse. This is important to note, since it is not each individual text *per se* that is interesting in this critical discourse study, but rather the comprehensive picture of the educational neuroscience discourse that they make together.

In order to keep to basic analytical vocabulary, and to follow Fairclough's example, specialised linguistic terms will not be used. Definitions, terms, and analytical categories will, instead, follow systemic functional linguistics as adapted by Fairclough in his critical discourse analysis, since these modes of analytical categories are more applicable to a social analysis of discourse (Fairclough, 1992, 2003, 2010). Moreover, to direct the focus towards the issues of textual analysis discussed in previous sections, in this study detailed text analysis will be concerned with textual notions such as intertextuality, difference, strategies, assumptions, discourses, representations of social events, modality and evaluation. As such, these modes of analysis will, include both structural analysis (e.g. analysis of relationships between orders of discourse) and textual and interactional analysis (e.g. linguistic analysis) (cf. Fairclough, 2003). Overall, structural, interactional and textual analysis will be relevant to each of the four research issues of emergence, hegemony, and recontextualisation across structural and scalar borders. However, lines of analysis and relevant data for examination will vary for every issue, as each discursive concept has its own sets of research questions, which inevitably direct the respective text analysis.

It should be emphasized that my critical discourse analytical study is broad, since I intend to clarify the manifestation of the educational neuroscience discourse in terms of the four concepts of emergence, hegemony, and recontextualisation at different discursive levels (i.e. the academic, public, political, and the Norwegian level). This indicates that what is gained in breadth is lost in depth, because time and scope constraints for my doctoral project do not allow for a comprehensive as well as an in-depth analysis of the educational neuroscience discourse. I will, therefore, not meticulously *explain* discursive changes in light of extensive social, historical, ideological and political theories in order to clarify *why* these discursive structures exist and operate in the way they do − simply because such a study would diminish the scope of my research considerably. Rather, my intention is to present a comprehensive account of the manifestation of the educational neuroscience discourse, where key concepts relevant to the emergence, hegemony, and recontextualisation of the educational neuroscience discourse are critically analysed and discussed.

With regard to the presentation and discussion of results from my critical discourse analysis, a chapter will be dedicated to each of the four critical discourse analyses of emergence (chapter 5), hegemony (chapter 6), and recontextualisation over structural and scalar borders (respectively chapters 7 and 8). It should also be noted that a central aim for critical discourse analysts is to illuminate certain discourses so "that people become more aware of the discursive practices they are a part of when using language and consuming texts, in addition to craft awareness of those social structures and power relations which discursive practices are formed by and, in turn, contribute to form and change" (Jørgensen & Phillips, 1999, p. 100). In other words, the aim is not to prove *which* discourse, text, or reading is 'correct', but rather to show such different views and consider them all as "evidence of the text's inherent ideological ambiguities, distortions and absences" (Codd in McCulloch, 2004, p. 47).

Specific clarifications to the four analytical parts

I have argued that four particular discursive concepts can be beneficial for a comprehensive analysis of the educational neuroscience discourse − namely the concepts of emergence, hegemony, and recontextualisation over structural and scalar borders. Procedures for analysing these four discursive concepts will, on the whole, follow the same general method design as presented above. However, certain concept-specific aspects and designs will be appropriate, and the subsequent sections will therefore clarify the notions exclusively related to each of the four analytical discourse concepts applicable to my critical discourse study on educational neuroscience.

Emergence

The analytical concept of 'emergence' is defined as an analysis of "the processes of emergence of new discourses, their constitution as new articulations of elements of existing discourses" (Fairclough, 2010, p. 367). As mentioned in the theory chapter, the basic principle is that nothing can emerge out of 'nothingness'. Regarding the development of discourse, it is argued that a discourse will arise from building on already existing discourses. Emergence can thus be seen as a 'reweaving' of existing discourses where discursive boundaries are questioned and crossed, elements of the old are articulated in new ways, and a new discourse is constructed. Considering that discourse is a complex notion, its development will inevitably also encompass notions of change − not only changes in texts, but also those in social practice, social agents, institutions, organisations, ideas etc. Changes in a discourse are therefore sought by: identification of intertextual articulations in historical series of texts, notions of discursive boundary crossing, detection of developing strategies, and other aspects which reveal a discourse's emergence process (Fairclough, 2010).

Outline of discursive boundaries and specific research questions

In my doctoral research, I intend to investigate how educational neuroscience has emerged and developed as an academic project and discipline. Accordingly, the analytical focus lies at the academic level of the educational neuroscience discourse. Considering that the emergence concept focuses on traces of early appearances and development of the discipline, prior and external discourses in a historical context related to educational neuroscience are also of interest. This implies that the analytical focus will be based at the academic level of educational neuroscience (i.e. the discipline we are familiar with in the present day), but the emergence analysis is also likely to encompass relevant discursive fields *prior* to the discipline's establishment. Considering that educational neuroscience has a central connection with relationships between the mind, the brain, and education, it will be relevant to investigate discourses pertaining to this link − such as the discourse of education, that of cognitive psychology, and of cognitive neuroscience. Historical notions are also considered in respect to these discourses, so that changes within discourses prior to how we know them today can be acknowledged[32]. Discursive delimitations in the critical discourse analysis of emergence will therefore encompass:

- the academic level of the educational neuroscience discourse
- prior discourses from which the academic project and discipline of educational neuroscience can be seen to have emerged (e.g. education, cognitive psychology, and cognitive neuroscience)
- educational neuroscience's earlier and more contemporary phases (i.e. 1800-2013)

The analysis of educational neuroscience's emergence will focus on a historical series of texts pertaining to the connection between the brain, the mind, and education, with the aim of explaining how, where and when the academic level of the discourse emerged and how it has continued to develop. The emergence analysis can therefore be done by focusing on research questions such as:

- Where can one locate the discourse of educational neuroscience within the field of prior discourses?
- How did the discourse of educational neuroscience emerge from this prior field?
- Which structural and strategic emergence processes can be found?
- Why has a discourse of educational neuroscience emerged in the past few decades, when the connection between mind, brain, and education has arguably existed for centuries?

[32] Neuroscience, for instance, appears to have been established as an academic discipline around the 1970s. Numerous sub-fields within the brain sciences such as neuroanatomy and neurobiology have, however, existed since the 1800s and these fields are important when considering educational neuroscience's history.

- What are the 'main themes' in the discourse of educational neuroscience, and how does the discourse represent, narrate and 'justify' these particular themes?
- Which particular perspectives, points of view, and positions are available within the discourse of educational neuroscience?
- Which recurring themes can be found throughout the history of educational neuroscience?
- Which changes in themes can be found throughout the history of educational neuroscience?

Analysis of relationships found *between* the discourse of educational neuroscience and the field of prior discourses will be identified, in addition to any identification of changed relationships *within* the discourse. This may explain emergence processes relating to problematisation of discursive borders, discursive transgression, changes in narrations, constitution of discursive positions, potential emergence strategies, and changes in narrative justifications[33]. Furthermore, clarification of these aspects concerning the emergence of educational neuroscience can explain the discourse itself, since "discourse is not simply an entity we can define independently: we can only arrive at an understanding of it by analyzing sets of relations" (Fairclough, 2010, p. 3).

Finding texts for the emergence corpus

The procedure for finding texts for the emergence corpus will, in general, follow the principles for literature searches that already have been elaborated on. However, certain clarifications should be made with respect to search procedures that are particularly influenced by the level of discourse at hand and concept-specific research questions of emergence. What can firstly be noted is that text material chosen must be relevant for analysing the emergence and development of educational neuroscience. It is also essential that these texts come from both the academic level of educational neuroscience discourse (viz. the educational neuroscience discipline) and from the field of external discourses such as those pertaining to the discourse of education, cognitive psychology, and cognitive neuroscience. Historical notions are also central in this respect, and texts chosen must cover a significant timespan wherein the discourse of educational neuroscience can be seen to have emerged and

[33] It must be noted that other authors before me have presented historical accounts and literature reviews of educational neuroscience (Beauchamp & Beauchamp, 2013; Théodoridou & Triarhou, 2009). However, my intention is not to give a descriptive historical account of the topic; rather, it is to present a critical discourse analysis where the emergence and development of educational neuroscience is discussed in light of critical discourse theories pertaining to structural and strategic emergence processes and changes in discursive elements. Furthermore, such critical discourse analysis of the emergence also provides a basis for the pending analysis of hegemonic relationships and recontextualisation of the educational neuroscience discourse, since these concepts seem to have been left in a void without a comprehensive historical foundation.

developed. As texts relevant to the emergence of educational neuroscience are likely to have been published as far back as the 19th and 20th centuries, it is important that literature searches focus on online engines such as the Web of Science[34], *in addition* to manual search methods in, for instance, library catalogues.

By using general and emergence-specific criteria, the search procedure for the final emergence corpus covered a timespan from 1815 to 2013. By using the four-step reading and evaluation procedure with specific inclusion and exclusion criteria relevant to the emergence concept, a total of 24 texts from the academic level of the educational neuroscience discourse were selected for the emergence corpus. As previously mentioned, the four-step evaluation criteria can be found in appendix B, and a complete list of the selected texts for the emergence corpus is presented in appendix C

Critical discourse analytical procedure

With regard to the actual analysis of the emergence of educational neuroscience, procedures will largely follow the general text analytical design for this study − namely interactional text analyses and structural analysis. Nevertheless, it should be mentioned that researching relationships between the discourse of educational neuroscience and prior discourses can be done by analysing the discipline's emergence and the relevant constitution of external discourses. Such analysis will require a genealogical approach, which locates the discourse within a historical context (cf. Fairclough, 2010). Emergence, development, and location of educational neuroscience in a historical context will further involve analysis of discursive articulations. In this respect, text analytical perspectives such as intertextuality and traces of interdiscursivity are essential, since such concepts can help to identify how the discourse of educational neuroscience bears resemblance to – and combines – features of other external discourses and texts. Analysing the emergence of educational neuroscience will also enable identification of any development in relationships found within the discourse. In addition to recognition of different discursive positions within the discourse, detection of the main themes and narratives presented in the discourse will therefore also be essential in the analysis. Such examination will comprise text analysis, where, particular, texts within the discipline itself will be analysed since the intention is to identify and locate certain statements

[34] It should be noted that some of the first key word searches in Web of Science 'only' date back to 1918. This indicates that I need to rely on other and more manual search strategies for relevant literature conducted before the 20th century.

in terms of thematic categories. Considering that each text in the historical series will be analysed with the same set of analytical categories and topics (cf. appendix D), it will also be possible to conduct an overarching critical discourse analysis of the whole sequence of texts. This overarching analysis can help to identify any changes and continuities throughout the historical line of discursive elements pertaining to relationships within the discourse of educational neuroscience and between the fields of related discourses.

After analysing, categorising, comparing, and evaluating the historical series of texts, the results are presented and discussed. Chapter 5, *'The emergence of educational neuroscience',* will present a general and chronological account of educational neuroscience development from the 19th century to present date. Direct quotes from texts in the corpus are used to underline the historical narrative presented. Chapter 5 will also encompass an interpretive and critical account of the emergence and development of educational neuroscience. In this part, findings from the textual analysis are critically analysed and discussed by approaching the topic from a critical discourse theoretical perspective. This implies that the general historical account is attempted illuminated by use of critical discourse theories concerning discursive boundaries, discursive structures, emergence structures, discursive change and other relevant theories. Quotations from texts in the corpora will also be used in this latter part, this time to underline interpretation and arguments.

Hegemony

The second research issue, 'hegemony', further examines discourse as it indicates analysis of "the processes of particular emergent discourses (and not others) and associated narratives becoming hegemonic" (Fairclough, 2010, p. 367). As already mentioned in the theory chapter, the concept of *hegemony* in critical discourse theories is concerned with notions of power relationships both within and between discourses. One basic principle underpinning the hegemony concept is that discursive 'truths' and regularities will constitute a natural focus for struggle and change (Fairclough, 2010). Essential in this respect are notions of discursive *struggle*, since dialogue, negotiation and conflicts between different discourses may lead to hegemony of particular discourses. One aim is therefore to show how some discourses gain prominence whilst others become marginalized over time. Relationships between texts and more permanent and institutionalised levels of 'reality' and social structures are therefore also essential.

> CDA can provide particular insights into the struggle between different strategies for transforming society in different directions through rhetorically oriented analysis of how strategic differences are fought out in dialogue, debate, polemic etc. But again such analysis must be informed by and integrated within transdisciplinary critique which seeks to explain the success of certain strategies and the failure of others, and also 'positive' critique which seeks to identify strategies which are, as we might put it, both desirable (in that they may advance human well-being) and feasible (Fairclough, 2010, p. 20).

In my research, the analytical issue of 'hegemony' will encompass an analysis of relationships of dialogue between discourses, in addition to debates, conflicts, and dominance between educational neuroscience and other related discourses.

Outline of discursive boundaries and specific research questions

Analysis of hegemony can help to illuminate points of negotiations, struggle, power, and hegemonic relationships pertaining to the discourse of educational neuroscience. With regard to the level of discourse of interest, I consider it essential to focus on the academic level of educational neuroscience when analysing hegemonic relationships. The reason for this is because I have decided to base my research at the academic level of educational neuroscience, and, from there, investigate its emergence, hegemony, and its further recontextualisation to other levels of discourse. This suggests that attention to hegemonic relationships at the academic level of educational neuroscience can help to further examine discursive changes identified in the analysis of emergence (e.g. changes in narrations, justifications, and discursive positions). Consideration of hegemony can also help to identify which topics that are significant points of struggle in the academic discipline, which voices in the academic debate are marginalised, and which practices have become more or less taken for granted, in addition to providing insight into how certain narrations have gained prominence over time at the academic level of educational neuroscience. In turn, this can be seen in relationship with the two analytical parts concerning 'recontextualisation', since these analyses will inevitably encompass certain hegemonic relationships with reference to educational neuroscience's public, political, and Norwegian level.

Regarding an outline of discursive boundaries relevant to the hegemony analysis, it should be noted that this analytical part does not necessarily benefit from studying exactly the same outline as the previous emergence analysis. This is because a more thorough analysis of hegemony may be obtained by paying attention to the later and more contemporary phases of the educational neuroscience discourse, rather than considering prior and historic discursive events in the 19th and early 20th centuries. Texts from the earliest phases of educational neuroscience history can reveal more of the appearance and development of the discourse than texts from 1980s and onwards, which are more likely to reveal hegemonic relationships found in debates during the time when educational neuroscience became established and developed as a distinct academic discipline (cf. findings from the emergence analysis). However, analytical focus is not strictly limited to the level of educational neuroscience, since in disciplinary borderlines, one can find negotiations, conflicts, and hegemonic relationships which may be valuable to consider in a hegemony analysis. Overall, this suggests that the outline of discourse in the hegemony analysis should encompass:

- the academic level of the educational neuroscience discourse
- closely related fields which may help to illuminate hegemonic struggles pertaining to educational neuroscience, and
- educational neuroscience's later and more contemporary phases (i.e. 1980-2014)

Outlining and defining the discourse under investigation are connected with the set of research questions for the discourse study. If we start by looking at the overarching aim in the analysis of *hegemony*, this is to investigate hegemonic relationships pertaining to educational neuroscience's academic level. Analysis of hegemonic relationships can accordingly be conducted by directing focus to research questions such as:

- Which narratives (including implied definition of terms such as assumptions and presuppositions) of educational neuroscience are represented? How concretely or abstractly, specifically or generally, are they represented?
- Are there any negotiations, struggles and conflicts pertaining to the educational neuroscience discourse?
- Do any sets of discursive conventions implicitly embody or naturalize certain (ideological) rationalities?
- Can any discursive elements (narrations, justifications, positions, practices etc.) be seen to hold a dominant and hegemonic position, and are any elements neglected?
- If there are hegemonic or neglected elements, then how can these discursive aspects appear to have gained hegemonic prominence, or have become marginalised, over time?
- Are there struggles and power relationships between different strategies for transforming society in different directions, and why do some of these strategies appear to succeed whilst others fail?

Considered together, questions concerning 'hegemony' entail locating points of struggle related to the academic level of the educational neuroscience discourse. Researching hegemonic issues can thus direct us toward confrontations between the new discipline of educational neuroscience and, for instance, more established and long-standing disciplines of education, psychology, and neuroscience. Furthermore, enquiries about 'hegemony' will direct attention towards conflicts pertaining to certain representations or themes, such as philosophical issues regarding mind, brain and education, issues of vocabulary and of a theoretical or methodological nature, struggles between discursive positions, or other contestations and struggles concerning educational neuroscience (cf. Fairclough, 2010; Wodak & Fairclough, 2010). Not only can such analysis be interesting because it considers tensions and struggles pertaining to the educational neuroscience discourse, analysis of hegemony can also be valuable since it seeks to critically analyse discursive aspects that have, to some extent, become 'naturalised' in the discourse. The aim is thus to explore both the heard and the *un*heard voices in the discourse, in addition to questioning *how* certain representations have become more salient than others.

Finding texts for the hegemony corpus

Regarding literature chosen for the final corpora, the most essential criterion is, indeed, that these texts are relevant for examining hegemonic relations pertaining to the academic level of educational neuroscience discourse. In this respect, texts including debates, negotiations, or conflicts are particularly interesting, since such 'points of struggle' are more likely to reveal hegemonic power relationships as they reveal tensions within and between discourses (Fairclough, 1992; Neumann, 2010). As such, relevant texts for analysis are monument texts, which can be seen as 'cruces' or 'moments of crisis'. Such 'cruces' make visible any conflicting opinions, problematisation of practices, changes and other points of difficulty pertaining to the discourse, and will consequently be ideal for analysing issues of hegemony and discursive struggles. Moreover, and contrasting with the analysis of emergence, the timespan for literature searches for the hegemony corpora will not date too far back in history. Instead, the focus is on later and more contemporary phases of the educational neuroscience discourse. Giving attention to the last couple of decades can also be justified due to findings from the former emergence analysis, as this discourse analysis has indicated an increase in debates pertaining to educational neuroscience in the 1980s, the late 1990s and onwards. Based on these findings, the timespan for the literature search for the hegemony corpora ranges from 1980 to 2014. It should further be noted that one comprehensive search tool which covers literature within these criteria is Web of Science. There are however limitations to this search-engine, since it chiefly covers peer-reviewed journal articles and thus excludes 'grey literature' and texts *not* published in the scientific journals covered by Web of Science. With respect to the analysis of hegemonic relationships − where both dominant *and* marginalised voices should be analysed − it is also important to rely on different types of literature gateway when searching for texts relevant to the corpora. Accordingly, I have chosen to deploy search engines such as web-based library catalogues from the libraries of Bristol University and the Norwegian University of Science and Technology, in addition to manual searches where relevant key words and references in texts can be followed up. In this way I can detect texts that are relevant to the discourse but fail to appear in Web of Science.

By systematically evaluating texts by a four-step examination plan with hegemony-specific inclusion and exclusion criteria (appendix B), I have obtained a final corpus consisting of 29 texts from the academic level of educational neuroscience discourse. A reference list for the final hegemony corpus is presented in appendix C, and a data extraction sheet for the critical discourse analysis of hegemony is presented in appendix D.

Critical discourse analytical procedure

Analytically, hegemonic relationships of the educational neuroscience discourse have been studied using the general text analytical design for this study. Each text has therefore been examined by using interactional qualitative text analyses and structural analysis, although, in the analytical part I have attempted to categorise and interpret the text's underlying meaning in accordance with pre-set lists of hegemony-related inquires (see appendix D). The analytical issues I have attempted to identify are, for instance: traces of negotiations or hegemonic struggles; argumentation standpoints and ideological manifestations; attempts to naturalise or *de*-naturalise discursive aspects; tendencies of domination or marginalization, whether or not certain narrations (significantly) have been excluded, whether or not the complexities of reality have been reduced and condensed, and whether or not there are any conflicts which can particularly be seen as negotiations with more ongoing or permanent and institutionalized levels of social reality and social structures (cf. critical discursive analysis pertaining to hegemony, as noted by Fairclough, 2003, 2010; Hitching & Veum, 2011; Wodak & Fairclough, 2010). Moreover, since every text in the corpora has been analysed with the same key concepts and target questions, together they have made available a more overarching and comprehensive picture of hegemonic relationships pertaining to the academic level of the educational neuroscience discourse. Analytical findings and discussions of results are presented in chapter 6.

Recontextualisation over structural borders

The concept of *recontextualisation* was originally suggested in Bernstein's sociology of pedagogy, although it has been operationalized as a category in critical discourse analysis in order "to explore the potentially distinctive recontextualising principles associated with different fields or networks of practices (governmental, academic, public sphere etc.)" (Fairclough, 2010, p. 422). The central goal of the analytical concept as such, is to investigate ways in which a certain discourse is distributed across its discursive boundaries and into other fields. In this respect, it is further distinguished from investigation of discursive dissemination across structural and scalar boundaries, where *structural* boundaries are seen to lie between organisations and institutions, or between different social fields such as education and politics.

Outline of discursive boundaries and specific research questions

The third analytical part of this research will focus on educational neuroscience's recontextualisation over *structural* boundaries. In this respect I consider it essential to focus on how the academic project of educational neuroscience has been distributed across the public and political fields, since it appears that aspects of education and neuroscience can particularly be found in these two fields. Accordingly, the analytical focus is on how the academic level of the educational neuroscience discourse has been recontextualised at the *public* level and at the *political* level of the discourse (see model 4.1). The outline for the recontextualisation analysis over structural borders is therefore *not* drawn with the intention of focusing mainly on the academic level of the discourse, as with the emergence and hegemony analysis. Instead, it focuses on the public and political levels which contain internalised aspects of educational neuroscience. Based on knowledge of previous literature searches and findings from the emergence and hegemony analysis, it will furthermore appear that four areas in particular are prominent in the educational neuroscience discourse − namely the media and the so-called 'brain-based' learning industry (viz. the public level), in addition to policy-makers and other significant interest actors within intergovernmental organisations (viz. the political level)[35]. Overall, this indicates that the outline of discourse in the recontextualisation analysis over structural borders encompasses:

i) the public level of the educational neuroscience discourse
   a. media
   b. the so-called 'brain-based' learning industry
ii) the political level of the educational neuroscience discourse
   a. policymakers showing interest in educational neuroscience
   b. international organisations and other actors interested in educational neuroscience (e.g. OECD, Royal Society, EU)
iii) educational neuroscience's earlier and more contemporary phases (i.e. 1800-2014)

The outline of the level of discourse under study connects to the set of research questions, where the overarching endeavour is to investigate: *how, where and how extensively has the academic level of educational neuroscience become recontextualised across structural boundaries to the public field and the political field?* In order to further direct the analysis, the following research questions can be useful (cf. Chouliaraki & Fairclough, 1999; Fairclough, 2010):

- Identification of traces where educational neuroscience is disseminated across structural boundaries to the *public field* and to the *political field.*
- How and where are educational neuroscientific representations articulated within the *public field* and the *political field?* I.e. how is educational neuroscience rearticulated in (and set in relationship to) the old field?
- How is educational neuroscience internalized within particular public and political fields (e.g. in businesses, in the media, in political domains, and in intergovernmental organisations)?
- Can traces of 'colonisation' and/or 'appropriation' of educational neuroscience's recontextualisation be found at the public and political fields?
- Which interest groups/agents give the impression of being significant where educational neuroscience is recontextualised across structural boundaries? How do these interest actors present educational neuroscience?
- What is the relationship between agents from educational neuroscience's academic level and agents in the respective public and political fields?

As these questions suggest, the concept of 'recontextualisation' will point the research towards structural dissemination of the discourse and narratives of educational neuroscience.

[35] *Academic* texts regarding, for instance, brain-based learning programmes and neuromyths, will be used as background information and not as text in the corpora *per se*. This is because academic texts (and texts pertaining to the academic level of educational neuroscience) are already analysed in both the emergence analysis and the hegemony analysis, whilst the chief focus in this part is on *recontextualisation* of the academic level of discourse.

It is thus of analytical value to see educational neuroscience being taken on board by political agencies, international organisations, and by the public. It is particularly interesting to consider how educational neuroscience is presented by the media (in news articles and popular scientific literature), how a so-called 'brain-based' learning industry has emerged, and also how educational neuroscience appears to have been adopted by policymakers and other significant actors within international organisations and institutions. It is also relevant to consider how educational neuroscientific narratives at public and political levels can be seen in relationship to narratives presented at academic level.

Finding texts to the recontextualisation corpus

The basic search strategy for finding a comprehensive corpus is, indeed, to cover appropriate texts wherein recontextualisation of educational neuroscience at public and political levels can be found. In contrast to the analysis of emergence and hegemony, analysis of recontextualisation of educational neuroscience will focus only on literature searches for grey literature. Grey literature is *not* academic and peer-reviewed texts, and thus media articles, 'brain-based' learning websites, and political reports and statements will fall into this category. Focusing on grey-literature will therefore alter some of the search procedures, since the search-engine for Web of Science is not adequate for the targeted literature. Instead, more internet searches and library searches of news articles, brain-based literature, and policy reports are used in order to find an adequate body of relevant texts for studying educational neuroscience's recontextualisation across structural borders and into the public and political domains. This further indicates that the possibility of conducting a *systematic* literature search is somewhat reduced, since general literature searches on the internet, using search tools provided by, for instance, Google or Firefox, do not have the same rigorous standards as the search-engine for Web of Science[36]. Nevertheless, to ensure as far as possible an ordered search and evaluation of the literature, I still follow the four-step search procedure which I have designed for this research − albeit, with content-specific searches and criteria corresponding to recontextualisation over structural borders. With regard to the timespan

[36] The possibility of conducting a stringent and systematic literature search does, indeed, seem to be reduced, due to the exceedingly large number of texts on the internet. To illustrate this, it can be noted that whereas my general literature search for the emergence corpora gave 121 115 hits and that of hegemony gave 2 082 hits (both chiefly conducted on the search-engine, Web of Science), my general literature search for the recontextualisation corpora on the Internet gave almost 365 million hits. To conduct a *systematic* literature search with such a large number of texts would therefore exceed the scope and possibility of this critical discourse analysis.

relevant for literature searches for the recontextualisation corpus, here I have also chosen to focus on educational neuroscience's later and more contemporary phases (i.e. 1980-2014). This is because previous findings, particularly from the emergence analysis, indicate that this is the period when educational neuroscience has undergone significant growth and spread to other fields.

Based on these criteria, a general literature search of grey literature was conducted in e-library resources, online archives, and library catalogues, and a total of 364 740 739 hits resulted. What became apparent after the first general literature search, was the enormous amount of text, how many different actors appeared to have an interest in educational neuroscience, and the range of different topics found − from neuroscientific aspects on sleep and learning, to thinking caps and cognitive abilities, presented in everything from pop-scientific media articles, blogs, 'brain training' games, to political manifestos. The amount of relevant texts and the number of different actors with an interest in educational neuroscience was too vast to be covered in this third analytical part of my critical discourse research. Search criteria needed to be narrowed down even further and I therefore decided to focus particularly on the USA and UK, because these are the two largest western English-speaking countries. Additionally, based on my general literature search and what this examination identified as recurring topics and prominent actors in the public and political fields, I decided to focus on:

- Prominent international media agents: particularly the BBC, The Times, The New York Times, The Guardian, Science Daily[37]
- Brain-based educational *products*[38]
- Prominent policymakers in the UK and US (cf. English speaking countries)
- Prominent international interest agencies: OECD, EU, The Royal Society, EEF and the Wellcome Trust
- Specific searches on different internet portals, archives and in library catalogues
- Additional searches for relevant texts by cues given in citations and reference lists
- Searches for the 'most cited' texts (because I am interested in texts that have/have had significant impact at the public and political levels).

[37] Selected because they are some of the largest news providers in the UK and in the USA.

[38] Brain-based education material can be seen as a broad umbrella term which covers 'brain-based education theories', 'brain based principles and corresponding instructional techniques', 'brain based neurofeedback training' and 'brain based educational products' (Sylvan & Christodoulou, 2010). Differences between these four sub-categories are elaborated on later, but for the moment, it can be noted that the latter, i.e. *brain-based educational products*, are commercialized programmes. Considering that this category is closely related to a profit-oriented learning industry that does not necessarily have an academic or professional foundation, this subcategory was selected as a point of focus in the analysis.

By focusing the search on these particular areas within the public and political fields, certain aspects were inevitably excluded from the literature search. However, what was lost in diversity was gained in more target-specific searches for what appear to be prominent actors and features in the public and political levels of educational neuroscience. In this respect, it must also be mentioned that due to the significant existence of educational neuroscience in the public and political fields – both in the array of topics and the numerous interest actors − this analysis does not seek to research in-depth any specific focus found in this area[39]. The aim is rather to 'skim the surface' in order to identify the scope of impact of the educational neuroscience discourse into the larger societal discourse. After evaluating texts from the general literature search on these focus areas, using the inclusion and exclusion criteria relevant for the recontextualisation-concept (see appendix B), I acquired a total of 27 texts for the recontextualisation corpus (see appendix C). Of these, ten texts are media articles[40], six are brain-based learning programmes, six are related to policymakers in the UK and US, and five are from other interest actors/organisations.

Critical discourse analytical procedure

Directing the focus on text analytical applications, 'recontextualisation' can be textually recognised as the mixing of 'new' recontextualised elements with 'old' elements. An analytical point is thus to identify how educational neuroscience is "articulated with discourses that already exist within these new contexts" (Fairclough, 2010, p. 509). In this respect, focus upon intertextuality and interdiscursivity can be of value. When it comes to the former, intertextual relations implies a focus on how features of educational neuroscience (e.g. words, phrases or larger elements) are incorporated in other texts external to the discipline of educational neuroscience. Analysis of interdiscursive relations, though, will imply endeavours to identify and examine traces of educational neuroscience in other discursive levels and fields external to the academic level of educational neuroscience. When it comes to analysing sections of texts and how they narrate and recontextualise certain aspects of educational neuroscience, it can further be of value to compare them in terms of

[39] Besides, there are already some in-depth analyses of some of these aspects, such as Gonon, Bezard, and Boraud's (2011) study on misinterpretation of neuroscience data on ADHD in the media, Sharp, Bowker, and Byrne's (2008) research on VAK learning programmes in primary schools in England and Wales, and O'Connor, Rees, and Joffe's (2012) study on media coverage of neuroscience in the UK daily newspapers. These studies do not look into the topic of educational neuroscience *per se*, but do touch upon central aspects related to the recontextualisation of the discourse in the societal field.

[40] More media articles were chosen since media articles often are approximately 400-800 words, whilst, in comparison, brain-based webpages can be 2 000 - 4 000 words and policy reports 2 000 - 40 000 words.

which elements are included or excluded in other fields, with what degree of generalisation aspects of educational neuroscience are represented, and how aspects of educational neuroscience are arranged, explained, legitimised and evaluated across structural boundaries (see appendix D). The text analytical procedures to be utilised are therefore detailed text analysis and structural analysis. The analytical issues that may be identified are, for instance, how features of educational neuroscience are internalised in public and political texts, how educational neuroscience narrations and practices are re-articulated and set in relation with 'old' elements in the particular field, traces of 'colonisation appropriation' dialectics, identification of significant interest actors and how they present educational neuroscience (cf. Fairclough, 2003, 2010; Hitching & Veum, 2011). Identification and interpretation of these discourse concepts are essential, since they can help make visible how and to what extent the academic level of the educational neuroscience discourse is recontextualised over structural boundaries and into the public and political fields. Critical discourse analytical findings and the related discussion will be presented in chapter 7.

Recontextualisation over scalar borders and to Norway

The concept of recontextualisation can, as noted in the previous section, be analysed with regard to how a discourse is distributed across structural borders and across scalar borders. The discursive concept of recontextualisation in the two approaches is the same, and thus they also share many discourse theoretical perspectives and analytical procedures for critically analysing a discourse's recontextualisation to other levels of discourse. Their difference can, however, be found in the analytical focus on discursive borders − where the former focuses on structural borders found between organisations and institutions or between different social fields, whereas the latter focuses on discursive recontextualisation across borders found between the local, the national, and the international (Fairclough, 2010). In this respect, my forth and last analytical part will focus on how educational neuroscience is recontextualised across scalar borders and to the Norwegian level of the discourse.

Outline of discursive boundaries and specific research questions

This analytical part aims to investigate the ways in which the international level of the educational neuroscience discourse is recontextualised over scalar borders and into Norway, and the discursive outline is therefore drawn with respect to the Norwegian level (see model 4.1). Considering that my analysis so far has focused on the academic level (viz. the emergence and hegemony analysis) and the public and political levels (viz. analysis of recontextualisation over scalar borders), I have chosen to also focus on the academic, public, and political fields which can be found within the Norwegian level of the educational neuroscience discourse[41]. The reason I have chosen to pay attention to all these three fields is because I have a hypothesis that a comparison over scalar borders can show some interesting aspects with regard to the ways in which educational neuroscience is distributed to the academic-, public- and political level in Norway. An outline of the recontextualisation analysis over scalar borders therefore encompasses:

i) The academic field related to the Norwegian level of the educational neuroscience discourse.
ii) The public field related to the Norwegian level of the educational neuroscience discourse.
iii) The political field related to the Norwegian level of the educational neuroscience discourse.
iv) Educational neuroscience's earlier and more contemporary phases (i.e. 1800-2014).

Outlining the discursive level to be studied is connected with the relevant set of research questions, where the overarching objective is to investigate *how, where and how extensively the international level of the educational neuroscience discourse has become recontextualised across scalar borders to Norway.* In order to direct the analysis further, the following research questions are helpful (cf. Chouliaraki & Fairclough, 1999; Fairclough, 2010):

- Identification of traces where educational neuroscience is disseminated across scalar boundaries to the academic, public, and political fields in Norway.
- How and where are educational neuroscientific representations articulated within the Norwegian academic, public, and political fields? I.e. how is educational neuroscience re-articulated in (and set in relation to) the old field?
- How is the educational neuroscience internalised within particular academic, public and political fields (e.g. in Norwegian academia, debates, media, and amongst national policymakers)?
- Can traces of 'colonisation' and/or 'appropriation' of educational neuroscience's recontextualisation be found at the Norwegian academic, public and political levels?
- What is the relationship between agents of the *international* level of the educational neuroscience discourse and agents in the respective fields of Norwegian academic, public and political?

[41] When it comes to an outline of the academic-, public-, and political fields in Norway, these fields will, by and large, follow the same principles as the outline of the international academic-, public-, and political levels. Borderlines between such categorisation can overlap and sometimes it can, as became evident throughout the sparse Norwegian search, be difficult to find texts relevant to such categorisations.

Concept of 'recontextualisation' will, as these questions suggest, point the research toward scalar dissemination of the discourse, where analytical focus is on educational neuroscience's uptake in the academic, political, and public domains in Norway.

Finding texts for the Norwegian recontextualisation corpus

As with previous literature searches, procedures for finding texts for the Norwegian corpus follow the general search design set out for this research. Certain concept-specific criteria were germane − for instance that literature searches must identify relevant texts wherein educational neuroscience's recontextualisation to the academic, public, and political fields in Norway can be found. In this analytical part, I have also decided to pay attention to educational neuroscience's later and more contemporary phases, and literature searches thus focus on the timespan ranging from 1980 to 2014. Relevant search engines in this respect are, therefore, databases for Norwegian academic and peer-reviewed articles (such as Idunn, Web of Science, and ERIC), general internet searches, and target-specific searches in databases such as 'Kunnskapsdepartementet' and 'Regjeringen'[42], and ATEKST[43]. Relevant key word searches focus on Norwegian target words such as 'utdanning, nevrovitenskap' ('education, neuroscience') and 'hjernebasert læring' ('brain-based learning'), but also on English words since Norwegian academics may publish their texts in English. This implies that the possibility of conducting a precise and *systematic* literature search is somewhat reduced, since general literature searches on the internet, using search tools provided from, for instance, Google or Firefox, do not have the same rigorous standards as the search-engine Web of Science. Nevertheless, to ensure as ordered a search and evaluation of literature as possible, I will follow the same general literature search design as in the previous analysis. Overall, literature searches for the Norwegian corpus focus on:

- Texts from the academic field relevant to the Norwegian level of educational neuroscience discourse
- Texts from the public field relevant to the Norwegian level of educational neuroscience discourse: particularly with focus on Norwegian media articles and brain-based educational products
- Texts from the political field relevant to the Norwegian level of educational neuroscience discourse

[42] 'Kunnskapsdepartementet' (Ministry of Education and Research) and 'Regjeringen' (The Norwegian Government) provide database searches in governmental achieves. These database searches automatically search through the Norwegian government's electronic documents that are open to the public – whether draft resolutions, official Norwegian reports (NOU's), white papers (Meld. St.), or other official documents.

[43] 'ATEKST Retriver' is a web-database where one can conduct complex searches for Norwegian electronic and printed media texts. ATEKST is said to offer 'complete' media coverage and articles from NRK, Aftenposten, VG, Dagbladet, Morgenbladet, Klassekampen and other Norwegian media agencies are included. In my search, texts (whether printed and/or web-based) from media agencies with a national reach were selected.

- Internet searches with different Norwegian (but also English) key words[44]
- Specific searches on different internet portals, archives, and in library catalogues (such as in ATEKST, Kunnskapsdepartementet, Idunn etc.)
- Additional searches for relevant texts by cues given in citations and reference lists

Certain clarification should be made with regard to this list. Most importantly, the analytical part concerning educational neuroscience's recontextualisation to Norway is similar to the other analytical parts in terms of the size of corpus, the amount of analytical work estimated, and scope for presenting my critical discourse analytical findings. This implies that the coverage of the Norwegian academic-, public-, and political fields will be considerably lower than the international academic-, public-, and political level of educational neuroscience (as three analytical parts are dedicated to addressing these levels of the educational neuroscience discourse). One should bear this in mind, since this further suggests that my discourse analytical findings from, for instance, the academic field in Norway are based on a smaller amount of textual data than discourse analytical findings related to the international academic level of the educational neuroscience discourse.

It should also be noted that the amount of texts pertaining to the linkage of education and neuroscience is significantly smaller in Norway than in an international context. The overall body of literature relevant for including in the Norwegian corpus is therefore less than that which is relevant for the corpora of emergence, hegemony, and recontextualisation over structural borders. Since the overall body of Norwegian text relevant to educational neuroscience is so small (at least in comparison with international literature searches), I also had to select texts that cannot be precisely allocated to either the academic, public, or political fields. Considering that segregations between these fields are overlapping, selections of texts at these borderlines can lead to difficulties when analysing, comparing, and discussing discourse analytical findings. There are, for instance, pop-scientific texts published in the media that bear a close relationship to the academic field − say, if academics co-author or are interviewed in an article presented in a public newspaper. One can, moreover, find differences between newspapers, as some media agencies have a more scientific profile (such as

[44] It must be emphasised that I intend to analyse Norwegian texts published within the Norwegian context of either the academic, public, or political field. As such, texts (co-)authored by *international* actors but published within the *Norwegian* context can be interesting to analyse, since these text are made available at the Norwegian level – and hence also are liable to influence events, practices and discursive structures at the Norwegian level. Texts published by *Norwegian* authors at the *international* level are, on the other hand, not necessarily essential in this analytical part, since this text will link more to the international discursive level, and not to the Norwegian level. Indeed, a Norwegian actor publishing educational neuroscientific texts at an international level would be of note, albeit, in this respect it would be more relevant if such an actor also published texts within his/hers own national context.

Morgenbladet) whereas other agencies focus on tabloid media stories (such as VG). The same goes for articles published with relation to the academic field in Norway, since some of these articles are peer-reviewed, whereas other texts are published in minor academic magazines (such as Lektorbladet). Other academic texts can further be closely interlinked with the political field if they, for instance, are commissioned research reports[45]. In order to elaborate on the type of texts that are selected in the academic, public, and political fields in Norway, in addition to showing a detailed list over the different literature searches in Norway, I have documented the four-step evaluation list for inclusion/exclusion criteria for the Norwegian corpus in appendix B.

Using general literature searches, a total of 452 849 hits resulted from the different key word searches and following of references. By systematically evaluating text documents through the four-step examination plan, I further managed to narrow the text material down to a final 31 texts in the corpora. Of these, 8 texts are from the academic field, 16 texts are from the public field (2 of these are brain-based learning programmes), whilst 7 texts are related to policymakers in Norway. A complete reference list of texts selected for the Norwegian corpus can be found in appendix C.

Critical discourse analytical procedure

The analytical procedure of recontextualisation in Norway is, by and large, similar to that of the recontextualisation analysis over structural borders at the international level − the only differences are related to the concept-specific research questions asked. Central to the investigation is identification of differences between educational neuroscience at an international scale in comparison with how educational neuroscience is distributed on a national scale in Norway. The essence is to identify how the international level of educational neuroscience is internalised within Norway (see appendix D). Accordingly, the analytical focus is, for instance, on how elements of the educational neuroscience discourse are re-articulated and put in context with discursive elements that already exist within these new contexts (Fairclough, 2010, p. 509). Examination is based on textual analysis and

[45] Commissioned research reports are a type of grey literature where research consultants − often academic researchers − are appointed and paid for by policymakers or organisations to undertake a certain type of research. In this respect it is noted by Jesson et al. (2011, p. 56) that "the final research report will have undergone several reviews by the commissioner until an agreement is made ... The final report may be the version with which the commissioners are happy because it meets their organisational needs".

interpretations of the texts in the recontextualisation corpora. Each text is studied using both interactional qualitative text analyses and structural analysis, where the text's underlying meaning is categorised and interpreted in accordance to pre-set lists of inquiries. Analytical issues which may be identified are, for instance, how features of educational neuroscience (e.g. words, phrases or larger elements) are internalised in the Norwegian academic, public and political texts, how educational neuroscience narrations and practices are re-articulated and set in relation to 'old' elements in the particular field, and traces of 'colonisation-appropriation' dialectics (cf. Fairclough, 2003, 2010; Hitching & Veum, 2011). The analytical part concerning educational neuroscience's recontextualisation over scalar borders and into the Norwegian level will be presented in chapter 8.

Considerations and limitations

This last section will consider some limitations with regard to my research on the discourse of educational neuroscience. In this regard it must be noted that the tradition of critical discourse analysis has been the subject of some general critiques, which may be germane for my research as well. The critical discourse tradition, as previously mentioned, has been particularly criticised for offering rather vague and unspecified methods. Lack of a general method procedure is, as argued by critical discourse analysts, due to the notion that every research project is unique, and method designs may thus vary depending on the object of study, research questions, sampling of corpus, and theoretical framework. Attempts to force incompatible projects into restrained method schemes would obstruct the research, and it is therefore argued that critical discourse analysts should strive to define a method design applicable to one's particular research (Fairclough, 2003). Construction of specific method procedures for each critical discourse study will, however, call for a certain degree of consideration and reflexivity from the researcher. Moreover, as researchers make numerous choices in order to design a research-specific method for their critical discourse study, notions concerning the study's replicability become an issue. In addressing questions of replication, it is emphasised that critical discourse analysts should strive for a high degree of research *transparency* – every choice and each step in the research should therefore be presented as explicitly as possible (Bratberg, 2014). In view of notions of replicability, and in consideration of issues of vague method procedures in the critical discourse tradition, in this chapter I have tried to present every step and every decision concerning my method design.

As I cannot elaborate on all the decisions made concerning literature searches and analytical designs, I have supplemented my method account with more detailed clarification in the appendices (see appendix B-D). Hopefully, this transparency will help illuminate the choices which have been made, and disclose the foundations from which interpretations have been drawn throughout the course of this research.

It must also be stressed that research transparency is particularly essential when it comes to selecting literature for the corpora. As selected text material constitutes the basis of a critical discourse analysis, much will depend on the selection criteria used. Moreover, the design of search procedures, definition of selection criteria, and the final assessment of which texts should be incorporated and which should be excluded from the corpora, will inevitably lay open to my subjective evaluation of what constitutes good and representative corpora for analysing the educational neuroscience discourse. The key question here is whether a similar analysis, but with *different* educational neuroscientific texts, would result in other discourse analytical findings and, subsequently, other interpretations of the educational neuroscience discourse. Indeed, questions regarding selection and representativeness of data are critical in all research, and in order to ensure adequate data material, I have chosen to follow certain principles. Firstly, I have ensured that design selection procedures for my literature searches are in line with the principles set by renowned authors in critical discourse studies and systematic literature reviews (cf. Fairclough, 2003, 2010; Hart, 2001; Jesson et al., 2011). Secondly, I have given much consideration to *where* I can locate relevant texts for each of the four analytical concepts and their related discursive levels, and *how* I can ensure that I detect as many relevant texts as possible. In this respect, systematic and comprehensive search engines such as Web of Science and university library catalogues have been utilised, in addition to general internet searches and specific archive searches in relevant databases. It has also been essential to follow up references and cues given in texts, in order to detect other relevant monument texts in the discourse. Thirdly, I have used comprehensive literature searches and relatively large corpora in this study as a means of addressing questions regarding representativeness of data. By choosing texts based on aspects frequently occurring in the general literature searches, in addition to choosing 25-30 texts in each corpus, I hope to have covered textual, discursive, and social aspects which are relatively representative for the educational neuroscience discourse. Moreover, by analysing four discursive concepts ranging over four different discursive levels, I also hope to present a relatively representative overview of the *overall* educational neuroscience discourse. Finally, what should be noted with regard to representativeness of data, is that some of my critical discourse analytical findings seem to correspond with findings from other studies concerning educational neuroscience (cf. Beauchamp & Beauchamp, 2013; Samuels, 2009; Théodoridou & Triarhou, 2009)[46]. Even if none of these studies have used critical discourse analysis, they nevertheless point to comparable or similar findings with regard to aspects pertaining to the discourse of educational neuroscience.

Another question, which should be addressed here is: 'can discourse explain'? There is much debate concerning whether or not discourse analysis should (or can) come to any conclusions about cause (Bratberg, 2014). In this respect it should be clarified that discourse analysts often focus their research on *interpretation* rather than explanation. Discourse analysis is therefore not about cause and effect; rather it is about understanding social and discursive events, actions and structures (Bratberg, 2014; Fairclough, 2010). Moreover, it is argued that discourse analysts have the potential to study *relationships of causality* in broader terms than quantifying cause effects.

> We can, first of all, attempt to say something about where a discourse comes from, and what there is that gives a certain discourse a prominent or hegemonic position. We can, secondly, be concerned with consequences or implications; what does the discourse lead to? Here the causal relation is about drawing connections from language to behaviour, in that it is assumed that social and political action is influenced by the dominant discourse (Bratberg, 2014, p. 51 [my translation]).

These notions should also be kept in mind with reference to this doctoral study, since my discourse analysis will focus on *interpretation* and discussion of *relationships of causality* with respect to educational neuroscience's emergence, hegemony and recontextualisation, rather than offering explanation of cause and effect related to the discourse.

Regarding critical discourse studies, there are other considerations which ought to be highlighted – particularly concerning the role of the researcher and his or hers relationship to the discourse. Reflexivity over notions of *objectivity* is essential in almost every research project and one cannot ignore the claim that pure objectivity is an impossible concept– every study will, from the moment the object of study is chosen and the research question is set out, be influenced by some form of subjective inclinations, choices, and preferences (Bratberg, 2014). The researcher, therefore, will inevitably, have some subjective predispositions which affect the development of the research. However, when conducting a critical discourse

[46] Some of which have been published during the course of my doctoral research.

analysis, such predispositions ought to be noted, since the researcher's analytical endeavour often is to look 'beyond' structures and manifested truths within a discourse. Paradoxically, however, a researcher tends to be part of the discourse under examination. Considering my interest in educational neuroscience, and the amount of work I have put into the task of examining the discourse, I cannot consider myself to be a neutral bystander completely detached from the discourse of educational neuroscience[47]. I am part of this discourse and as such will be subject to representations, discursive relationships, and structures central to the discourse. Despite my best efforts, I will become entangled in the discursive web which I myself am trying to disentangle. I therefore suggest that a completely objective analysis is impossible to achieve. However, entangled as I will be, I am not *unaware* of being in the discourse. After all, my aim is to *critically* analyse the discourse and I will thus be obliged to attend to the constant task of reflexivity within potential discursive structures and relationships pertinent to educational neuroscience.

Another aspect worth mentioning is related to the analysis of texts in this research: even if I make use of detailed text analysis, I will not be conducting micro-linguistic text analysis at micro-detailed grammatical, lexical and vocabulary level. This is because the majority of text material used in this study is written in English. Even if my English is acceptable, I am not a native speaker and have not studied English linguistics. Nevertheless, I will use detailed text analysis, focusing on this analysis at a more basic level and *not* being concerned with micro-linguistic textual analysis. Moreover, and in line with what is noted in the section above, it should be stressed that text analysis is a process encumbered by selection. "In any analysis, we choose to ask certain questions about social events and texts, and not other possible questions" as Fairclough (2003, p. 14) notes, before continuing: "There is no such thing as an 'objective' analysis of text, if by that we mean an analysis which simply describes what is 'there' in the text without being 'biased' by the 'subjectivity' of the analyst". This notion is also in line with a realist ontology of science, which emphasizes that 'what is there' cannot be reduced to our *knowledge* of reality (Bhaskar, 2008). Arguments based on critical realist ontology will therefore also apply to texts, and "we should not assume that the reality of texts is exhausted by our knowledge about texts" (Fairclough, 2003, p. 14).

[47] I am not only subjective concerning the discourse of educational neuroscience, I am also part of an *academic* discourse with its own rules and its own relationships of hegemony, ideology, and power. My reasons for choosing the topic of educational neuroscience, as well as the particular philosophic, theoretical and methodological framework, are not coincidental.

This is a recurrent philosophical principle in my research on educational neuroscience, of which readers should be aware.

Moreover, I cannot escape from personal engagement with this research − I do have opinions which, unavoidably, will be reflected in the evaluation and discussion of issues relevant to educational neuroscience. The importance of being honest about such engagement is often emphasised within the tradition of critical discourse analysis, and Jørgensen and Phillips (1999, p. 76) even note that "critical discourse analysis does not perceive itself as politically neutral (as objectivistic social science often do); but as a critical approach politically engaged in social change … Besides, one often has the intent that results derived from critical discourse analysis can be used in the strive for radical social change". It is important to note, however, that reflections, evaluations and considerations should not be camouflaged as neutral accounts of reality, and that the respective presentations of analysis and evaluation will therefore clearly be separated. In my dissertation, therefore, I have separated my most subjective and evaluative notions from the critical analysis and discussions and, instead, documented them in the distinct chapter for *'final reflections'*. Furthermore, as a researcher I should be aware of the responsibility I hold when presenting certain aspects of the world – in this case, aspects key to the discourse of educational neuroscience.

> [T]he critical analyst, in producing different interpretations and explanations of the area of social life, is also producing discourse. On what grounds can we say that this critical discourse is superior to the discourse which its critique is partly a critique of? The only basis for claiming superiority is providing explanations which have greater explanatory power. The explanatory power of a discourse (...) is its ability to provide justified explanations of as many features of the area of social life in focus as possible (Fairclough, 2010, p. 8).

In view of this, a chief endeavour is to provide a solid analysis (both in the number and range of features that are chosen, and in the quality of analysis), so that explanations provided can bear a certain degree of explanatory power and profundity.

Summary of the method chapter

This chapter has presented a methodological justification of critical discourse analysis, in addition to a more specific account of the method procedure and analytical design, which are used in my critical discourse analysis of educational neuroscience. When selecting and arguing for a particular method procedure, particular suggestions have been made about the importance of linking detailed text analysis with more macro-social theories of discourse. I have further presented a method design for analysing four concepts of the educational neuroscience discourse − namely emergence, hegemony, recontextualisation over structural borders, and recontextualisation over scalar borders. The value of analysing these discourse concepts are supported by my argument that this combination of discursive concepts can provide a multi-faceted and comprehensive identification of different levels of the educational neuroscience discourse. Not only can such an approach present an account of the development and emergence of the discipline of educational neuroscience, it can also indicate different discursive position and representations, points of struggles, and relationships of hegemony both within and between the discourse and other central discourses to educational neuroscience. In this respect, issues of recontextualisation are apposite, and the significance of steering the analysis towards how processes of educational neuroscience impact at different 'scales' and over different 'structural borders' is highlighted. Overall, I suggest that the method design selected for this study is advantageous for addressing the aim and research questions defined at the outset of my research. I further suggest that the method design is consistent with a realist approach to critical discourse analysis, which further helps to build coherence in my philosophical, theoretical and methodological framework for analysing the discourse of educational neuroscience.

Chapter 5

The emergence of educational neuroscience

What we group under the name of the sciences is, as the application of the word in the plural shows, no single entity, but consists of many separate fields of knowledge, which often lie far apart. Through the increase of such knowledge, these fields increase, and their boundaries, originally far apart, approach each other more and more. The investigation of these border zones then becomes one of the most interesting problems in science and a new branch of science itself, whereby the experience and methods of one speciality are applied to the other and entirely new points of view are reached that lead to fruitful work in both fields.

Constantin von Economo (1876-1931)
in Théodoridou and Triarhou (2009)

In the following chapter, my critical discourse analysis of the emergence of educational neuroscience's academic level is presented. The central elements in this respect are analysis of the ways in which educational neuroscience emerged as an academic project and discipline, which recurring themes, strategies, and positions can be found in the course of its history, and which changes can be discovered throughout educational neuroscience's development. The first part of the chapter will present a descriptive account of educational neuroscience's history from the 19th century to the early 20th century, and the second part provides a critical analysis and discussion of certain key elements of the emergence of the academic level of educational neuroscience.

Historical account of the development of educational neuroscience

The following descriptive account of the academic project of educational neuroscience is based on textual and historical references ensuing from my literature search and my discourse analysis. In order to present a cohesive timeline, findings related to the emergence analysis are organised chronologically – starting with the late 19th century and ending with the present 21st century. In addition, findings are linked to a broader historical context in order to provide a more comprehensive account of the development of educational neuroscience as an academic project and discipline. It must be further stressed that some aspects of educational neuroscience's emergence are related to forthcoming analysis and discussions, such as hegemonic aspects and educational neuroscience's recontextualisation to other levels of discourse. When this is the case, I will give as full an account as possible, whilst signposting forthcoming chapters where these aspects are elaborated on more thoroughly. Overall, the first part aims to establish a general historical account of educational neuroscience's development upon which the subsequent discussion in part two is based.

Late 19th century and early 20th century

Findings from my emergence analysis indicate that some of the first traces associated with a linkage between brain, mind, and education can be found as far back as the late 19th century and the early 20th century[48]. Before elaborating on these emergence references for educational neuroscience, I will provide a brief contextual and historical account. What can be mentioned first is that the 19th to the mid-20th century is often associated with 'the behaviouristic era' (Duit & Treagust, 1998; Tomic, 1993). The doctrine of behaviourism is concerned with the study of behaviour of individual organisms, and a central tenet within the behaviourist school of thought is that "behaviour can be described and explained without making ultimate references to mental events or to internal psychological processes. The sources of behaviour are external (in the environment), not internal (in the mind, in the head)" (Graham, 2015 para. 1). In other words, behaviour is perceived as a response to external stimuli, and renowned examples of these theories can be seen, for example, in Pavlov's classic conditioning theory and Skinner's operant conditioning theory (Woolfolk, 2006). With its focus on behaviour, the doctrine also comprises elements relevant for *learning* – and thus behaviourism is interlinked with the discourse of education. J. B. Watson (1878-1958) and his behaviouristic learning theory can also be mentioned in this regard, where he claims that learning is what an organism does in response to stimuli. For Watson and other (radical) behaviourists, learning is therefore explained by focusing on the external events which cause these changes in observed behaviour (Woolfolk, 2006; Graham, 2015).

During the 19th century's behaviouristic era, one can also detect the early burgeoning of another field – namely that of brain research. Here attention was drawn to 'the mystery' of the

[48] Much insight into the history pertaining to the educational neuroscience discourse was found during my systematic literature search and the evaluation work for the emergence corpus. By identifying the first occurrences when neuroscience/brain science was linked with education, one can acquire an indication of the *timespan* within which the educational neuroscience discourse emerged and developed.

brain and the nervous system, and post-mortem examinations and animal studies were conducted in an attempt to elucidate anatomical and functional aspects of the brain. Gradual advances were made and new insights, such as the effect of muscle stimulation on the spinal cord and the cerebral cortex, were postulated (Windle, 1975 [in corpora])[49]. Other renowned neurological studies include those by Paul Broca in 1861 and by Carl Wernicke in 1876. Those studies of stroke victims suffering from language and speech deficits resulted in increased attention to how focal brain damage in particular areas can cause specific behavioural deficits (Gazzaniga et al., 2009). Some of the biggest breakthroughs within the field of neurological research, however, came in the 1890s when 'the neuron doctrine' emerged from the postulation of the renowned 'neuron theory'. Who first proposed the existence of specific interneuronal connections is in dispute, but Santiago Ramón y Cajal is often accredited for his revolutionary neural hypothesis in the 1890s, where he claimed that neurons are discrete entities which transmit electrical information in one direction from the dendrites to the axon (Rosenzweig, 1976 [in corpora]; Rutledge, 1976, p. 329 [in corpora])[50]. Historical references further indicate how the neural theory was expanded on and re-defined by numerous scientists, such as the neuroanatomist Waldeyer who introduced the term *neuron* and thus 'popularised' the neuron doctrine in 1891 (Théodoridou & Triarhou, 2009), the work of the Italian neurologist Tanzi, who, in 1893, suggested that plastic changes within the brain were likely to be found at the junctions between neurons, and Foster and Sherrington in 1897, who elaborated on Tanzi's work and also bestowed the name 'synapse' on these neural connections (Rutledge, 1976; Rosenzweig, 1976). Together, these significant studies created the neuron doctrine.

As progress was made in studies pertaining to the brain and nervous system during the last decades of the 19th century, links were also drawn between the brain and *the mind*. According to Windle (1975), one of the first pioneers in this respect is Clarence L. Herrick.

> He [Herrick] was the pioneer American neuroscientists, not the first to study brains, but the first to try to explore interrelations between neural structure and function, comparative and integrative, in a search for understanding the mind of man. Others before him had described results of research in the nervous

[49] In Windle's (1975) introduction to the journal issue *'Neuroscience Now: Education, Manpower, and Opportunities'*, two pioneering works in brain science are noted: The first is Brown-Séquard (1849) who studied pigeons' spinal cords and the effect of movements, sensation, and the occurring histological changes in the spinal cord. The second is Fritch and Hitzig (1870) where they stimulated the exposed cerebral cortex of dogs as they induced muscle constrictions of the legs.

[50] Both Camillo Golgi and Santiago Ramón y Cajal were neck to neck in suggesting the ground-breaking neuron theory. Even if Cajal often is accredited the pioneering work, it must be noted that Golgi's method for making neurons visible played a significant part in Cajal's discoveries. The story also goes that Golgi and Cajal were jointly awarded the Nobel Prize in Physiology or Medicine in 1906 for their work on the structure of the nervous system (Gazzaniga et al., 2009).

> system. He was the one, however, who saw the necessity of bringing them together, and the need to compare species. And he was among the first to try to lift psychology out of the esoterism of the metaphysician, and to bridge the dichotomy of body and mind (Windle, 1975, pp.1-2).

As well as the mention of Herrick's pioneering efforts in linking the brain and mind, other historical references also indicate early and significant studies in the emerging cognitive field in the 1880s and 1890s. In his account of memory research, Rozin (1976 [in corpora]) notes the importance of Ribot's classical research on 'Diseases of Memory' in 1882, where the pathology of memory is outlined and fundamental registration and recollection aspects of the memory process are described. In 1889 Korsakoff expanded on Ribot's work and published some redefined research on memory deficit, and in 1890 James published his work on memory in *Principles of Psychology* − a text which was later recognised as a significant monument in the history of psychology. Together, these and similar advancements led to the labelling of the 1880s as 'the Golden Decade of memory research' (Rozin, 1976), and the 1890s as 'the Silver Decade' (Rosenzweig, 1976).

Evidently, during the last decades of the 19th century, interest was increasingly focused on the mind and the brain, as numerous scientists emphasised the importance of these concepts. As a consequence, contemporary behaviourist theories were questioned because, apparently, there was *more* to human behaviour than simply stimulus-response causalities. Cognitive factors could no longer be neglected, it was argued, and since behaviourism persistently sidestepped aspects of the mind, behaviourist explanations were deemed inadequate by many within the field of brain science and cognitive research. This problematisation of behaviourism at the start of the 20th century marks the early emergence of what later would be known as the 'cognitive revolution'. It should be noted, however, that even if the transition from the 19th to the 20th century is often associated with a shift from the 'era of behaviourism' to the early beginning of 'the cognitive revolution' (Tomic, 1993), this does not imply that behaviouristic perspectives ceased to exist. Rather, historical references indicate an ideological split at this time: On the one hand there were those, often within brain science and cognitive research, who questioned behaviourism for its lack of cognitive explanations. On the other hand, however, one can find researchers in fields such as education and psychology who were dissatisfied with the results suggested by the novel cognitive field. Research into human mental processes was considered to have little solid substance and little to contribute, and thus many within the educational and psychological field continued to study observable behaviour instead (cf. Duit & Treagust, 1998). In the late 19th century and up until the mid-20th century, one can therefore still find a predominantly behaviourist tone in, for instance, educational theories. Cognitive-based research can, indeed, also be found in this period, but it did not become mainstream within the educational and psychological disciplines until the 1950s (Woolfolk, 2006).

It is in the shift between the 19th century's behaviourism and the 20th century's cognitive revolution that I found some of the first historical references where linkages are made between brain, mind, and education. Early references from my search are, for instance, Thomas I.M. Foster's (1815) *'Essay on the application of the organology of the brain to education'*, Edward H. Clarke's (1874) work on women's education in *'Building of a Brain'* where it is argued that women's biological constraints in education are due to "an error in female building", and J. Crichton-Browne's (1884) work *'Education and the nervous system'*[51]. Another early work linking brain research with education, and which is included in the corpus, is the work by neurologist Henry H. Donaldson. As early as 1895, Donaldson published his book entitled '*The growth of the brain: A study of the nervous system in relation to education'*, where he describes the growth of the nervous system and the brain, diffusion of nerve impulses, the native character of mental powers, and "the comparative insignificance of formal education" (Donaldson, 1895, pp. 5-6). Donaldson even dedicates an entire chapter to *'the education of the nervous system'*, where he links neurological and cognitive aspects with aspects pertaining to education:

> Education consists in modifications of the central nervous system. For this experience the cell elements are peculiarly fitted. They are plastic in the sense that their connections are not rigidly fixed, and they remember, or, to use a physiological expression, tend to repeat previous reactions. By virtue of these powers the cells can adjust themselves to new surroundings, and further learn to respond with great precision and celerity to such impulses as are familiar because important (Donaldson, 1895, p. 336).

Donaldson elaborates further on the linkage between education and modifications of the central nervous system by relating it to more practical aspects pertaining to formal education.

> Connections between the exercises of formal education and brain change have not been demonstrated. It is not known how a year's schooling affects the central system, and it is not probable that we shall soon arrive at facts of this sort. Available, however, are the facts of anatomical growth during this period, and to these, plausible explanations have been given. The aim at the moment, therefore, is to determine what limitations anatomy places to the educational process, and thus to obtain a rational basis from which to attack many of the pedagogical problems. It appears probable that the education of the schools is but

[51] Brown (1884) and Clarke (1874) are not included in the emergence corpus since they do not meet relevant criteria concerning the educational neuroscientific topic, and Foster (1815) was unfortunately difficult to obtain.

> one, and that, too, rather an insignificant one, of many surrounding conditions influencing growth (Donaldson, 1895, pp. 342-343).

What becomes evident when reading Donaldson's account is that factors related to education and schooling are given less prominence in influencing brain growth and neurocognitive processes than inner biological properties such as gender, brain plasticity, and critical periods. Formal education and nurture is thus considered "insignificant" and of "much less importance than nature" since the most significant capacities "are certainly inborn rather than made" (Donaldson, 1895, p. 344). Donaldson's emphasis on aspects pertaining to nature rather than nurture may not be surprising, considering his neurological background. Besides, and as Donaldson himself stressed, at the time there was scarcely any research on the linkage between educational practice and the brain − to attempt to demonstrate education implications to brain growth was therefore deemed too premature.

Further findings from my analysis show that Donaldson was not alone in relating neuroanatomical and neurocognitive aspects to education in the late 19th century. In 1896, a year after Donaldson's book was published, another work was published which has similar connections − namely Reuben P. Halleck's book, '*The education of the central nervous system. A study of foundations, especially sensor and motor training'*. Whereas Donaldson was a neurologist, Halleck's background was education − a difference detectable throughout the text. Similarly to Donaldson, Halleck (1896) stresses the importance of normal brain growth for optimal cognitive functioning and "intellectual powers", although Halleck attributes to education a much greater role in influencing "modifications in brain cells". This is already evident in the preface of Halleck's book where he calls attention to "the importance of early purposeful training of the central nervous system while its brief morning of plasticity lasts" (Halleck, 1896, p. vii). Dissimilarities are also apparent in how education and neuroscience are represented in the two works. This can be seen when Halleck gives the impression of informing and even 'prescribing' educationally relevant neurological knowledge to teachers, parents and others with little or no previous background in neurology − as exemplified in the following:

> It has been known for some time that the higher processes of thought are dependent on modifications in brain cells, and that the highest intellectual superstructure can be no firmer than the sensory foundation, but this knowledge has not been properly applied in training these cells. Practical application of truths lags far behind a theoretical knowledge of them. The principal object of this book is to prescribe for our complex central nervous systems at the proper time, the special kinds of exercise, sensory, motor, and

> ideational, demanded for full development ... The writer has endeavoured to present herewith some facts which every parent and teacher must know and apply in order to secure the fuller development of children at a critical time (Halleck, 1896, p. viii).

More detailed and critical reflections on these texts will be provided later in the discussion, but for this descriptive account, it can be noted that regardless of different academic backgrounds and despite their differing degrees of emphasis on the role of training and education, both Donaldson (1895) and Halleck (1896) appear to have authored some of the first and most extensive works where brain, mind, and education are linked. It is significant in respect of the discourse of educational neuroscience that these works were already published in the late 19th century. At a time when the discipline of neuroscience was in its infancy, when scientific studies on the connections between the brain and the mind were novel, and *decades* before educational neuroscience became established as an academic discipline, the novelty of connecting brain, mind, and neuroscience is indeed noteworthy.

The 20th century

As noted above, at the start of the 20th century the cognitive revolution had commenced in certain areas of academia, and advancements were continually being made in fields pertaining to the brain and mind. Despite this progress, brain science and cognitive research were still in their earliest stages. 'Neuroscience', as a separate academic discipline, had not yet been established and the field still bore a resemblance to collaborative work between different areas such as neuroanatomy, neurobiology, neurochemistry, neuropsychology, clinical medicine, and other work pertaining to the neural systems (cf. Rosenzweig & Bennett, 1976b). In addition, behaviourist explanations were still predominant in certain disciplines such as psychology and education, and cognitive research was thus often doubted within these fields up until the 1950s (Tomic, 1993).

Even considering the early stages of brain research and cognitive studies, a linkage between the brain, mind, and *education* was still a rather unusual endeavour in the 1900s. Historical references from my analysis nevertheless indicate some noteworthy texts with regard to educational neuroscience's emergence at this time. In 1903, only six years after Halleck's publication, the educational psychologist Edward L. Thorndike published *Educational Psychology* − a work republished in 1923 as a book including three volumes, the first of which is entitled *'The Original Nature of Man'* [included in the corpora]. Thorndike's objective is to outline elementary psychology, and in the first volume he aims to describe "man's original mental equipment, the inherited foundation of intellect, morals and skill" (Thorndike, 1923, p. vii). Regarding the emergence of educational neuroscience, it is interesting that Thorndike puts significant emphasis on neural structures and their relation to learning, memory and intelligence in his educational psychological theories[52]. This is, for instance, seen in Thorndike's grounding principles where he states that: "Intellect, character and skill have their psychological basis in the structures and activities of the neurones and accessory organs which compose the nervous system. The original nature of man in these respects depends on the original structure and activities of neurones" (Thorndike, 1923, p. 209). On these and analogous premises, Thorndike builds his working hypothesis by drawing connections between neural processes and cognitive aspects of learning and memory. In his account of *'the hypothesis of the physiological mechanism of learning'* it is concluded:

> Thus, certain synaptic intimacies are strengthened and others weakened, the result being the modifiability of the animal as a whole which we call learning. The simple avoiding-reaction of the protozoa, inherited by the neurones of the brain, is the basis of the intelligence of man. The learning of an animal is an instinct of its neurones (Thorndike, 1923, p. 228).

My discourse analytical findings show that even if Thorndike's psychological account of 'the original nature of man' puts great emphasis on connections between neural processes and cognitive functions such as memory and learning, general education is barely mentioned. A few general remarks are nevertheless made as he makes recommendations for education:

> The basis of intellect and character is this fund of unlearned tendencies, this original arrangement of the neurones in the brain. The original connections may develop at various dates and may exist for only limited times; their waxing and waning may be sudden or gradual. They are the starting point for all education or other human control. The aim of education is to perpetuate some of them, to eliminate some, and to modify or redirect others (Thorndike, 1923, p. 3).

However, detailed educational advice is not explicitly given in this volume, except for some general advice about providing adequate stimuli (perpetuation), withholding stimulation or 'associating discomfort with their action' (elimination), and 'substituting another response instead of the undesirable original one' (redirection) (Thorndike, 1923, p. 4). These vague educational recommendations are perhaps not surprising, because Thorndike gives the impression of taking a rather cautious approach throughout his text, frequently stating that

[52] Although my analysis shows that the words 'neurone' and 'neural' appear frequently throughout Thorndike's text (1923), the word 'neuroscience' is not mentioned once. Again this underlines the notion that the discipline of *neuroscience* had not yet been established under this name in academia, and that the neuroscientific field was still in its infancy in the 1920s.

'knowledge is lacking' and that it is 'too premature' to make certain connections (Thorndike, 1923). Vague links to education notwithstanding, the significance of Thorndike's work should not be underestimated. Not only did Thorndike present an exhaustive account of the connection between cognitive functions such as learning and neural processes at a time when such linkages were relatively novel in educational psychology, but the significance of this work must also be seen in relation to the status and prominence he acquired over his career in the field of educational psychology. Overall, Thorndike's work is indeed an emerging trace of a connection between education and neuroscience, and his approach appears to be significant, as one of the first in a line where attention chiefly lay on the relationship between neurological processes and *learning* (and not necessarily education and schooling).

Findings from my literature search from the next few decades of the 20th century do indeed indicate that numerous studies were published on topics pertaining to neural processes and learning[53] − a majority of which had a basis in animal research on rats, monkeys, and dogs[54]. These findings further indicate a significant growth and development within the neuroscientific field throughout the 20th century. For instance, it can be noted that in 1903 the first international neuroscience organisation, *'The Brain Commission'*, was founded in London (cf. Théodoridou & Triarhou, 2009). In 1949, Donald Hebb published his findings concerning pre- and post-synaptic elements (Morris, Kandel, & Squire, 1988), and from 1938 to 1952 Alan Hodgkin and Andrew Huxley published a series of ground-breaking articles describing action potential in neurons (Gazzaniga et al., 2009). Progress in brain research continued throughout the 1960s and 80s, further driven by technological advances such as the PET-scan and EEG-technology, and thus, by the late 20th century, it appears that *neuroscience* had become firmly established as a separate discipline within academia[55]. During this period, the field of *cognitive neuroscience* also starts to emerge[56].

[53] Findings from my literature search show that a frequent subject from 1900 to the 1980s was nursing and education of people with brain injuries or brain dysfunctions (e.g. Henrikson, 1949). During the 1980s my search includes articles where neuroscientific topics (e.g. language, brain development and right/left hemispheres) are connected to education − but again, mostly with connections to brain dysfunctions. Another frequent topic from the 1970s and 80s is how one should purposefully teach neuroscience to students − or 'neuroscience education' as it is often referred to (e.g. Wolf, 1967). Even if these texts match my key word search they are evaluated as being irrelevant for the corpus, because their focus is on nursing and medicine or on how to educate students in neuroscience (rather than on general education).

[54] Examples are Lashley (1929) *'Brain mechanisms and intelligence'*, Gengerelli (1934) *'Brain fields and the learning process'*, Rosenzweig, Krech, and Bennett (1960) *'A search for relations between brain chemistry and behaviour'*, and Krech, Rosenzweig, and Bennett (1960) *'Effects of environmental complexity and training on brain chemistry'*.

[55] The term *neuroscience* is said to date back to 1962, when Francis O. Schmitt used it to designate his Neurosciences Research Programme (N. Rose & Abi-Rached, 2013).

[56] It is said that the field received its name in the late 1970's from Gazzaniga and Miller when they were on their way to a meeting where cognitive psychologists and neuroscientists "were joining forces to study how the brain enables the mind".

Moving from the domain of natural sciences to the social scientific domain, it is noted by other authors that in the 1950s and 60s one starts to see traces of a 'positivistic' movement within social scientific fields − including the educational discipline. Positivism has objective and natural scientific modes of studies as 'a gold standard', and more interpretative methods are therefore problematised since they are not seen to result in verified data in the form of empirical evidence (e.g. from observation and experimentation). Positivism further holds that *society,* and not only the natural and physical world, is also law-governed and should thus be studied by use of 'objective' methods (Choudhury, Nagel, & Slaby, 2009). Besides certain positivistic perspectives and their problematisation of prior social scientific modes of studies, between1960 and 1990, one can again detect significant traces of brain, mind, and education connections − this time, however, the endeavour appears to have had a slightly bigger impact than in the late 19th century and early 20th century[57]. One of these endeavours is Herman Epstein's publication from 1974, '*Phrenoblysis: Special brain and mind growth periods. Human mental development*'[58] [included in the corpora]. Epstein refers to previous studies where brain and skull development are indicated, but takes the endeavour further by addressing the question of "whether brain growth spurts are correlated with mental growth periods" (p. 218). Epstein takes a psychobiological approach in his work and the article is mainly on the relationship between human brain and mind development, although, in his concluding discussion, explicit parallels to teaching and schooling are drawn:

> Increase in GA [grade age] specifies the capacity to handle certain tests and to learn certain common information or concepts. By themselves, these increases do not tell us whether the periods of slow growth, such as that at age 13 yr, are times for trying to teach children more or for teaching them less. A number of indications lead to the inference that children cannot benefit from attempts to help them learn any of the more abstract information at this age. For one thing, the near-zero value of the Cattell fluid intelligence factor at age 13 indicates that children have little available creative intelligence at that period ... [This] would indicate that in the normal course of events such children assimilate little *new* thinking capacity, and hence it might be worth postponing many learning activities until age 15 ... It would hardly be likely that attempts to do intensive teaching at this age [of slow learning at 13] could be particularly effective (Epstein, 1974, pp. 222-223 [my brackets]).

Since the topic lacked a name, the term 'cognitive neuroscience' was coined to describe "the question of understanding how the functions of the physical brain can yield the thought and ideas of an intangible mind" (Gazzaniga et al., 2009, p.3).

[57] My literature search shows that whereas one can find few articles linking the brain, mind, and education in the shift from the 19th to 20th century, there is a significant increase in the topic from 1960s and onward. This increase corresponds with the development of the educational neuroscience discourse, but again, an upsurge in search results must also be seen in relation to the database used (e.g. Web of Science) since their archives are generally more voluminous in later years.

[58] The term *phrenoblysis* is used by Epstein to describe brain and mind spurts during growth periods (Epstein, 1974, p. 217).

This paragraph will be left at this descriptive stage for the time being, leaving further critical reflections for the impending discussion part. To keep to the historical description, it is evident that the linkage between the brain, the mind, and education is yet again raised by researchers during the 1970s.

Epstein's work is just one example of a growing interest from scientists in connecting neuroscientific and cognitive theories with education, and during the 1970s numerous events followed. Findings from my literature search indicate, for instance, that in June 1974 a five-day conference was held at Asilomar in California, where the main theme was "current research approaches being used to find out how learning and memory occur in terms of neural processes" − a conference whose papers were later published in the book *'Neural mechanisms of learning and memory'* edited by Rosenzweig and Bennett (1976a, p. ix)[59]. In general, these 39 conference papers approach the field from a neurological or cognitive psychological perspective, and the main focus appears to be on the linkage between neurological aspects and cognitive processes, such as the biochemistry of human memory, and information processing and memory. Nevertheless, some implicit and explicit linkages to education can be found throughout the participants' papers − advice and 'hopeful applications', which are emphasised in the introductory and summary chapters of the book.

> The chapters of this volume offer a rich and varied panorama of research largely directed toward understanding the biological processes involved in learning and memory. Such basic research is undertaken with the hope, often implicit but amply justified by history, that it will eventually lead to applications that become socially beneficial. As such basic research is pursued, it may supply concepts and techniques that can be applied to problems such as improving classroom teaching, alleviating the difficulties of the retarded, the aphasic, and the senile, and fostering the fullest development of human intellectual potential (Rosenzweig & Bennett, 1976b, p. xi).

Anticipation that research in this field will be able to aid educational practice and teaching is evident, and related questions and recommendations are frequently posed. For example, to the question of "how a person's time [can] be allocated most efficiently for learning", aspects such as repetition, depth of analysis, sufficient time and effort spent on the material to hand, and motivational factors are recommended (Rosenzweig & Bennett, 1976b, p. xii). Other neuroscientific and cognitive aspects are also put forward, such as efficient information

[59] This book is relevant for the emergence corpus, but because it is a collection of conference papers, it encompasses too much text for a thorough discourse analysis for this study. Consequently, only the preface, introduction, and conference summary (Rosenzweig & Bennett (eds.) 1976) and the chapters by Rozin (1976) and Rutledge (1976) are analysed, since these are the most relevant chapters with respect to the linkage of neuroscience and education. See full reference details in appendix C.

‘packages’ for retrieval and learning, mental strategies, and the benefits of early experiences. Based on these and similar premises, it is concluded: “Therefore, it should be possible to apply this knowledge to the scheduling of learning tasks in relation to age and also to the planning of training for the early childhood years” (Rosenzweig & Bennett, 1976b, p. xiii). Overall then, the 1974 conference and the editors’ note on the resulting book, *‘Neural mechanisms of learning and memory’,* give the impression of a collective and rather optimistic outlook for the application of neuroscientific and cognitive findings for classroom practice, teaching, and childhood learning. In relation to the emergence of the educational neuroscience discourse, this optimism is indeed interesting. Even more noteworthy is that this five-day conference in California was not the only event to be held on neuroscience and its possible applications to related fields. A few months later, in October 1974, the Society for Neuroscience held its fourth annual meeting. As with the conference in California, this symposium also resulted in a publication − namely the journal issue entitled *‘Neuroscience now: education, manpower, and opportunities’* published in Experimental Neurology in 1975[60]. The symposium aimed to “survey the current number and characteristics of teachers and investigators in the basic neurologic and communicative sciences and the anticipated needs in 1985” (Shooter, 1975, p. 13), and the conference’s focus was accordingly on neuroscientific education and manpower, rather than the linkage of neuroscience and *general* education. Nevertheless, and as exemplified by the extract below, the conference papers express a general optimism for the future of neuroscience, and possible applications to other sectors such as education, are encouraged.

> In case of the biobehavioral sciences, major additional developments may be expected in clinical psychology, social welfare, special education, and a variety of paramedical fields relating to patient care and rehabilitation and to community health ... Coincidentally, in the near future, a *Year Book of the National Society for the Study of Education* will be devoted to “Implications for Education of Research upon the Brain,” advancing relations between the neurosciences and general education ... By 1985, the employment market for neuroscientists may be extended substantially into these fields, as well as that of special education (Shooter & Magoun, 1975, pp. 40-41).

The two symposia held in 1974 indeed bear witness to a shared optimism with regard to the growth and advancement made within the neuroscientific field in the mid-20th century. These neuroscientific conferences, and their subsequent publications, also point to great expectations

[60] This journal issue edited by Marshall and Magoun was published in Part 2 of Experimental Neurology Vol. 49, No. 1. Only the most relevant articles in the journal issue are analysed and included in the emergence corpora – namely Shooter’s preface (1975), and the articles by Windle (1975) and Shooter and Magoun (1975). See appendix C for references.

amongst neuroscientists that knowledge within their field would have great academic and even greater social benefits in areas such as general education and schooling[61]. These texts, however, are first and foremost neuroscientific discussions, where neuroscientists' views and visions are expressed − but what about opinions voiced from the educational domain? How did educationalists view the linkage between neuroscience and education?

A publication resulting from my literature search, which features opinions from the educational field, is the text from the National Society for the Study of Education (NSSE). The purpose of this American society is to investigate important educational issues, and in consideration of the growing interest in linking neuroscience and education, the NSSE Board deemed it, in 1973, appropriate for a "serious analysis" and "an overview of current scholarship in the neurosciences that has implications for educational theory, research, and practice" (Chall & Mirsky, 1978a, p. xiii). In order to present neuroscience to educational researchers, administrators, and teachers, eminent neuroscientific scholars − such as Teyler, Wittrock, Grossman, and Epstein − were asked to contribute papers to a volume of NSSE's seventy-seventh yearbook dedicated to *'Education and the Brain'* (Chall & Mirsky, eds., 1978)[62]. Findings from my discourse analysis show that the papers in the yearbook are written from a neuroscientific approach, with suggestions for possible educational implications. It is only in the volume's preface and, particularly, in the summary chapter that the educationalists Chall and Mirsky comment on four general themes which they have identified throughout the book. The first theme is "the central role of environmental stimulation and experience in growth and development of the brain", which is deemed to signify that "neuroscientists writing in this volume are saying to educators that education is central for optimal brain development" (Chall & Mirsky, 1978b, p. 371). Secondly, Epstein's contribution on brain and mind growth is noted, and the importance of early and 'proper timing' is emphasised. The third theme throughout the papers is that "certain kinds of training are more effective than others" (Chall & Mirsky, 1978b, p. 373). As an example of such methods, Chall and Mirsky cite Wittrock's work, where it is indicated that "it may be possible in the foreseeable future to match some instructional methods most useful to the left-brained and others to the right-brained and still others to differentially organized brain typologies" (p. 373). The last and most 'popular' topic highlighted is "the importance of cerebral lateralization for the

[61] As demonstrated in the texts Shooter (1975), Shooter and Magoun (1975), and Rosenzweig and Bennett (1976b).

[62] Also this book encompasses too much text for a thorough analysis and thus only the most relevant chapters for education and neuroscience are included in the emergence corpus – i.e. the introductory chapter and the yearbook's summary chapter written by the editors Chall and Mirsky (1978a; 1978b). See appendix C for full reference details.

development of human cognition and for understanding differences in learning style" (p. 373). Even if cerebral lateralisation is considered to offer an "exciting hypothesis for education", Chall and Mirsky (1978b) are 'cautious', as they say, in drawing exact applications to educational practice. In their supposed 'careful' approach, they refer to general literature on lateralisation and learning by indicating educational recommendations "that students who are weak in academic skills (based heavily on the left hemisphere) be taught music, construction, and other activities involving right-brain processing in order to provide these right-brained children with some activities in which they can excel" (Chall & Mirsky, 1978b, p. 374)[63]. Optimism for linking neuroscience and education is evident in NSSE's yearbook, and overall it appears that the editors believe that neuroscience can help inform education.

> In essence, the neuroscientists writing in this volume are saying to educators that education is central for optimal brain development. Indeed, the more recent the findings, the stronger the evidence for the importance of education appears to be ... The neuroscientists have presented evidence here that environmental stimulation helps the "healthy" brain develop to its optimal condition (Chall & Mirsky, 1978b, p. 371).

At the same time, the editors also stress a cautious approach and the importance of a mutual collaboration. "Since the application of the neurosciences to education is still relatively new, it must therefore be approached with caution as well as with the excitement that comes from viewing old problems in a new light" Chall and Mirsky (1978b, pp. 374-377) note, before continuing, "It would appear from the neuroscientists writing this volume that the next decade should bring a fruitful collaboration between neuroscientists and educators ... To be fully beneficial to both groups, the collaboration must be a mutual one". With hindsight, and in view of what the two editors have concluded concerning a cautious approach and mutual collaboration, Chall and Mirsky's final notes are rather remarkable in that they attempt to predict "an exciting utopian aid to education in the twenty-first century":

> It is tempting to speculate on a possible future collaborative effort between educators and neuroscientists as we enter the twenty-first century ... Each child in the school system needing special assistance would, according to this [new educational neuropsychological] scheme, be tested by this new professional ... Computer-assisted analysis of these data [brain size, maturity, degree of myelinisation, and neurohumoral balance] would enable the educational neuroscientist to perform an accurate assessment of the child's developmental stage, his particular strengths and weaknesses, the instructional materials he would best be able to handle, and the problem areas that would most likely be encountered during his educational career. This information would be made available to the child's teacher or

[63] Characterisations of 'right-brained' and 'left-brained' children have, in later years, been considered as simplifications and misinterpretations of neuroscientific research. A more critical discussion of this is provided in later chapters.

> teachers, and would be continuously updated and upgraded at regular intervals (Chall & Mirsky, 1978b, pp. 377-378 [my brackets]).

The 77th yearbook of the National Society for the Study of Education is a significant indicator of the emergence and development of the educational neuroscience discourse, since it conveys the view from some educationalists on the implications and prospects of a linkage between neuroscience and education. It is interesting to note that educationalists in the 1970s are said to have been 'interested in the neurosciences for some time' (Chall & Mirsky, 1978a, p. xi), and the view conveyed by the editors is a shared optimism for the implications and futuristic prospects amongst educationalists which also has been noted by neuroscientists in the mid-1970s. Similar optimism and enthusiasm is also noted by other authors, and in Frank Vellutino's book review of NSSE's 'Education and the brain' it is "concluded that this text is well worth reading, and the authors and editors are to be commended for a job well done" (Vellutino, 1979, p. 866 [in corpora]).

My analytical findings indicate that confidence in the prospect that neuroscience can bring new perspectives and have valuable implications for the educational field continued into the 1980s, and an increased number of articles were dedicated to the topic. My literature search and discourse analysis also shows how both neuroscientists and educationalists held a general view that new neuroscientific knowledge about the human brain may be beneficial to formal education. For instance, Rita Peterson (1984, pp. 74 & 79 [in the corpora]) predicts "Great expectations: collaboration between the brain sciences and education ... It seems especially appropriate for us to contribute to building a bridge between the brain sciences and education", and Leslie Hart states that:

> New understandings of the triune brain, of the two-sided brain, of an organ that grows and develops, influenced in good party by experiences and input, of brains that are "normal" even though they use strikingly different styles and strategies − all these can carry school organization and practices to a far more sophisticated level and bring educators more enjoyable and satisfying conditions of work. The doors stand open. Those who go through them may well find what must be found if public schools are to survive (Hart in Sylwester, Chall, Wittrock, & Hart, 1981, p. 17 [in corpora]).

Similar claims are made by Robert Sylwester when he says that, "What we now know about the human brain and what we'll discover in the years ahead may well transform formal education (Sylwester in Sylwester et al., 1981, p.7), by M. C. Wittrock (in Sylwester et al., 1981, p.12) claiming that "there are important educational implications of the recent research on the human brain", and by Thompson (1986 [in corpora]) in the following statement:

> More generally, education, a multibillion dollar industry in the United States alone, strives to achieve the most effective and meaningful learning. The science most basic to all these conditions and endeavours is the neurobiology of learning and memory − how the brain codes, stores, and retrieves memories (Thompson, 1986, p. 941).

However, historical references from this period also indicate a growing awareness and warnings of misinterpretations of neuroscientific findings, particularly concerning so-called right-hemispheric and left-hemispheric learning. Accordingly, greater emphasises are put on 'cautious approaches' and 'mutual collaborations'[64]. But despite these notes, the 1970s and 80s indicate a common optimism for the emerging link between education and neuroscience.

Even if one can find increased interest in the linkage of education and neuroscience from the mid-20th century and onwards, it should be noted that this period within the educational field is perhaps better known for its linkage between education and cognitive psychology − and not necessarily neuroscience. This can for instance be seen with Jean Piaget's (1954, 1964) and Lev Vygotsky's (1962, 1978) renowned cognitive perspectives on internal mental events, learning and development. The cognitive approach represented by Piaget and Vygotsky further indicates a move away from behaviouristic learning theories within the educational field in the mid-20th century, as learning is understood as changes in internal mental structures and not entirely as changes in behaviour. It has also been noted that Vygotsky's development and learning theories in particular, which encompass social and interactional aspects to a greater extent than Piaget's theories, have retained a strong foothold within the educational domain up until the present day (Woolfolk, 2006).

At the beginning of the last decade of the 20th century, findings from my discourse analysis indicate that neuroscience as a discipline had caught the attention of politicians and the public at large − indeed, the 1990s were even labelled '*The Decade of the Brain*' by the U.S. government (Bush, 1990). Simultaneously, publications and debate concerning the linkage of education and neuroscience continued to escalate throughout the 1990s. What is interesting to note from my discourse analytical findings is that the 'common optimism' seen in the 1970s and 1980s was confronted by a more *sceptical* position, which gradually manifested itself over the years. Misinterpretations of neuroscientific findings, such as erroneous left-and-right hemispheric learning strategies, were now turned against optimistic and collaborative endeavours to 'build a bridge' between the brain sciences and education. It is, for instance, noted that 'more research is needed', that the endeavour to transfer neuro-

[64] As seen in Peterson (1984), McGuinness (1987), and Chall and Mirsky (1978a; 1978b).

scientific findings to educational practice is "too immature", that some authors "grasp at straws that are exceedingly dangerous", and basically that the education and neuroscience venture fails because "its advocates are trying to build a bridge too far"[65]. Additionally, and in response to the 70s and 80s optimism shared by many in the educational field, it is noted, for instance, by Peterson (1984) and McCall (1990) that many educators in previous decades seemed to have been misled by 'runaway movements' which promoted educational practices such as right-and-left hemispheric teaching with no apparent neuroscientific grounding:

> Regardless of who initiated or promoted them, many teachers and administrators attended lectures, workshops, and in-service training sessions in which they were urged to consider plateaus in brain growth as a possible explanation for poor school performance and a basis for changing curricula. The information many received at such sessions was not always tempered with uncertainty, tentativeness, and caution, and some educators and school systems reportedly were all too eager to hear and act upon the good news. After all, here apparently was a biological explanation for past educational failings and a scientific, neurological basis for educational reform that might satisfy their many critics (McCall, 1990, p. 888).

Sceptical voices such as these, particularly remembered by John Bruer's (1997) renowned article '*Education and the brain: a bridge too far'*, did not go unchallenged and numerous authors took an optimistic and cautious position in the education and neuroscience debate[66]. Despite the nature of the arguments being voiced, though, the 1990s indicate an increased international attention and academic debate on the linkage of education and neuroscience[67]. The double issues of *Educational Psychology Review* in 1998 are illustrative of such debates, as these two journal issues were dedicated to Byrnes and Fox's text '*The educational relevance of research in cognitive neuroscience'* (1998a) and eight responding commentaries[68]. In the emergence of the educational neuroscience discourse, the 1990s are particularly noteworthy, since this decade witnessed the establishment and significant expansion of educational neuroscience as a topic of debate in academia.

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[65] As seen in McGuinness (1987), McCall (1990), and Bruner (1997) [in the corpora].

[66] As seen in Byrnes and Fox (1998a), and Berninger and Corina (1998) [in the corpora].

[67] My literature search indicates that the word 'neuroscience' first appeared in the most 'renowned' international *educational* journals in the 1990s. This is evident when searching for the key word 'neuroscience' only in educational journals (such as Educational Psychology Review, Educational Philosophy and Theory, and Educational Research), where the first texts resulting are Berninger and Abbott (1992) in Educational Psychologist, and the two issues of Educational Psychology Review (Volume 10, Issue 3 & 4) in 1998 which were dedicated to education psychology and neuroscience.

[68] I will not include the entire double issue in the emergence corpus, since there is too much text material for a thorough analysis at this point. Three articles instead are selected, since they can be seen to represent the general theme of this issue – namely Byrnes and Fox (1998a) central article 'The Educational Relevance of Research in Cognitive Neuroscience', Berninger and Corina's commentary article (1998), in addition to Byrnes and Fox (1998b) responding article.

The 21st century

Whereas the 1990s were labelled 'the Decade of the Brain', the 21st century has been labelled the 'neuroscientific revolution', as progress continues to be made within brain sciences and cognitive research (Brown & Bjorklund, 1998). With regard to the social scientific field and the educational domain, one can also find developments and changes here also, and one can particularly detect a slight ideological and political 'evidence movement' in the 21st century. Further elaboration on this ideological and political shift will be presented in later discussions, but for the moment it can be noted how, in the run-up to the new millennium, one can detect a renewed interest, and in particular, political requests, for 'evidence', 'what works' and 'scientifically based practices' in education (Davies, 1999).

Findings from the literature review and the discourse analysis indicate further development of the discourse of educational neuroscience at the turn of the 21st century. For instance, this can be seen in an augmented debate concerning the linkage of education and neuroscience, but also in debates concerning the application of brain research to education (Posner & Rothbart, 2006 [in corpora]) and the "gulf between current [cognitive neuro]science and direct classroom applications" (Goswami, 2006, p. 2 [in corpora]). What is also interesting to note from the findings is that numerous authors are starting to argue for 'sustainable bridges' between education and neuroscience, 'reciprocal collaboration', and the 'need to be cautious' − as seen in the texts by Blakemore and Frith (2005b; 2004), Ansari and Coch (2006), Fischer et al. (2007), and Varma and colleagues (2008) in the emergence corpora. In addition to this, findings from my literature search indicate that the linkage of education and neuroscience is starting to be referred to as a "developing field" (Ansari & Coch, 2006), "a new and emerging discipline of educational neuroscience" (Royal Society, 2011b; Szücs & Goswami, 2007), "a new science" (Fischer et al., 2007), and that "there is now a global emergence of educational neuroscience" (OECD, 2007a, p. 21).

But the 21st century does not only witness mere talk of 'a new science' and 'a developing field and discipline'; the beginning of the 21st century is also suggestive of more concrete initiatives related to developments in educational neuroscience discourse. What can firstly be noted in this respect is that in 1999, the OECD's Centre for Educational Research and Innovation (CERI) launched an eight-year long project called '*Learning Sciences and Brain Research'*. This project was an international and political endeavour stretching from 1999-2007, whose purpose "was to encourage collaboration between learning sciences and brain research on the one hand, and researchers and policymakers on the other hand" (OECD, 2007a, p. 3). Another noteworthy instigation can be found within the academic domain around the same time, as the Harvard Graduate School of Education initiated a programme in 'Mind, Brain, and Education'. Following this Mind, Brain, and Education programme, Fisher and Gardner began in 2002 to teach a year-long course called 'Cognitive development, Education and the Brain' − a course believed to be "the first course on this topic to be regularly offered at a school of education" (Blake & Gardner, 2007, p. 61). Further initiatives at Harvard Graduate School of Education followed and soon the first master degree and doctoral programme in Mind, Brain and Education was offered.

It did not take long before other collaborative programmes and postgraduate courses followed the example of Harvard University, and during the first two decades of the 21st century numerous centres, collaborative works, and university programmes were established around the globe. Some of these are *'International Mind, Brain, and Education Society'* (IMBES) in the USA, *'Centre for Educational Neuroscience'* (CEN) in London, *'Centre for Neuroscience in Education'* (CNE) at the University of Cambridge, *'Brain, Neuroscience and Education'* (BNE; SIG), *'Research School Network'* (RSN) in Texas, and the centre for *'Mind and Brain in Educational and Social Contexts'* (MBESC) at Bristol University. Other significant developments in the academic field pertaining to educational neuroscience worth mentioning are the launching of the scientific journal *'Mind, Brain, and Education'* in 2007, followed by the journal *'Trends in Neuroscience and Education'* which published its first issue in 2012.

Besides academic publications and collaborative work, there is also evidence of growing interest amongst politicians with regard to the linkage of education and neuroscience. Not only can the OECD's project '*Learning Sciences and Brain Research'* indicate such interest, but a similar educational and political project, for instance, can be found in the American early learning and childcare project *'Head Start'* and *'Early Head Start'* (US Department of Health & Human Services, 2014), and the UK initiative of TLRP (2007). As well as the political interest, analytical findings also show an increased interest within the public and commercial field in the 21st century. This is evident from the numerous popular-scientific books published on 'the learning brain', media articles and TV programmes based on topics pertaining to 'how to improve your brain', in addition to several commercial 'brain based' learning programmes offered to teachers and schools. Overall, then, the 21st century has seen significant growth and development of the educational neuroscience discourse, as the discipline appears to have attracted interest outside academia and in other domains such as the political and public spheres. Considering that the analysis in chapters five to eight will focus on the contemporary phase and development of the discourse, further description of educational neuroscience in the 21st century is not included at this point, since this will be thoroughly elaborated on in the following sections.

With the establishment of numerous academic centres and collaborative works pertaining to educational neuroscience, the founding of postgraduate courses and degrees in numerous universities around the globe, annual conferences, the launching of two academic journals, and an extensive archive of academic articles and books, the 21st century has witnessed the establishment of educational neuroscience as a distinct academic discipline. Even if the most significant and rapid developments in the discourse of educational neuroscience have occurred over the last four decades, historical references show early tendencies to link education with brain science and cognitive research as far back as the late 19th century. Obviously much has changed since the early references made by Donaldson and Halleck in the 1890s, and even after the neuroscience and education debate re-emerged in the 1970s and later in the late 1990s. But there is more to the history and development of the academic project and discipline of educational neuroscience, and a critical analysis and discussion also reveal continuities, recurring narratives and justifications throughout the decades. Whilst the first part of this chapter has been dedicated to descriptive accounts of the emergence and development of educational neuroscience, the next sections will take a more critical and reflective approach to the development of the discourse.

Educational neuroscience's emergence and development

Analytical findings from the emergence corpora reveal certain 'problematisations' concerning discursive borders within and between discourses pertaining to educational neuroscience, in addition to changes in certain narratives, justifications, and practices. In order to critically analyse and discuss these findings, the following sections are structured around the main research questions related to educational neuroscience's emergence process. In the discussion's first section, boundaries between related discourses are examined, and strategies used to develop the field are scrutinised. The second section asks what the main themes in the discourse of educational neuroscience are, and reflections concerning continuity and changes in these themes are presented. Overall, this critical analytical approach helps to elucidate how and why educational neuroscience has emerged, which recurring themes, strategies, and positions can be found during the course of its history, and what has changed throughout its development.

Educational neuroscience and the field of prior discourses

A central tenet in critical discourse theories is that discourses do not suddenly, and miraculously, emerge of their own accord out of nothingness, fully equipped with discursive structures, relations, and narrations of the world (Fairclough, 2010). Discourses are instead perceived to develop through a reweaving of already existing discourses, as discursive boundaries are questioned, negotiated, and crossed. With regard to the discourse of educational neuroscience, the same principles apply, and thus this discourse cannot have emerged and developed in a vacuum. It is therefore expedient to see educational neuroscience as emerging from a field of already existing discourses. In view of such an emergence perspective, it is germane to enquire into, and explore, the field of prior discourses from which educational neuroscience has emerged, in addition to discussing how the discourse emerged from this field. Certain critical discourse concepts are useful when elaborating on educational neuroscience's emergence, and in the following sections, theories pertaining to i) problematisation of discursive boundaries, ii) changes at different levels, iii) discursive transgression, and iv) construction of new articulations are drawn upon.

Problematisation of discursive boundaries

Fairclough (1992) stresses that discursive boundaries indicate what can and cannot be thought, said, and done in a discourse, because these restrictions confine what are liable discursive representations. In other words, a discourse is outlined by its boundaries at any given time, since these constraints help to define the set of premises, representations and practices found in a discourse. Discursive boundaries, from the perspective of a singular discourse, are not problematic *per se,* since such borderlines merely define a discourse. But a discourse does not exist in emptiness and it will inevitably have some form of relationship with other discourses (Jäger & Maier, 2009). Alignment of discourses makes the boundaries *between* them potential points for tension, since one discourse's representations do not necessarily correspond with another discourse's representations. Contradictory represent-tations and tension between discourses can further lead to problematisation of discursive boundaries and hegemonic struggles as conflicting discourses strive to protect their discursive regularity[69] (Fairclough, 1992).

If we start by looking back to historical references from the 19th century, one can see how behaviourism held a strong position within numerous academic disciplines at this time. Findings from my emergence corpus also show how the 19th century saw growing advancement in the field of brain sciences, as numerous studies pertaining to neuro-anatomical insights and structural functions of the brain were carried out[70]. With reference to discursive boundary theories, it can further be noted how these discursive boundaries can be seen as points of potential struggle due to different discursive narrations. On the one hand, there was the long-standing behaviourist discourse, which gave stimulus and response explanations as the central cause for human behaviour and learning. On the other hand, however, there was the relatively novel discourse of brain science and cognitive research, where it was claimed that modification of neurons in the central nervous system were crucial factors for behavioural changes related to memory, learning, and intelligence[71]. Differences in discursive narrations are evident, and historical references, particularly during the transition from the 19th to the 20th century, suggest boundary conflicts between the two discourses. This discursive conflict can be demonstrated by the censure and problematisation of behaviourism, as it was argued that behaviouristic stimulus-response representations were inadequate in their explanation of human behaviour since they did not encompass *cognitive* aspects. This censure can further be seen as relating to the development of the novel field of brain science and cognitive research, since this field put the concept of *mind* on the agenda by frequently publishing studies emphasising the importance of brain and mind in human factors such as learning, memory and intelligence[72]. In view of this, discursive boundaries between the behaviouristic discourse and that of brain science and cognitive research, give the impression that they were points of significant tension. Struggles over discursive narrations also appear in

[69] Discursive regularity is, as mentioned in the theory chapter, a set of regularities existing between a discourse's representations of reality, values, and institutions. When there is a resilient and closed feedback-loop between discursive regularities, the discourse can be seen to be a stable and unchallenged system of self-maintenance (Neumann, 2010).

[70] As noted in the texts by Shooter and Magoun (1975) and Rosenzweig and Bennett (1976b).

[71] As seen in the texts by Donaldson (1895), Halleck (1896), and Thorndike (1923).

[72] As for instance seen noted in the texts by Donaldson (1895), Halleck (1896), Epstein (1974), Shooter and Magoun (1975), and Rosenzweig and Bennett (1976b).

the gradual change from the dominant behaviouristic discourse of the 18th and 19th centuries, to the commencement of what was later called the 'cognitive revolution' in the 20th century.

Changes at different levels

Problematisation of discursive boundaries can further be linked to aspects of discursive change at different levels, in addition to theories concerning interdiscursive and intertextual relations. What this implies is that aspects of one discourse may affect aspects of other, closely linked discourses (Fairclough, 1992). Thus, when discursive boundaries are challenged at one level, other closely interlinked discourses may be affected by these alterations. It can be further noted that changes in a discourse can have varying degrees of impact depending on their range − on a local level these may be restricted to changes within a specific discourse, but they can also affect closely related discourses, or can result in larger structural changes in an order of discourse (Fairclough, 1992). Intertextual aspects found in related discourses can thus be an important factor in processes of change, since this can indicate how one discourse affects other discourses.

Arguably, this suggests that problematisation of the behaviouristic discourse in the late 19th century was likely to affect connected discourses at other levels. In other words, when behaviouristic representations, narrations, and justifications were being doubted within academia at large, these doubts were likely to affect disciplines which relied on behaviouristic explanations. Of note in this respect is that both the discipline of psychology and that of education had strong behaviouristic traditions throughout the 19th century and up until the mid-1900s (cf. Duit & Treagust, 1998). When the behaviouristic discourse was problematised within academia, one can therefore assume that similar doubts affected education and psychology. Historical references, in fact, indicate that numerous educationalists and psychologists abandoned behaviouristic stimulus-response explanations in favour of more cognitive theories and perspectives such as those of Piaget and Vygotsky. Not only is this evident in the gradual change of focus to neural correlates between learning and memory[73], this is also evident with the emergence of separate disciplines such as educational psychology, cognitive psychology, and neuropsychology.

[73] As seen demonstrated in Donaldson (1895), Halleck (1896), and Thorndike (1923).

Discursive transgression and new articulations

Changes at different levels bring us to concepts concerning *discursive transgression* and construction of *new articulations.* Here it is noted that problematisation of discourses can lead to requests for new representations and explanations that are more adequate than prior narrations. In the process of crafting new representations, one often finds transgression, negotiation, and crossing of discursive boundaries. On this note, Fairclough (2010, p. 19) argues that the appearance of new discourses occurs by dialogue, as "they are formed through articulating together (features of) existing discourses". Discourses can, as such, emerge as a result of boundary transgression, as different discursive boundaries are crossed and combined in new ways. New discursive articulations do not only imply changes in *textual* notions; construction of new articulations can also indicate changes in social practice, new discursive positions, novel institutions, new ways to act, new structural changes and other alterations within and between discourses. Again, concepts of interdiscursivity and intertextuality are apposite since they indicate relations *between* discourses and texts, and how one discourse can both affect and be affected by other discourses (Fairclough, 1992).

My analysis of historical series of texts pertaining to educational neuroscience does, in fact, suggest that numerous works in the late 19th and early 20th centuries combine concepts of prior discourses (e.g. education), with concepts from new discourses (e.g. the emerging field of brain science and cognitive research). Almost every text in the corpora bears witness to such transgressions, and authors' cross-disciplinary endeavours are frequently manifested in how the linkage is described, such as "formal education and the central nervous system" (Donaldson, 1985; Halleck, 1986), "neurones of the brain and education" (Thorndike, 1923), "brain and mind development and teaching and schooling" (Epstein, 1974), "education and neural mechanisms of learning and memory" (Rosenzweig & Bennett, 1976a), "education and the brain" (Chall & Mirsky, 1978a), "education and brain research" (Sylwester et al., 1981), and "brain sciences and education" (Peterson, 1984). Other explicit manifestations of discursive transgression found throughout the historical series of texts are labels identifying educational neuroscientific work as 'interdisciplinary', 'multidisciplinary', or 'trans-disciplinary' work[74]. Yet another clear identification of a cross-disciplinary endeavour is the commonly used metaphor of 'a gap' and the 'bridging' of this division between the

[74] Respectively in Blakemore and Frith (2005b); in Rosenzweig and Bennet (1976b), Berninger and Corina (1998), Ansari and Coch (2006) and Varma et al. (2008); and in Samuels (2009) and Beauchamp and Beauchamp (2013) from literature searches.

disciplines[75]. Furthermore, and perhaps most obviously, the cross-disciplinary endeavour is even manifested in the discipline's *name*. Titles alluding to the discourse, for example, include "Mind, Brain, and Education" (Fischer et al., 2007; Samuels, 2009), "educational neuroscience" (Samuels, 2009; Beauchamp & Beauchamp, 2013), "neuroeducation" (Théodoridou & Triarhou, 2009), "neuroeducational research" (Howard-Jones, 2010), "pedagogical neuroscience" (Fawcett & Nicolson, 2007), and "neurolearning" (Petitto & Dunbar, 2004). Even if the name has varied throughout the decades, and actually still varies from author to author, the title of the discourse clearly indicates a cross-disciplinary venture between neuroscience, psychology, and education.

Table 5.1: Examples of how prior discursive elements are combined in new reconstructions.

New combinations of articulations and representations	***New metaphors and collaborative indicators***	***Disciplinary titles for the new discourse***
'Formal education and the central nervous system' (Donaldson, 1985; Halleck, 1986). 'Neurones of the brain and education' (Thorndike, 1923). 'Brain and mind development and teaching and schooling' (Epstein, 1974). 'Education and neural mechanisms of learning and memory' (Rosenzweig & Bennett, 1976a). 'Education and the brain' (Chall & Mirsky, 1978a). 'Education and brain research' (Sylwester et al., 1981). 'Brain sciences and education' (Peterson, 1984).	Metaphors of 'a gap' and talk of 'bridging' of this division between the disciplines (Peterson, 1984; Bruer, 1997; Blakemore & Frith, 2005b; Ansari & Coch, 2006; Varma et al., 2008). 'Educational neuroscience work is *interdisciplinary* work' (Varma et al., 2008; Howard-Jones, 2010). 'Educational neuroscience work is *multidisciplinary* work' (Rosenzweig & Bennet, 1976; Berninger & Corina, 1998). 'Educational neuroscience work is *transdisciplinary* work' (Samuels, 2009; Beauchamp & Beauchamp, 2013).	'Mind, Brain, and Education' (Fischer et al., 2007; Samuels, 2009). 'Educational neuroscience' (Pettitto & Dunbar, 2004; Samuels, 2009; Beauchamp & Beauchamp, 2013). 'Neuroeducation' (Théodoridou & Triarhou, 2009). 'Neuroeducational research' (Howard-Jones, 2010). 'Pedagogical neuroscience' (Fawcett & Nicolson, 2007). 'Neuroscience in education' (Della Sala & Anderson, 2012). 'Neurolearning' (Petitto & Dunbar, 2004).

[75] As seen in Peterson (1984), Bruer (1997), Blakemore and Frith (2005b), Ansari and Coch (2006) and Varma et al. (2008).

Further reflections on the development of educational neuroscience

Intertextual references in historical series of texts reveal aspects related to boundary crossing, tension, and a struggle between the field of education, brain science, and cognitive research, in addition to reweaving of prior discursive elements to new articulations (see table 5.1). What these findings further suggest is that educational neuroscience has emerged and developed from a field of prior discourses pertaining to what we today identify as cognitive neuroscience, cognitive psychology, and education[76]. However, the aim of this section is not to point out the (rather obvious) notion that educational neuroscience is a cross-disciplinary endeavour, rather, it is to shed light on *how* educational neuroscience came to emerge from this field of discourses. In view of my historical findings, in addition to critical discourse theories, I will argue that the emergence of educational neuroscience is interlinked with i) development and advancement made in fields related to brain science and cognitive research, ii) problematisation of discursive elements, such as 'insufficient' behaviourist accounts in other and related discourses, and iii) transgression of discursive boundaries and reconstruction of discursive elements from prior discourses. In the same way, I will suggest that these three notions are not only relevant to the early *emergence* of educational neuroscience, but that in varying degrees the aspects appear to have affected the further development of educational neuroscience throughout the 20th and early 21st centuries. Furthermore, the emergence and development of educational neuroscience's academic level should be seen as a *shifting process,* more likely to have developed in stages rather than a smooth linear progression.

My argument about a somewhat uneven developmental phase is based on my analysis of the historical series of texts, where publications and augmented debate pertaining to the linkage of brain research and education appear at certain periodic intervals. One can, for instance, detect a first and emerging phase in the late 19th century and early 20th century with the work of Donaldson (1895), Halleck (1896), and Thorndike (1923), where brain science and cognitive aspects were provisionally linked to education. It is worthy of note that this

[76] I will argue that the emergence of educational neuroscience must not be seen as fixed interrelations between the discourse of education, cognitive research, and brain science; considerations must also be paid to notions that these different discourses have their *individual* history and discursive developments. Up until the early 20th century 'neuroscience' was not yet established as a singular academic discipline, but was a field under development, comprising research in neuroanatomy, neurology, neurochemistry, neurobiology, electrophysiology, and clinical brain research. The discourse of psychology has also undergone cross-disciplinary alterations throughout the history (viz. cognitive psychology, developmental psychology, and neuro-psychology are identified); so has the educational field (viz. educational psychology, educational sociology and educational philosophy). The field of prior discourses related to educational neuroscience therefore encompasses a complex set of discursive relations, as different discourses are crossed and combined in new disciplines over the course of history.

period of time corresponds with the period of early problematisation between the behaviouristic discourse and the novel field of brain science and cognitive research. From the 1930s until the 1950s and 60s, however, findings from my literature search indicate that there is a small interval during which the main focus is on linkages between brain science and cognitive aspects such as learning and memory, with scarcely any explicit links to formal education and schooling.

In the 1970s and 1980s another peak of increased effort to link brain science and cognitive research within education is found. This can be exemplified by the three separate conferences pertaining to neuroscience and possible application to education from the emergence corpora[77], in addition to separate work from authors such as Epstein (1974), Sylwester et al. (1981), and Peterson (1984). Again, this developmental peak corresponds with development and increased optimism about the neuroscientific discourse, advanced by brain research technologies such as PET-scan and EEG. Increased attention to a linkage between education, cognitive psychology, and neuroscience at this time can, additionally, be interlinked with a renewed 'cognitive revolution' in the disciplines of education and psychology. Up until the mid-20th century, a behaviourist approach was predominant in these fields, but around the 1950s it was widely acknowledged that behaviourism could only offer limited explanations for human behaviour. In line with this, cognitivism gained significant ground in education and psychology (cf. Duit & Treagust, 1998). This can, for instance, be seen in the emergence of cognitive psychology as a distinctive field of science, in addition to the discipline of educational psychology. In the same way, developmental and cognitive learning theories from Piaget and Vygotsky started to capture the interest of educational academics − approaches which focus on how individual cognitive processes generate learning (Woolfolk, 2006). It can also be noted how a positivistic perspective, with its 'gold standard' of natural scientific methods and philosophies, started to gain an increased foothold in social scientific research and in the educational sector, during the 1950s and 60s (Choudhury et al., 2009; Telhaug & Mediås, 2003).

From the 1980s onwards, several publications have been found concerning the brain-mind-education linkage, but it was not until the late 1990s and early 2000s that the educational neuroscience debate again received increased attention, with arguments from

[77] As demonstrated by the 4th annual meeting of the Society of Neuroscience in 1974 (Marhsall & Magoun, 1975), 'The conference on Neural Mechanism of Learning and Memory' in 1974 (Rosenzweig & Bennett (eds.), 1976), and National Society for the Study of Education's project on 'Education and the Brain' from 1973-1978 (Chall & Mirsky (eds.), 1978).

authors such as Byrnes and Fox (1998a, 1998b), Bruer (1997) and Blakemore and Frith (2005b). In comparison to the last developmental peak in the 1970s when numerous conferences were held, the peak in the late 1990s and early 2000s also featured the initiation of political projects and reports, the foundation of collaborative centres, the establishment of postgraduate university courses, and the launching of specific mind, brain, and educational journals. If one again links this developmental peak with advancement in the neuroscientific discourse, it can be noted that the 1990s is labelled 'the Decade of the Brain' and that the 21st century 'neuroscientific revolution' has caught the attention of society at large (Brown & Bjorklund, 1998). Moreover, and as will be further discussed in the recontextualisation chapters, the 21st century has shown renewed interest, and a particular political request for more 'scientifically based practice' in education.

Overall, I will therefore argue that the history of educational neuroscience reveals three developmental peaks − the first in the shift from the 19th and 20th century, the second around the 1970s, and the third around the late 1990s and early 2000s. I will further argue that the three developmental peaks in the emergence of educational neuroscience appear to be connected with advancements made in fields related to brain science and cognitive research, in addition to the problematisation of related discourse in pursuit of more 'scientific' approaches − whether the uproar against behaviourism at the end of the 19th century, the positivistic debate in the educational sector in the 1950s, or later in the early 21st century when more 'evidence-based' research and practices were demanded. Moreover, and with reference to discourse theories, I will argue that these aspects are linked to the ensuing transgression of discursive boundaries pertaining to education, cognitive science, and neuroscience, as discursive aspects of these prior discourses are reconstructed into new discursive elements, consistent with educational neuroscience discourse.

Educational neuroscience and emergence strategies

A basic premise for this chapter is the notion that discourses do not emerge of their own accord out of nothingness (cf. Fairclough, 2010). The previous section, therefore, elaborated on how educational neuroscience appeared and developed from a field of external discourses. However, emergence and development of discourse must also be seen in the light of emergence processes found *within* a discourse. Accordingly, this section will approach the question by focusing mainly on discursive strategies and actions.

Structural and strategic processes

Notions of structural and strategic emergence processes bring us to aspects pertaining to the *power to act* and the *power to change discourse*. In the theory chapter, I explained how discourses have their own power, and can thus be seen as powerful structures, due to internal mechanisms which can enhance and resonate discursive regularities in a self-sustaining process. This power *of* discourse lies in discursive structures, as discourses exercise power by regulating and institutionalising how subjects think, talk, and act (Neumann, 2010; Fairclough, 2010). It is further noted how discourses are supra-individual in the sense that "everybody is co-producing discourse, but no single individual or group controls discourse or has precisely intended its final result" (Jäger & Maier, 2009, p. 38). Theoretical notions about the power *of* discourse can easily give the impression that discursive developments resemble a domino game − as soon as the first piece in a discursive chain has been set in motion, the succeeding pieces will automatically and effortlessly fall into place. However, discourses do not develop automatically, and they are not driven by the mere power *of* discourse found within and between prior fields of discourses. Rather, development of discourses must be seen as a process, which also includes power *over* discourses. This idea ascribes human subjects with an active role in the discursive matrix, as they are considered liable to develop and change discourses by means of strategic actions[78]. Emergence and development of discourses must therefore be related to discursive and structural mechanisms found within and between discourses, *and* to human actors (individuals or groups) and their 'successful' use of strategies, practices and actions pertaining to a discourse's progress (Fairclough, 2010; Jäger & Maier, 2009)[79]. In view of this, it should be noted that different discursive aspects and different human actors hold different possibilities of discursive impact and change. Some individuals and groups will, for instance, have a greater chance of influence, because they have more power over discourse than others − for example, if they have greater financial resources or privileged access to the media (Jäger & Maier, 2009). One can also detect differences in the effects derived from discursive aspects. "A single text has minimal effects, which are hardly noticeable and almost impossible to prove. In contrast, a discourse, with its recurring contents, symbols and strategies, leads to the emergence and solidification of

[78] Whether use of strategies are *conscious* actions or not, is another matter, since it can be argued that human actions and practices can be regulated and institutionalised by the power of discourse as 'natural ways' of being and acting in the world.
[79] The term 'successful strategies' is used when differentiating between the success and failure of competing strategies in discursive processes (Fairclough, 2010). Words of 'success' or 'failure' are therefore not normative validations of a strategy (or the outcome of a strategy), but rather a term describing whether or not a strategy can be seen as being connected to change.

‘knowledge’ and therefore has sustained effects” Jäger and Maier (2009, p. 38) note, before continuing, “What is important is not the single text … but the constant repetition of statements”.

Consideration of both discursive structural processes *and* strategic actions by individuals and groups is therefore important with regard to the emergence of a discourse. Different emergence processes and strategies can also be said to have different degrees of success, depending on their impact and effect in changing and developing the discourse. It is also important to note that discursive emergence processes and actors’ strategies can be perceived as being intertwined with one another, because discursive structures may prompt certain strategic actions, and strategic actions may in turn instigate certain structural processes.

Emergence processes and strategies in the discourse of educational neuroscience

With regard to educational neuroscience’s developments, numerous emergence processes and strategies are found in my analysis. As mentioned in the previous section, problematisation, negotiation, crossing of boundaries, and re-articulation of discursive elements can signify emergence processes and strategies. To ascribe these emergence processes merely to *one* discursive aspect or to *some* individual’s, would, however, be unproductive. Arguably, and in line with critical discourse theories, the emergence of educational neuroscience occurred through a combination of discursive emergence processes and actors’ strategies. In other words, discursive problematisation and ‘reweaving’ of discursive elements in the field of external discourses must be seen as having been brought into play as a result of both discursive structural dispositions and human actions.

Discursive structural dispositions are, for instance, found in the very arrangement of relations within and between discourses pertaining to educational neuroscience. What I mean by this is that the field of prior discourses also contains the seeds of possible conflicts, since boundaries between discourses are potential points of tension and conflict. Moreover, the nature of conflicting elements also creates possibilities of resistance, because those elements that challenge dominant representations also provide people with resources to make resistance (Jørgensen & Phillips, 1999). In the words of Fairclough (1992, p. 96): “The immediate origins and motivations of change in the discursive event lie in the problematization of conventions … Such problematizations have their bases in contradictions". In the same way, I will argue that discursive structures within and between discourses related to educational neuroscience present structures with the potential for discursive conflicts, contradiction, and thus discursive change. For instance, in the field of prior discourses in the late 19th century, such conflicting elements are seen between the discourse of behaviourism and the novel discourse pertaining to brain science and cognitive research. As already argued, similar boundary conflicts are also found throughout the history of the same field of discourse pertaining to education, cognitive psychology, and neuroscience, in addition to conflicts pertaining to positivism in the social sciences in the 1950s and claims for more of an evidence base in the 1990s.

Considering that emergence processes should also be seen to be interrelated with human actions and strategies, it should be stressed that whereas discursive structures hold the seed to possible problematisation, it is individuals or groups holding alternative representations who, in the end, will convey disagreement (Fairclough, 1992). Moreover, problematisation of discourse necessitates new representations, and the field of prior discourses, on the basis of their inherent power, offers the resources to craft new discursive elements. This, however, requires human action and the use of strategies to negotiate, re-articulate and combine prior discursive elements into new constructions. In problematising the behaviourist discourse, authors and researchers claimed that behaviourist stimulus-response representations were too limited, since they did not encompass cognitive factors. Accordingly, discursive boundaries were being crossed and prior discursive elements were re-articulated in new narrations that justified relations between the brain, the mind, and behaviour. These processes of problematising behaviourist narrations and the postulation of new articulations can therefore be seen as central actions and strategies in the early emergence process of the educational neuroscience discourse.

Other strategies related to the development of educational neuroscience are found in the ways in which educational neuroscience is *talked* about − either explicitly or implicitly, for example, in how an author chooses to refer to educational neuroscience. In 1895, it was noted by Donaldson that "education consists in modifications of the central nervous system" (p. 336), and later in 1923, Thorndike hypothesised that "the capacity to learn and remember could find its physiological basis in the movement-process of the neurones" (p. 225). During the 20th century, there is more explicit mentioning, and often warm appraisal, of "fruitful collaboration between neuroscientists and educators" (Chall & Mirsky, 1978b, p. 376), "great expectations − collaboration between the brain sciences and education" (Peterson, 1984, p. 74), and need for "interdisciplinary dialogue" (Blakemore & Frith, 2005b). Strategies are also used in arguments for 'building bridges', and recommendations such as "it seems especially appropriate for us to contribute to building a bridge between the brain sciences and education" (Peterson, 1984, p.79) are seen in numerous texts[80]. In the 1980s and 90s, numerous strategies to *constrain* the development of educational neuroscience are also found, in warnings about the 'exceedingly dangerous' pitfalls of neuromyths and 'a bridge too far'[81] (see further representations in table 5.2).

Emergence strategies are not solely detected in how different authors refer to educational neuroscience; strategic actions related to the development of educational neuroscience are also seen in instigations of social events and practices, and in materialised aspects of discourse. Some of the first traces of this are found in the 1970s, with the launching of many conferences and projects − all of which sent an optimistic message about neuroscience and its possible applications in the field of education[82]. Later, in the 1990s and the two first decades of the 21st century, the instigation of numerous conferences and projects on educational neuroscience[83], the establishment of collaborative centres, postgraduate degrees in several universities such as Harvard University, Cambridge University, the University of London, and the University of Bristol, and the launching of two academic journals on the linkage of mind, brain and education, are also clear evidence of actions and strategies pertaining to the development of the educational neuroscience discourse (see table 5.2). The discourse of educational neuroscience, therefore, reveals numerous individual and group strategies, which together have crafted discursive change and development.

[80] Also seen in Byrnes and Fox (1998a) and Ansari and Coch (2006).
[81] As seen in McGuinness (1987) and Bruer (1997).
[82] As seen by the 4th annual meeting of the Society of Neuroscience in 1974 (Marshall & Magoun (eds), 1975), the conference on Neural Mechanism of learning and memory in 1974 (Rosenzweig & Bennett (eds), 1976), and the National Society for the Study of Education's project on Education and the Brain from 1973-1978 (Chall & Mirsky (eds), 1978).
[83] As seen by the projects by OECD (2007), TLRP (2007), and The Royal Society (2011a; 2011b).

Table 5.2: Examples of strategies found in the development of the discipline.

Strategies in form of value-laden articulations		***Strategies and actions pertaining to practices, instigations of events etc.***
Positive	***Negative***	
“Fruitful collaboration between neuroscientists and educators” (Chall & Mirsky, 1978b, p. 376). “The educators who sheds past confusions to see that the brain is the organ for learning enters an enchanting new world ... The doors stand open. Those who go through them may well find what must be found if public schools are to survive” (Hart in Sylwester et al., 1981, p. 17). “Great expectations - collaboration between the brain sciences and education ... It seems especially appropriate for us to contribute to building a bridge between the brain sciences and education” (Peterson, 1984, p. 74 & p. 79). “[T]he importance of anchoring education in an evidence base derived from neuroscience” (Blakemore & Frith, 2005b, p. 459). “It is time for education, biology and cognitive science to join together to create a new science and practice of learning and development. The remarkable new tools of biology and cognitive science open vast possibilities for this emerging field” (Fischer et al., 2007, p. 1).	“Some ambitious authors [are] grasping at straws in trying to draw parallels with what might be relevant to the classroom about their unique areas of expertise. Often these grasps at straws are exceedingly dangerous ...” (McGuinness, 1987, p. 117). “[It] points rather more to dead ends (what does not work) and promising leads than to definitive solutions” (McGuinness, 1978, p. 119). “Advocates [for neuroscience and education] are trying to build a bridge too far. Currently, we do not know enough about the brain development and neural function to link that understanding directly, in any meaningful, defensible way to instruction and educational practice” (Bruer, 1997, p. 4). “Neuroscience has discovered a great deal about neurons and synapses, but not nearly enough to guide educational practice” (Bruer, 1997, p. 15).	Instigation of conferences such as the 4th annual meeting of the *Society of Neuroscience* (1974) and *Neural Mechanism of learning and Memory* (1974). Instigation of National Society for the Study of Education’s project on Education and the Brain (1973-1978). OECD’s project *Learning Sciences and Brain Research* (1999-2007). TLRP’s project *Neuroscience and Education: Issues and Opportunities* (2007). The Royal Society’s project *Brain Waves: Neuroscience: implications for education and lifelong learning* (2011). Establishment of postgraduate degrees, such as the master and doctoral degree of Mind, Brain, and Education at Harvard University (2002). Establishment of collaborative university centres, such as IMBES, CEN, BNE: SIG, and MBESC (21st century). Launching of journals, such as the *Mind, Brain, and Education* (2007).

Why did the discourse of educational neuroscience emerge when it did?

In order to tie up some loose ends, in this section I will consider *why* the academic level of educational neuroscience only became established during the past few decades, when the linking of mind, brain and education has arguably existed for centuries. In this respect, I will particularly emphasise three factors. I will argue, firstly, that the establishment of educational neuroscience is interlinked with neuroscientific advancement, secondly, that it can be related to dynamics in education, and thirdly, that emergence can be connected with successful strategies. Starting with *neuroscientific advancement,* I have already argued that developments within the neuroscientific discourse have influenced developments in the educational neuroscience discourse. I will further argue that advancement within the neuro-scientific field also can be ascribed a central role as to why educational neuroscience was established at the time it was, and not earlier. If we look at historical references from my corpora, one can clearly detect a sense of 'novelty' in the endeavour to link education with aspects of the mind and brain. This is easily seen in much of the *critique* of educational neuroscientific endeavours, as much censure is grounded in claims that "more research is needed before application" (McCall, 1990, p. 885), and that "advocates are trying to build a bridge too far. Currently, we do not know enough about the brain development and neural function to link that understanding directly, in any meaningful, defensible way to instruction and educational practice" (Bruer, 1997 p. 4). Interestingly enough, it is not only sceptics who note a lack of insight concerning the mind and the brain − almost every author in the emergence corpora who expresses optimism for a linkage between the brain, the mind, and education also says that there is a 'lack of current knowledge' and that there will be 'better possibilities in the future'. Donaldson (1895, p. 342), for instance, notes that "it is not known how a year's schooling affects the central nervous system, and it is not probable that we shall soon arrive at facts of this sort". Additionally, Thorndike (1923) makes similar reminders that "knowledge is lacking" and it is even stressed in one of his footnotes that:

> The attempt made here to give a physiology of the adaptive element in learning − of modifiability in favour of the satisfying – is too premature and speculative to be of much value; and the discussion of it, without reliance upon technical acquaintance with the physiology of the neurones and the behaviour of the micro-organisms, is necessarily inadequate (Thorndike, 1923, p. 224).

Other references can be found in Epstein's text (1974)[84], in Sylwester et al. (1981)[85], and in the text by Blakemore, Winston and Frith (2004). Thus, even if numerous actors express optimism with regards to the future of educational neuroscience, they also show caution by emphasising that there is 'lack of current knowledge'.

Findings from my discourse analysis indicate that something has changed over the last few decades, as from the 1990s onwards, one can detect more confidence in the neuroscientific field. This can be associated with the introduction of ground-breaking technologies such as MRI and fMRI which opened new doors for neuroscientific research. Such neuroscientific advancements further led to proclamations such as 'the Decade of the Brain' in the 1990s and 'the neuroscientific revolution' in the shift to the 21st century, in addition to a growing interest in the brain amongst both politicians and the public at large. Increased attention and confidence in the neuroscientific discourse can also be found amongst many working at the interface of education, cognitive psychology, and neuroscience[86]. In view of this, it can be assumed that technological advancement and new research possibilities in the neuroscientific field, in addition to a growing body of knowledge concerning the brain and the mind, were significant factors in the establishment of an academic discipline of educational neuroscience.

Another factor which can be linked to the establishment of educational neuroscience as a distinctive discipline around the 21st century is, as I will argue, the dynamics within the educational discourse itself. What I will specifically point out is a shift in educational perspectives from the 1990s and onwards, where increased attention was given to 'scientifically grounded practices', 'evidence-based knowledge', 'what works' and a request for 'evidence-based education'. This shift can further be seen as being connected to a larger ideological and neo-liberal shift in educational policies, ensuing from the 21st century's increased globalisation, attention to human capital, calls for greater accountability from educational institutions and, hence, also requests for better and more efficient educational systems which meet politicians' and society's high standards. It can further be noted that the direction of change in educational thinking and practice is increasingly top-down, as central governments, think tanks, intergovernmental organisations (such as the OECD), and the

[84] "Without further evidence no inferences should be drawn about single individuals" (Epstein, 1974, p. 223).
[85] "It's still too early for schools to effect immediate organisational, curricular, and instructional change ... But can we afford to wait until all problems are solved before we begin to study educational issues implicit in this research?" (Sylwester et al., 1981, p. 8).
[86] Seen in Byrnes and Fox (1998a, 1998b), Berninger and Corina (1998), Blakemore et al. (2004), Blakemore and Firth (2005b), Posner and Rothbart (2006), Ansari and Coch (2006), Goswami (2006), Fischer et al. (2007), and Varma et al. (2008).

media influence the educational discourse (Davies, 1999). Seeing that one during the 21st century, one can find top-down calls for 'evidence-based education' and request for 'scientifically grounded practices', the linkage of education with the 'hard science' of neuroscience can *seemingly* appear to meet the 21st century's 'evidence-movement'. In later chapters, I will discuss why the discipline of educational neuroscience does not necessarily fit neoliberal ideas about evidence in education, but for now it should be noted how the shift towards 'evidence-based practice' in education may have contributed to the progression of educational neuroscience in the 21st century.

A third factor, also significant in the development of educational neuroscience, is the use of particularly successful strategies (successful in that they have crafted discursive changes). Numerous strategies appear to have been rather successful in the last decades, such as initiation of projects like OECD's '*Learning Sciences and Brain Research'* in 1999, TLRP's project *'Neuroscience and Education: Issues and Opportunities'* in 2007, and The Royal Society's project '*Brain Waves: Neuroscience: implications for education and lifelong learning'* (2011a, 2011b). What is interesting about these emergence strategies is that they have caught the attention of policymakers and the media − discursive actors who in turn can be said to have potential influence both within the political domain and the public domain[87]. Other successful strategies in the establishment of educational neuroscience are instigations of conferences and seminars, crafting of collaborative networks and centres, and launching of academic journals − all actions particularly occurring within the academic sphere. Perhaps some of the most substantial strategies can be seen to be establishment of the many courses, university programmes and degrees (both postgraduate master degrees and doctoral degrees) pertaining to educational neurosciences. One significant facet of these university programmes is the continual recruitment to the field which they provide, in addition to the competence they provide to new academics by offering participants a background in the three areas of cognitive neuroscience, cognitive psychology, and education. Overall, it therefore appears that these successful strategies, in addition to advancement in neurosciences, changes in dynamics in education such as increased focus on 'scientifically grounded practice', a growing body of knowledge regarding the brain and the mind, and increased confidence in the neuroscientific discourse are significant factors in the establishment of educational neuroscience as a distinctive academic discipline in the 21st century.

[87] Educational neuroscience's recontextualisation to political and public fields is analysed and discussed further in chapter 7 and 8.

Discussion of the main themes in educational neuroscience

Whereas attention in previous sections for the most part is on relations found *between* the discourse of educational neuroscience and other adjacent discourses, this section will focus on relations found *within* the discourse. This is because the discourse of educational neuroscience also has undergone internal changes during its development. As a means to detect educational neuroscience's internal changes, a critical discourse analysis and discussion of *discursive narrations* and *discursive positions* found throughout the history is presented. Research questions investigated are accordingly 'how has the discourse of educational neuroscience represented, narrated and justified particular aspects of the world throughout its history' and 'which particular perspectives, points of view, and positions are available within the discourse?' Investigation of discursive representations will follow the idea that crossing of discursive borderlines has resulted in 'new articulations' in the educational neuroscience discourse. Investigation of representations is also purposeful since it can reveal how the world is narrated and justified by subjects within the educational neuroscience discourse – an aspect which, furthermore, is liable to resonate with other discursive elements, such as discursive subject positions, social practices, values, organisations and institutions. A useful way to present these findings is to discuss them in relation to aspects of *continuity* and *change* in the development of educational neuroscience[88].

Which recurring themes can be found in the discourse's development?

Even if elements pertaining to the academic level of educational neuroscience have developed since the late 19th century, my analysis of historical series of texts reveals certain recurring themes. Intertextual findings suggest that the most obvious and continuing theme in the discourse concerns the cross-disciplinary endeavour to link aspects of the brain, the mind, and education. I have already elaborated on this notion in previous discussions on the field of prior discourses, however this section aims to analyse changes and recurrences of relations found *within* the discourse of educational neuroscience. A critical discourse analysis of such internal discourse elements can reveal more of the inner development of the educational

[88] Alignment in accordance with *continuity* and *change* can easily lead to the idea that a distinct line can be drawn between 'new' and 'old' discursive elements. However, and as concepts of interdiscursivity and intertextuality point out, every discursive element – whether it be textual narrations, social practices, or discursive positions – will bear some resemblance or 'luggage' from previously discursive elements. Thus, when categorising something into either continuity or change, this will inevitably imply an alignment with restrictions, since there will always be some aspects of continuity in 'new' articulations, just as some alterations in seemingly consistent and recurring themes are likely to be found.

neuroscience discourse by identifying recurring themes, perspectives, and which 'parts of the world' are represented and which are neglected (cf. Fairclough, 2002, p. 129). Overall, this can help to elucidate the main themes that have remained central throughout the history of educational neuroscience, and how the discourse keeps representing, narrating and justifying particular parts of the world and not others.

Cautious optimism

My critical discourse analysis indicates that a recurring theme in academic texts from the educational neuroscience discourse is an emphasis on 'the novelty of brain science' and that 'there is still much we don't know about the brain'. Intertextual findings from my analysis also show that an acknowledgment of 'lack of neuroscientific knowledge' is often followed by a note of *cautious optimism*. In later years, 'cautious optimism' appears to have become a catch phrase amongst numerous academics in the educational neuroscientific discourse, as it is often used deliberately to signify an author's position towards educational neuroscience[89]. In short, this position can be seen to indicate an *optimistic* standpoint towards the linkage of brain, mind, and education, albeit that it is also stressed that one should be *cautious* in drawing educational recommendations from neuroscientific findings (Flobakk, 2011). The article by Varma et al. (2008) argues strongly "for a cautious optimism", but other references of cautious optimism can also be found in texts by Byrnes and Fox (1998a), Blakemore et al. (2004), and Blakemore and Frith (2005b).

The phrase 'cautious optimism', or variations of it, is often detected in texts from the last three decades. What is interesting to note, however, is that similar phrases of cautious optimism are found throughout the history of educational neuroscience. As far back as 1923, Thorndike suggests a cautious optimistic approach, as he optimistically notes the linkage between the brain and cognitive aspects such as learning and memory, albeit that he also firmly stresses that 'knowledge is lacking' and that some of his hypothesis is 'too premature' and 'inadequate' (Thorndike, 1923, p. 224). Similar sentiments are also seen in the text by Epstein (1974). Another and perhaps more explicit note is found in the summary of the five-day conference on 'Neural Mechanisms of Learning and Memory' in 1974, where it is noted: "To conclude, it seems to me that a feeling of progress and optimism has pervaded our

[89] A discussion of different discursive positions in the educational neuroscience discourse is presented later in this chapter.

discussions, even as we acknowledge the problems that we still have to face" (Rosenzweig, 1976, p. 599). Additionally, in NSSE's yearbook dedicated to 'Education and the Brain' it is stressed that "[s]ince the application of the neurosciences to education is still relatively new, it must therefore be approached with caution as well as with the excitement that comes from viewing old problems in a new light" (Chall & Mirsky, 1978b, p. 375)[90]. Other references are found in Vellutino's (1979, p. 864) text where a general optimism is noted, albeit "[one] should be cautioned against premature acceptance of seminal research findings as a basis for instructional programming", in the text by Sylwester et al. (1981), and in Peterson's (1984) concluding remarks in her optimistic article: 'Great expectations: collaboration between the brain sciences and education':

> What then are the implications of research in the neurosciences? Those who are expecting to find classroom applications will be disappointed for there simply are none that are obvious at this time [1984]. If neuroscientists themselves are wary (and they are wary) of drawing from their work conclusions about how to teach children differently, how much more cautious educators should be (Peterson, 1984, p.79 [my inserted brackets]).

Intertextual findings from my emergence analysis therefore show how statements of *cautious optimism* are a recurring notion amongst scientists working at the interface of education, psychology, and neuroscience from Thorndike's work in 1923, to numerous later works in the 21st century. A recurring statement of cautious optimism can therefore be seen as an element of continuity throughout the development of educational neuroscience, although, and as previously stressed, the meaning of the term appears to have changed slightly since the early 1900s, since it now also appears to have connotations with a distinctive position within the discourse.

Different levels of analysis

The endeavour to link aspects of neuroscience, cognitive psychology, and education has been at the very heart of the educational neuroscience discourse since the late 19th century. In line with this clearly stated cross-disciplinary endeavour, one also finds numerous themes regarding *the relation* which ought to pertain between these disciplines related to educational neuroscience. For instance, there are statements of inter- multi- and transdisciplinarity, calls

[90] Even if Chall and Mirsky (1978b) note of a cautious optimism, in hindsight, one can deem that they were not cautious enough in some of their claims, for instance by linking brain lateralisation with implications for education.

for collaboration and dialogue between disciplines, in addition to debates concerning 'bridging of the gap' between the discourses[91]. This evident *awareness* of a cross-disciplinary project is also seen in relation to another major theme in the educational neuroscience discourse − namely acknowledgment of *different levels of analysis* found between the disciplines.

Findings from my analysis suggest that statements regarding awareness of different levels of analysis recur throughout the history of educational neuroscience. Some of the more explicit references, for instance, are seen in Rosenzweig and Bennett's conference synopsis from the 1970s, where it is stressed under the headings 'Multidisciplinary research − problems and potentialities' and 'Levels of analysis' that:

> Some of these problems between disciplines can be alleviated by the understanding that many of us are really working at different levels of analysis ... Solving problems at one level does not necessarily solve them at another, although it should provide help and encouragement ... The long-run goal is to discover the rules or transformations that permit translation from one level of analysis to another (Rosenzweig, 1976, pp. 597-598).

Similarly, Wittrock notes how "we should go slowly and carefully with the development of these educational implications, remembering the great difference in level of research between neuroscience and education" (Sylwester et al., 1981, p. 15). Other references from the corpora regarding differences in analysis and methodology between the disciplines pertaining to educational neuroscientific work are: McGuinness (1987), Bruer (1997), Byrnes and Fox (1998a, 1998b), Berninger and Corina (1998), Ansari and Coch (2006), and Varma et al. (2008, p. 141), where the scientific distance between education and neuroscience is investigated by asking if "their different methods, different data, and different theories constitute a fundamentally unbridgeable divide?".

Analysis of historical series of texts indicates cross-disciplinary and intertextual aspects of 'different levels of analysis', which seem to run through the history of educational neuroscience − even if it is more explicitly stated from the mid-20th to the 21st century. One can therefore argue that attention to analytical and methodological differences between disciplines pertaining to educational neuroscience's cross-disciplinary endeavour have been a continuous theme throughout most of the development of educational neuroscience.

[91] As seen in Chall and Mirsky (1978a, 1978b), Peterson (1984), Byrnes and Fox (1998a, 1998b), Bruer (1997), Blakemore and Frith (2005b), Varma et al. (2008).

Misinterpretations of neuroscientific findings

Another recurring theme found when analysing historical series of academic text concerns how neuroscientific findings can easily be misinterpreted when related to educational practice. Mentioning of misinterpretations of neuroscientific findings and warning against neuromyths have been particularly central features in the educational neuroscience debate in academia in the 90s and up to the present day. Furthermore, it can, appear that such 'warnings' are either used as a strategy for arguing *against* the educational neuroscientific endeavour[92], or as a reminder for caution and awareness in linking education and neuroscience, from more optimistic advocates of educational neuroscience[93]. However, warnings against misinterpretation of neuroscientific findings and censure of vague links drawn directly from neuroscience to recommendations for educational practice are not a recent phenomenon − findings from my analysis and from other historical references show similar representations as far back as the 1890s. The contributions from Donaldson (1895) and Halleck (1896) are noteworthy in this respect, as they provide an early and significant linkage between the brain and education. However, whereas Donaldson, the neuroscientist, gives the impression of being cautious in drawing links from neural changes in the brain to educational practice, Halleck tends to simplify complex neuropsychological knowledge throughout his text in order to provide "facts which every parent and teacher must know and apply in order to secure the fuller development of children at a critical time" (Halleck, 1896, p. viii). It is interesting to note, when reading later historical references related to Halleck's text, that Halleck met with considerable criticism in the aftermath of his publication, largely because his work was considered 'incomplete' due to:

> inadequate treatment of brain structure and function and the disproportional discussion of sensation and memory, while leaving out ideas such as the neuron theory (...) He was further criticised for lack of correct scientific thinking, and for making deductions based on inadequate data (Editorial, 1896, and Herrich, 1897, in Théodoridou & Triarhou, 2009, p. 126).

It is noteworthy that Halleck, the educationalist, was criticised for misinterpretation when working to link neuroscience and education as early as in 1896. It is also noteworthy that historical references continue to provide similar 'warnings' of misinterpretations throughout the centuries and up until the present day. For instance, it is stated in the summary of the neuroscience conference 'Neural mechanism of learning and memory' from 1976, that "It is

[92] As seen in McGuiness (1987) and Bruner (1997).
[93] As seen in Byrnes and Fox (1998a), Ansari and Coch (2006), Goswami (2006), and Varma et al. (2008).

certainly our ongoing responsibility to communicate our research, and to try to do this in such a way as to prevent misuse of our findings, to prevent misunderstanding, and to prevent attempts to use biological shortcuts to solve long-term social problems" (Rosenzweig, 1976, p. 598). My analytical findings include numerous other references to misunderstandings and misapplications, and during the late 20th century many of the complaints were about brain lateralisation, as it was argued that research concerning brain hemispheres went astray and was broadcast via misinformed educational practices concerning right brain and left brain learning (cf. Williams, 1983). In this respect it is noted that "it is important to conclude with a cautionary note ... It is unfortunate that the simplistic notion of teaching to one or the other hemispheric process of the brain has become widespread and popular" (Sylwester et al., 1981, p. 15), and in Peterson (1984) it is similarly noted that:

> Unfortunately, caution has been thrown to the wind by many in the name of advancement. Presently [in 1984] a runaway movement characterized by Right Brain-Left Brain workshops is sweeping through the schools, leading one to believe that every school district in America has its own resident neuroscientist. But few of those who actually conduct local workshops appear to understand the basic research underlying the implications they extract from brain laterality or hemisphericity (Peterson, 1984, p.79 [my inserted bracket]).

One can therefore argue that warnings against both misinterpretation of research findings related to cognitive neuroscience and misapplication in educational practice are elements of continuity throughout the development of the educational neuroscience discourse. Again it must be noted that even if warnings against misinterpretations are recurring in the discourse, some changes are also found here. The most notable of these is perhaps that misinterpretations, misinformation, and/or over-interpretations of neuroscientific findings − or 'neuromyths' as they have been called in recent years − appear to have taken a more distinctive *commercial* turn from the 1980s up until today. This is noted by numerous authors[94], as they warn about the growing commercial 'brain-based learning industry' which approaches teachers with learning programmes arguably based on 'neuroscientific evidence'. However, this commercial turn notwithstanding, warning against misinterpretations and neuromyths appears to run through the history of educational neuroscience from the late 19th century to the 20th century, and continues as a central theme in the 21st century's educational neuroscience discourse.

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[94] As seen in Peterson (1984), McCall (1990), and Goswami (2006).

Table 5.3: extracts illustrating some reoccurring themes in the history of educational neuroscience.

Cautious Optimism	***Different level of analysis***	***Misinterpretations, misinformation, and/or over-interpretations of neuroscientific findings***
"To conclude, it seems to me that a feeling of progress and optimism has pervaded our discussions, even as we acknowledge the problems that we still have to face" (Rosenzweig, 1976, p. 599). "Since the application of the neurosciences to education is still relatively new, it must therefore be approached with caution as well as with the excitement that comes from viewing old problems in a new light" (Chall & Mirsky, 1978b, p.375). "If neuroscientists themselves are wary (and they are wary) of drawing from their work conclusions about how to teach children differently, how much more cautious educators should be" (Peterson, 1984, p. 79). "...educational researchers should view these [neuroscientific] results with appropriate caution" (Byrnes & Fox, 1998a, p.305). "[W]e need to be cautious when interpreting the results of neuroimaging studies..." (Blakemore et al., 2004, p. 216). "[W]e argue for a cautious optimism. Neuroscience cannot replace education, nor is that the goal of educational neuroscience" (Varma et al., 2008, p. 141).	"Some of these problems between disciplines can be alleviated by the understanding that many of us are really working at different levels of analysis ... The long-run goal is to discover the rules or trans-formations that permit translation from one level of analysis to another" (Rosenzweig, 1976, pp. 597-598). "We should go slowly and carefully with the development of these educational implications, remembering the great difference in level of research between neuroscience and education" (Wittrock in Sylwester et al., 1981, p. 15). "[T]he problem of trying to relate "brain", "cognition", and "education" as if they were one-dimensional constructs. Not only do brain science, cognitive science, and educational research address completely different levels of a hierarchy, but there are many more levels within each discipline" (McGuinness, 1987, p.117). "[T]he scientific distance between education and neuroscience. Do their different methods, different data, and different theories constitute a fundamentally unbridgeable divide?" (Varma et al., 2008, p. 141).	"It is certainly our ongoing responsibility to communicate our research, and to try to do this in such a way as to prevent misuse of our findings, to prevent misunderstanding, and to prevent attempts to use biological shortcuts to solve long-term social problems" (Rosenzweig, 1976, p. 598). "It is important to conclude with a cautionary note ... It is unfortunate that the simplistic notion of teaching to one or the other hemispheric process of the brain has become widespread and popular (Wittrock in Sylwester et al., 1981, p. 15). "[M]any teachers and administrators attended lectures, workshops, and in-service training sessions in which they were urged to consider plateaus in brain growth as a possible explanation for poor school performance and a basis for change in curricula. The information many received at such sessions was not always tempered with uncertainty, tentativeness, and caution, and some educators and school systems reportedly were all too eager to hear and act upon the good news" (McCall, 1990, p.888) "[A]t present, teachers are at the receiving end of numerous 'brain based learning' packages. Some of these contain alarming amounts of misinformation ... These neuromyths need to be eliminated. The dominance of these myths obscures the important strides being made by cognitive neuroscience in many areas relevant to education" (Goswami, 2006, pp. 2-3).

Discursive positions

Another theme which seems to continue throughout the history of educational neuroscience is that of the *discursive positions* available within the discourse of educational neuroscience. A discursive position is a certain standpoint taken toward a central − or *the* central − discursive theme. In consequence, one can easily be led to believe that there will be just as many discursive positions as there are subjects within a discourse, since each individual may have a distinct interpretation and stance towards a discursive theme. However, the term 'discursive position' covers a much broader ensemble of perspectives than just a few individual opinions. A discursive position can therefore be seen as a collective consortium of subject positions holding relatively the same representation, perspective and ideology. In other words, discursive positions imply an institutionalised way of 'being in the world' that is offered within the discourse (Neumann, 2010; Fairclough, 2010). What can also be noted is that stable and rigid discourses with little change, often have one discursive position − or at least one dominant position. Discourses with greater notions of discursive tensions and instability, however, may have more possible discursive positions available. This is because discourses whose boundaries are crossed and where continuous alterations are being made, may also experience constant negotiations over representations − negotiations which will often be congregated around different subjective positions.

As to whether it is a stable discourse or one associated with change, educational neuroscience indeed appears to fall under the latter category. Not only is educational neuroscience suggestive of discursive tension, and crossing and negotiation of boundaries, but one can also find constructions of new articulations, numerous intertextual and interdiscursive relations, and an evident debate concerning 'bridges over troubled waters' (cf. Ansari & Coch, 2006). In accordance with these aspects of 'instability' and 'negotiations', I will therefore argue that there may be a number of different discursive positions available in relation to the educational neuroscience discourse. With reference to my critical discourse analysis of the emergence corpora, in addition to my previous critical discourse research on the academic debate regarding educational neuroscience (Flobakk, 2011)[95], I will argue that one can find four main positions within the educational neuroscience discourse − positions I have chosen to label as *cautious optimism*, *apprehension, over-enthusiasm,* and *neutrality/indifference*. In order to illustrate the different discursive positions, I have produced a

[95] It must be noted that I have made some minor alterations to the model I proposed back in 2011.

basic illustration. Although the model is simplistic, it provides an overview of the different discursive positions one can take with regard to educational neuroscience's chief endeavour[96].

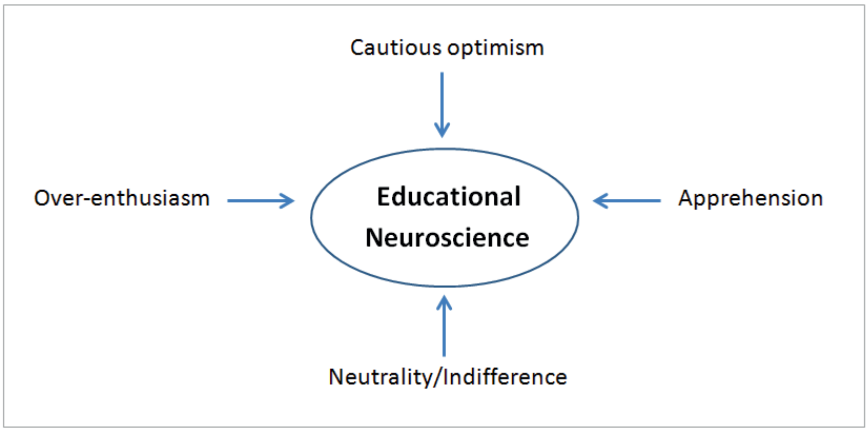


Figure 5.4: Different discursive positions in the educational neuroscience discourse.

Diametrically opposed to each other are the discursive positions of *apprehension* and *over-enthusiasm*, whereas the positions of *cautious optimism* and *neutrality/indifference* are somewhere in-between these two camps[97]. The latter of these lie somewhat outside the discourse, because those taking a neutral/indifferent position cannot truly be seen engaged in educational neuroscience discourse. Conversely, the other three positions are more involved in the academic level of the discourse since they all appear to take a stand on major issues and debates regarding educational neuroscience.

Regarding the discursive position of 'over-enthusiasm', this can be allocated to groups of people who are overly enthusiastic about what neuroscience can 'offer' education. Within this overly enthusiastic position, often one also finds a top-down translation, where attempts are made to translate neuroscientific findings directly into classroom practices. What appears to be problematic with this approach is that these overly enthusiastic actors, in their eagerness to apply neuroscientific findings to educational settings, may draw overly hasty conclusions by leaping from neurobiological findings at a lower micro-level of analysis to the higher level of analysis found in a classroom's complex social setting. Moreover, and what is even more alarming, is that individuals within this overly enthusiastic position, seldom appear to have a

[96] These discourse positions are also in concurrence with similar accounts from authors such as Geake (2005) and Varma et al. (2008).

[97] These four positions also correspond with critical discourse theories, where it is argued that available positions in a discourse often take the form of either loyalty/identification, voice of opposition/contra-identification, or dis-identification/exit (Neumann, 2010).

background in cognitive neuroscience or cognitive psychology, perhaps not even in education. Neuroscientific findings can therefore easily be misinterpreted and over-simplified, which again enhances the inadequacy of the educational recommendations suggested. As a result, misguided enthusiasts are at risk of crafting and advocating *neuromyths* to teachers and schools, rather than offering recommendations founded in educational neuroscience. Unfortunately, a commercial aspect has also come into play, and numerous seminars, workshops, and so-called 'brain-based learning programmes' are sold to teachers and schools[98]. So-called 'brain-based learning' advocated by misguided enthusiasts includes, for instance, learning programmes on how left and right brained children should be taught, on how children should be labelled as 'visual', 'auditory' or 'kinaesthetic' learners (the VAK programme), and on how 'Brain Gym' and pressing certain 'Brain Buttons' can improve children's learning (cf. Goswami, 2006; Howard-Jones, 2010; Flobakk, 2011). It can therefore be argued that the discursive position of over-enthusiasm holds a rather misguided and un-informed perspective towards educational neuroscientific research. For that reason, actors who are overly enthusiastic about the linkage of education and neuroscience are meeting with strong censure. Not only do numerous neuroscientists criticise them for simplifying and misinterpreting neuroscientific research, but also some who work within the educational neuroscience discourse itself censure the over-enthusiasts for obstructing the more cautious and scientifically grounded endeavours of educational neuroscientists[99].

In contrast to the over-enthusiasts, people adopting a perspective of 'apprehension' are more inclined to consider the endeavour to link education and neuroscience as a rather fruitless exercise. It is therefore no surprise that the most profound criticism of educational neuroscience comes from this discursive position. By reviewing historical texts from the literature search and from the corpora, disapproval and criticism are seen to be anchored by at least two aspects. Apprehension can, first of all, be based on strong condemnation of the misguided learning industry and its neuromyths − sometimes one can also detect confusion here, as the discipline of educational neuroscience is confused with so-called 'brain-based learning'[100]. Censure is further emphasised by referring to studies where 'brain-based' learning programmes have failed in their attempt to improve children's learning (cf. Varma et al., 2008). In the same way, the entire discipline of educational neuroscience seems to be

[98] Further discussion of this commercial 'brain-based' learning industry will be presented in chapter 7 and 8 regarding the recontextualisation of educational neuroscience to other discursive levels.
[99] As seen in Goswami (2006) and Varma et al. (2008).
[100] As seen in Davis (2004).

discredited, since the difference between overly enthusiastic programmes based on neuro-myths and the more scientifically grounded discipline of educational neuroscience are deemed to be separated only by a fine line. Another criticism is aimed at the assumed reductionistic approach which educational neuroscientific endeavours is believed to take, as one is afraid that the role of the brain is given predominance over social explanations, in addition to claims that neuroscientists invade, cannibalise, and de-professionalize the educational field[101] (cf. Flobakk, 2011). Yet another, and often related, critique voiced by the apprehensive position concerns judgments about 'the gap' between education and cognitive neuroscience. Arguments arise from the numerous differences found between the discourse of education and that of neuroscience, such as differences in philosophy, theories, methodology, methods, definitions and vocabulary. In other words, this 'gap' between the different levels of analysis is considered to be so vast and profound that a bridging project would be a 'dead-end street' and should not even be attempted − or, at best, that it is still too soon to start such bridging projects[102]. For these reasons, the camp of apprehensive actors, gives the impression of wishing to dismiss the link between the two fields, and the project of educational neuroscience is thus also dismissed. What is interesting to note, and this will be discussed in later sections, is how much of this critique misses its target because many of these worries do not conflict with current educational neuroscientific representations.

I have already elaborated on 'cautious optimism' earlier in this section, when I argued that a recurring theme within the educational neuroscience discourse appears to be a note of cautious optimism. The discursive representation of cautious optimism, however, is so common that it can be seen manifested as a distinct discursive position within educational neuroscience. To restate, this discursive position adopts an optimistic perspective towards the educational neuroscience venture, in addition to emphasising the importance of a cautious approach. Attempts to link neuroscience, cognitive psychology, and education are therefore deemed to be profitable and important, as long as one is careful when translating findings from one level of analysis to the other levels. In view of this, requests for reciprocal collaboration between neuroscientists, cognitive psychologists, and educationalists are

[101] As seen in Schumacher (2007) and Davis (2004).
[102] As seen in Bruer (1997) in the corpora, and in Mayer (1998), Bruer (2006), Davis (2004), and Schumacher (2007).

stressed[103]. 'Reciprocal' is a key word here, as it is believed that 'sustainable bridges' should be bi-directional:

> Education is not neuroscience, and neuroscience is not education. Each discipline addresses a broad range of research questions using a variety of methods ... Educational neuroscience will need to mind these and other gaps − but it need not be defined by them (Varma et al., 2008, p.150).

By taking a cautious approach when making links between the brain, the mind, and education, in addition to the importance of reciprocal collaborations, the discursive position of cautious optimism appears to distance itself from the perspective of over-enthusiasm and rebuke some criticism voiced by the apprehensive. Detachment from the discursive position of over-enthusiasm is evident in the cautious optimists' disapproval of the brain-based learning industries' diffusion of neuromyths amongst schools and teachers. As previously shown, such warnings of neuromyths and so-called 'brain-based' programmes are found by numerous authors within the discourse and throughout the history of educational neuroscience[104]. Additionally, cautious optimism addresses some of the apprehensives' criticisms by firmly stressing that reciprocal collaboration has to be founded on mutual dialogue amongst neuroscientists, cognitive scientists, and educationalists. This implies that a cross-disciplinary endeavour can bridge aspects pertaining to the brain, the mind, and education. Attempts to link concepts of the brain directly to educational practice are rendered inadequate (cf. the censure of over-enthusiasm), and insights from cognitive psychology are considered to be highly relevant. The 'bridge' is therefore not solely made between neuroscience and education, despite what the discipline's name might suggest[105], and cognitive psychology is also assigned great importance.

Overall, it can be noted that a critical discourse analysis of historical texts gives the impression that four main discursive positions are offered within the discourse of educational neuroscience − namely 'cautious optimism', 'apprehension', 'over-enthusiasm', and 'neutrality/indifference'. Even if debates regarding educational neuroscience have been more pronounced in later years, meaning that the different discourse positions are more prominent now, I will argue that these subject positions have been available throughout the history of

[103] As seen in text from the emergence corpus, such as Ansari and Coch (2006), Goswami (2006), Fischer et al. (2007) and Varma et al. (2008), in addition to other texts from the literature search such as Geake and Cooper (2003), Petitto and Dunbar (2004), Howard-Jones (2010), and Ansari et al. (2011).

[104] As demonstrated in Chall and Mirsky (1978b), Vellutino (1979), Sylwester et al. (1981), Peterson (1984), McCall (1990), Goswami (2006), and Varma et al. (2008).

[105] Some advocated within the educational neuroscience discourse have therefore taken names such as 'brain, mind, and education' (Fischer et al., 2007), and 'Mind and Brain in the educational and social context (MBESC)' (Howard-Jones, 2010).

educational neuroscience. The reason behind such a suggestion is because these four discursive positions offer the main viable positions that can be taken towards a discursive theme[106]. However, even if it can be argued that the different discursive positions available have been largely unchanged throughout the development of educational neuroscience, the *meaning* and the narratives in the debate can be seen to have changed during the centuries. Alterations in narrations and meaning attributed to, for instance, the linkage between brain-mind-behaviour takes us to the next section, where changes in discursive aspects pertaining to educational neuroscience are analysed and discussed.

Which changes can be found in the discourse's development?

There are certain recurring themes and enduring subject positions at the academic level of educational neuroscience, but my analysis also shows a discourse that has undergone significant *changes* throughout its hundred or more years of history. Discussion of some aspects of developmental change was presented earlier in this chapter, and its focus was on relations between discourses in the field pertaining to educational neuroscience. In the current section, however, changes occurring *within* educational neuroscience are analysed and discussed. Attention is primarily given to changes concerning the main discursive themes, since this can reveal how particular parts of the world are represented, narrated and 'justified' at the academic level of the educational neuroscience discourse (cf. Fairclough, 2010).

Relations between the brain, the mind, behaviour, and the environment

The brain-mind-education relation recurs throughout the history of educational neuroscience from the late 19th century to the 21st century, and it can therefore be argued that it is a constant aspect within the discourse's academic level. However, even if this cross-disciplinary endeavour is a constant aspect in educational neuroscience, my critical discourse analysis shows that the *perception* of the brain-mind-education concept has changed significantly throughout the centuries. It is essential to elucidate how this perception has altered, given the centrality of the brain-mind-education link to the discourse. Moreover, and in line with critical discourse theories, *how* this concept is understood is also likely to affect perspectives, theories, narrations, justifications, and practices within educational neuroscience.

[106] See page 68 in the theory chapter with regard to critical discourse theories on 'loyalty', 'voice' and 'exit'.

What should first be noted with regard to perceptions of the brain-mind-education link is that it is closely connected to perceptions concerning links between the brain, the mind, behaviour, and the environment[107]. Arrows of causation or correlation drawn between brain, mind, behaviour, and environment are well-known and recurring themes in science, because variations of these links will, inevitably, be the basis of explanations pertaining to human action. Narrations found in the educational neuroscience discourse are no exception, and my analytical findings show how changes in key concepts appear to be influenced by changed ideas concerning which arrows can be drawn between brain, mind, behaviour, and environmental aspects. In order to demonstrate changes in perception of this relation in the educational neuroscience discourse, we can start by looking at the main representation found in the 19th century. At this time behaviourism was a dominant perspective within academia and key representations appear to resemble a stimulus-response model. This implies that certain stimuli, such as hearing a bell, cause a behavioural response such as drooling (cf. Pavlov and his dogs). Models of stimulus-response relation are also evident in brain research in the 19th century, for example in studies showing how stimuli to nerve endings in a dog's exposed brain cause muscle contractions in its legs (cf. Fritch and Hitzig's study in 1870, in Windle, 1975). In the 19th century one can thus often find explanations in line with stimulus-response relations and, concurrently, with brain-behaviour models (see my illustration in figure 5.5).

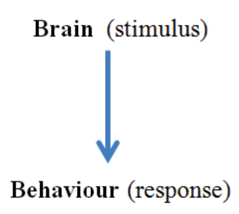


Figure 5.5: The brain-behaviour relation as often featured in the 19th century.

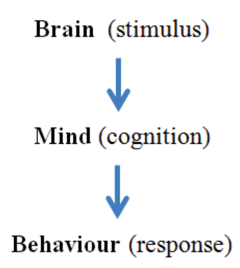


Figure 5.6: The brain-mind-behaviour relation as often featured in the late 19th and early 20th century.

[107] One must be careful not to confuse a relation sequence of 'brain-mind-behaviour' with a 'brain-mind-*education*' sequence, since the term 'education' can imply both *environmental* educational aspects such as teaching and classroom settings, as well as individual behaviour aspects of education such as reading or solving math problems.

When approaching the first epoch of educational neuroscience as it develops from the 19^{th} to the 21^{st} century, one detects a shift from behaviourism to the burgeoning of a cognitive revolution within academia. Behaviourist explanations were problematised and the importance of cognition was emphasised. This shift also implies a shift in explanations of the factors that cause behavioural outcomes − for instance outcomes pertaining to educational achievements. It can therefore be argued that the stimulus-response relation found in the 19^{th} century's brain-behaviour model was altered to a model that also encompassed a *cognitive* level. Concurrently, the relationship between the brain, the mind, and behaviour became established, as it was argued that changes in the level of the brain would lead to changes in cognition, which in turn would result in certain behavioural outcomes (see my illustration in figure 5.6). Historical references from text pertaining to the educational neuroscience discourse, show this idea of a top-down brain-mind-behaviour relation. For instance, Donaldson (1895) notes how anatomical growth of the brain and arrangement of cell elements influences mental powers, which in turn affects behavioural aspects pertaining to education. This idea of a top-down relation between the brain, mind, and education can be illustrated in the following extract from Donaldson:

> On neurological grounds, therefore, nurture is to be considered of much less importance than nature, and in that sense the capacities that we most admire in persons worthy of remark are certainly inborn rather than made ... No amount of education will cause enlargement or organisation where the rough materials, the cells, are wanting; and on the other hand, where these materials are present, they will, in some degree, become evident, whether purposely education or not (Donaldson, 1895, p. 344 & p. 355).

Similar ideas about a top-down model of brain-mind-behaviour relation are found in Thorndike's work from 1923. In his work on 'the original nature of man', he notes how cognitive aspects like "the capacity to learn and remember could find its physiological basis in the movement-process of the neurones" (p. 225), as neural activities in the brain are seen as the basis for learning and memory. Apparently, therefore, arrows can be drawn from the brain to cognitive aspects, and onward to the behavioural level by references such as "the response to be made to a situation may be determined by man's inborn organization" (p. 3) and "[t]he fact is that it is the neurones, not the body as a whole, whose life processes are primarily concerned in the 'successful' operation of a behaviour-series" (p. 126). Gazzaniga and colleagues (2009) also elaborate on Thorndike's early work, arguing that he holds to a form of behaviourist-associationist psychology, since he claimed that operation of a behaviour series could be seen as an associative process emerging from sensory information (stimulus) on which pre-existing mental structures act (Gazzaniga et al., 2009). Thorndike's work from the first epoch of educational neuroscience's development therefore appears to be based on a perception of top-down relations between the brain, the mind, and behaviour.

Representations in line with a top-down model of brain-mind-behaviour are central within educational neuroscience discourse up until the mid-20th century, when one can find increased argumentation for also including *environmental* aspects[108]. The brain-mind-behaviour model, in the mid-20th century, thus appears to have been extended in order to encompass layer(s) of environmental influences (see figure 5.7). This change in perception is evident in numerous historical references from my literature search, as many authors from the mid-20th century refer to animal studies where deprivation of environmental stimulus leads to changes in brain development and cognitive performance. An example is seen in NSSE's yearbook project on 'Education and the brain' where it is noted how "rats reared in an enriched environment (with litter mates in a cage full of 'interesting' objects) show marked changes in brain development, compared to rats reared in impoverished environments" (Chall & Mirsky, 1978a, p. xiii). Based on neuroscientific studies such as these, the importance of education is further stressed by noting that:

> One of the strongest themes relates to the central role of environmental stimulation and experience in the growth and development of the brain − animal and human − and in overcoming the effects of inherited deficiencies or acquired injuries. In essence, the neuroscientists writing in this volume are saying to educators that education is central for optimal brain development. Indeed, the more recent the findings, the stronger the evidence for the importance of education appears to be (Chall & Mirsky, 1978b, p. 371).

Similar ideas, which also suggest perceptions based on a model encompassing environmental influences on brain-mind-behaviour relations, are found in Vellutino (1979), in Sylwester et al. (1981), and Peterson (1984). These and other historical references underline a change in perception of the mind-brain-behaviour relationship during the 20th century, as environmental factors were incorporated in the model (cf. Morton & Frith, 1995). Furthermore, changes in the perception of environmental influences on the brain-mind-behaviour model appear to have influenced the educational neuroscience discourse, as factors pertaining to formal education were now perceived to have a more significant role than previously believed. However, what is distinctive about the brain-mind-behaviour model from the early 20th century (figure 5.6)

[108] It should be noted that by 1896, Halleck had already argued for the importance of environmental aspects such as formal education, by noting that "[w]e certainly have sound reason for believing that we can by the proper training make our nervous system more helpful machines" (Halleck, 1896, p. 42).

and the mid-20^{th} century model, which also encompasses possible influences from environmental aspects (figure 5.7), is that representations of the brain, the mind, and behaviour indicate a top-down relationship. In other words, the arrows in the models are *uni-directional* because they indicate a relationship moving from the brain, to the mind, and finally to behaviour.

My critical discourse analysis of the emergence corpora suggests yet another shift in perceptions pertaining to the arrows which can be drawn between aspects of the brain, mind, behaviour, and environment in the educational neuroscience discourse − a shift which is particularly noticeable in representations from the 21^{st} century. Arguably, the model from the mid-20^{th} century remains the same, although during recent decades arrows have also been drawn the other way round (Howard-Jones, 2010; Flobakk, 2011). What this implies is that the model appears to have changed from a top-down relationship (cf. my illustration in figure 5.7), to encompass possible bi-directional links, which can be drawn from behaviour to cognitive aspects and on to aspects of the brain (cf. my illustration in figure 5.8).

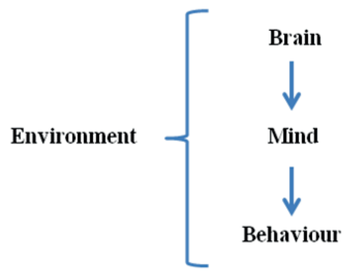


Figure 5.7: The brain-mind-behaviour relation as often featured in the mid-20^{th} century.

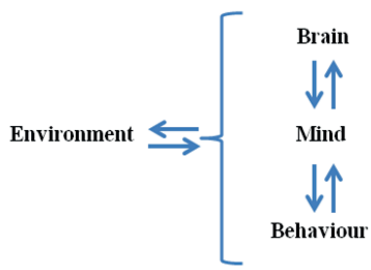


Figure 5.8: The brain-mind-behaviour relation as often featured in the 21^{st} century.

Changes in perception in the 21^{st} century again appear to follow new insights into cognitive neuroscience, as numerous recent studies concerning the plasticity of the nervous system have shown how environmental factors and experience can lead to changes in synaptic connections in the brain's circuitry and changes in the brain's structure (Gazzaniga et al., 2009). For instance, Elbert and colleagues' (1995) study on musicians who began their training early in life suggests that they had increased cortical representation, owing to their altered sensory experience. This finding indicates that alterations in behaviour and experience can also lead to alterations at brain level, as Elbert and colleagues themselves conclude: “These results suggest that the representation of different parts of the body in the primary somatosensory cortex of humans, depends on use and changes to conform to the current needs and experiences of the individual” (Elbert et al., 1995, p. 305). Other studies show similar evidence of how alterations in experience and environment can lead to changes at the neural level of the brain, such as Maguire and colleagues’ (2000) famous study on London taxi drivers which concludes “[i]t seems that there is a capacity for local plastic changes in the structure of the healthy adult human brain in response to environmental demands” (p. 4398). Blakemore, Winston, and Frith (2004) also emphasise the importance of environmental and social aspects in matters related to the brain:

> Humans crave the company of others and suffer profoundly if temporarily isolated from society. Much of the brain must have evolved to deal with social communication and we are increasingly learning more about the neurophysiological basis of social cognition ... It may once have seemed foolhardy to work out connections between fundamental neurophysiological mechanisms and highly complex social behaviour, let alone to decide whether the mechanisms are specific to social processes. However, as we shall see, neuroimaging studies have provided some encouraging examples (Blakemore et al., 2004, p. 216).

The role of environmental influences on the brain-mind-behaviour relation appears to have become stronger in the 21st century, as the possibility of a complex net of relations in the model is emphasised. This has concurrently altered certain perceptions within educational neuroscience discourse, as now one increasingly finds representations of *bidirectional* links − a change which is also highlighted by Howard-Jones:

> [B]ehaviour is most often explained in terms of the contents of the mind, and cognitive neuroscientists usually attempt to understand the mind by drawing upon our understanding of the brain. Hence, there are arrows leading from brain to mind, and from mind to behaviour. However, these arrows might also be drawn as bi-directional. For example, environmental influences (such as being able to access new stimuli) can influence our behaviour that also, in turn, influences our mental processes. If these processes produce learning, this learning can be assumed to have some neural correlate at a biological level, such as the making of new synaptic connections in the brain (Howard-Jones, 2010, pp. 90-91).

Models of the relationship between the brain, the mind, behaviour, and environmental factors therefore appear to have become more complex throughout history, in the move from a brain-behaviour model to a model encompassing bi-directional arrows between brain, mind, behaviour, and environmental aspects in the 21st century. Changes in models are essential for understanding changes within the educational neuroscience discourse, since these basic perceptions of relations between the brain, the mind, behaviour, and environment are fundamental for understanding the relationships between brain, mind, and education. The following sections will continue this discussion by drawing further links to discursive practices, hierarchies and justifications of central educational neuroscientific theories.

The relations between neuroscience and education

With reference to the previous section, I will thus argue that changes in the key concept of how linkages between the brain, mind, behaviour, and the environment have been understood, may lead to changes in how theories and ideas of educational neuroscience are narrated. Furthermore, it can be argued that there have been alterations in the way in which practical relations between the discipline of neuroscience and that of education, and hence also social relations between neuroscientists and educationalists, are understood. For instance, this can, be explored by looking at the relationship between educationalists, cognitive psychologists, and neuroscientists, and how this relationship has encountered a range of responses throughout its history – from great expectations and optimism, to reductionism, ignorance, de-professionalisation, cannibalisation, and misinterpretation. In the following analysis I attempt to clarify and discuss this aspect of change in more detail.

My discourse analysis shows that one view of the relationship between education and neuroscience seen in the emergence corpora is a top-down perspective where the field of brain research and cognitive science are located at the top, whereas the educational field is located at the bottom[109]. This view implies that neuroscientists, with research from the cognitive neuroscientific field, are in a position of valuable knowledge that can *inform* educationalists in how they should improve educational practices. I will further argue that evaluation of a 'superior' and 'informing' neuroscientist can be suggestive of a situation where neuro-scientific findings hold a dominant position, as neuroscientific explanations are used as 'justifications' of educational recommendations. This does not necessarily mean that educational aspects are completely neglected; they are just somewhat overrun by more dominant neuroscientific representations. It must also be noted that a top-down view, in which neuroscientists prevail over educationalists, does not necessarily imply that this view is

[109] As seen in Donaldson (1895), Thorndike (1923), Chall and Mirsky (1978a, 1978b), McCall (1990) and Goswami (2006).

only taken by neuroscientists who prefer to assess their own field as superior − far from it. Historical references suggest that some authors in the educational field also hold this view[110].

Neuroscience

$\downarrow$

Education

Views of such 'neuroscience → education' hierarchies are detected in my emergence corpora when critically analysing how neuroscience and education are talked about − for instance, how the collaboration is referred to, how relations between educationalists and neuroscientists are presented, and how arguments are justified. One example from the corpora which indicates a view of a pre-eminence of neuroscience is seen in Donaldson's work from 1895, where it is stressed that "nurture is to be considered of much less importance than nature" (p. 344) and "education must fail to produce any fundamental changes in the nervous system" (p. 343). Similar notions are found in Thorndike's work (1923) where the original structure and activities of the neurones are said to be primary in 'the successful operation of a behaviour series'. A later historical reference is seen in the yearbook of the National Society for the Study of Education from 1978, where numerous "noted scholars in the neurosciences ... were asked to bring their knowledge to interested workers in other fields" (Chall & Mirsky, 1978a, p. xiii). The yearbook therefore comprises papers solely from neuroscientists, and a few psychologists, who elaborate on neuroscientific aspects which might have implications for education. Only in the preface and the final summary does one find notes from the educationalists − the instigators of the yearbook project − where lines of argument are justified by statements such as, 'neuroscientists are saying to educators that...' and 'the neuroscientists have presented evidence here that...' (Chall & Mirsky, 1978b). Despite being noted that "it is hoped that the findings and insights from neuroscience will be added to what we [educationalists] already know − not replace it" (p. 376), it can be argued that the yearbook gives an overall impression consistent with a top-down view of 'what neuroscience can bring to education'.

The examples above show texts from the 19th and 20th centuries that appear to consider neuroscientific findings as being somewhat 'superior' to educational knowledge. What is interesting to note, though, is how this perception of the relation between neuroscientists and

110 As seen in Chall and Mirsky (1978a, 1978b).

educators is also consistent with the different top-down models of the relations between brain, mind, behaviour, and environment which were central at the academic level in the 19th and 20th centuries (cf. figure 5.4-5.7). What is also noteworthy is that even if there is a change to bidirectional and reciprocal models in the 21st century (cf. figure 5.8), findings from my critical discourse analysis show that even in the 21st century one can find traces of top-down views where findings from neuroscience are seen as being in a superior position to inform and help educators and teachers. This appears most markedly within the position of over-enthusiasts, in neuromyths and in the so-called 'brain-based' learning industry. This assertion is due to the notion that many neuromyths and over-enthusiastic actors from the 'brain-based' learning industry are inclined to draw conclusions directly from neuroscientific findings and apply them to educational practice. Neuroscientific explanations (whether they are misinterpreted or not) are thus used as a significant 'informer' that can advise teachers and schools how best and most efficiently to teach children in accordance with their brains. One can thus argue that neuroscientific findings appear to have been given a dominant role in shaping educational recommendations, whilst educational aspects have been overrun[111]. Moreover, in addition to this branch of over-enthusiastic actors, findings from my analysis also show how a top-down perspective is also found (often implicitly) amongst authors holding a position of cautious optimism. Such top-down 'neuroscientists → educationalists' views are particularly found in texts warning against neuromyths. Here, teachers and schools are often depicted as 'ignorant', 'naïve', 'preferring broad brush messages with a big picture', 'preferring to be told what works', and in a position to 'be easily misled' by neuromyths suggested by misinformed brain-based learning industries. On the other hand, neuroscientists, in these instances, are often more likely to be portrayed as the 'saving party' who 'have much to teach educators'[112]. Even if these authors advocate reciprocal collaboration in educational neuroscientific work, one can find tendencies in their texts to take a top-down view, where neuroscientists are portrayed as being able to offer 'ignorant' teachers help and guidance[113].

[111] Again it should be noted that this top-down relationship between neuroscience and education does not imply that it is neuroscientists *per se* who hold such perceptions. This is, for instance, the case with numerous overly-enthusiastic actors (many of whom have no formal degree in neuroscience), who contribute to forming neuromyths by misinterpreting neuroscientific data and translating them directly into educational recommendations. Further discussions about the neuromyths and 'misinformed' translations from the neuroscientific level to the educational level will be presented in the chapter concerning hegemonic relations (chapter 6) and recontextualisation processes (chapter 7 and 8).

[112] As seen in McCall (1990) and Goswami (2006).

[113] Aspects of power and hegemony concerning relationships between education and neuroscience will be further discussed in chapter 6 concerning 'hegemonic relations' in the educational neuroscience discourse.

In addition to this top-down perception, my critical discourse analysis of the emergence corpora indicates that there is another frequently-held view regarding the relationship between education and neuroscience. This view describes a more balanced understanding of the relationship, as it stresses that the relationship between neuroscientists and educators must be one of mutual and reciprocal collaboration. In comparison with top-down assessments of how 'superior neuroscientists can inform education', voices for reciprocal collaboration also stress how educationalists have valuable knowledge to give to neuroscientists[114]. In representations like these, neither neuroscience nor education are considered to be superior to the other, as both parties are acknowledged as being significant contributors in educational neuroscientific work.

Neuroscience ⟷ *Education*

In line with representations regarding mutual and reciprocal collaboration between educationalists and neuroscientists, in my analysis I often found statements concerning different levels of analysis, in addition to representations concerning the importance of environmental and social factors. In this viewpoint, educationalists are not placed under the dominion of neuroscientific theories, since each discipline seems to be acknowledged for its own differences in theories, methods, and philosophies. This further indicates that the 'neuroscience ←→ education' view often goes hand in hand with both the discursive position of cautious optimism and the perception of a model of bi-directional links which can be drawn between factors of the brain, mind, behaviour and environmental. Furthermore, it is interesting to note that perspectives of reciprocal collaboration and mutual dialogue appear to be found in the major fraction (i.e. cautious optimism) within educational neuroscience's contemporary academic level − demonstrated here by Varma et al. (2008):

> [B]ridging the divide that separates the education and neuroscience *disciplines* requires bridging the divide that separates the education and neuroscience *communities* ... [W]e should remain cautious in our optimism. Education research and neuroscience can inform each other, but within limits, which we have yet to discover ... [A] strategy is for education researchers and neuroscientists to view themselves as collaborators, not competitors, in the pursuit of knowledge (Varma et al., 2008, p. 149).

Even if many within the current educational neuroscience discourse appear to consider the relationship between education and neuroscience as one of reciprocal collaboration, my textual analysis shows that it is not always explicitly stressed *which* discipline should be

[114] As seen in Peterson (1984), Blakemore et al. (2004), Blakemore and Frith (2005b), Ansari and Coch (2006), Fischer et al. (2007), and Varma et al. (2008).

joined in such mutual collaboration. Should the collaboration be between education, psychology, and neuroscience, or should it consist of education and cognitive neuroscience? And indeed, should this latter link include or exclude the discipline of psychology? In order to answer this, it appears that − despite the name allocated to the academic project − there is common agreement that this complex cross-disciplinary endeavour should not exclude any discipline pertaining to educational neuroscience[115]. This implies that disciplines (and sub-disciplines) such as neurobiology, neurochemistry, clinical neurology, cognitive neuroscience, social cognitive neuroscience, cognitive psychology, educational psychology, developmental psychology, and education are potential disciplines for collaborative work − it is even noted that socio-political theories and other social theories are important since they can help by illuminating more political and societal aspects of educational neuroscience.

Overall, therefore, it appears that the history of the academic level of educational neuroscience indicates a relationship which has moved from a top-down view where neuroscientists should inform educationalists, as often found from the late 19th up to the mid-20th centuries, to a contemporary view of reciprocal collaboration where neuroscientists and educationalists inform each other[116]. It can further be argued that this shift corresponds with shifts in perceptions concerning causal relations between the brain, mind, behaviour, and environment.

Changes in justifications of narrations

The last discursive aspects of change that will be discussed, is changes in how discursive narrations and relations have been *justified* throughout the history of educational neuroscience. Changes of justifications within the educational neuroscience discourse are closely linked to changes in ideas pertaining to key narratives around brain, mind, behaviour, and environment, in addition to how the relationship between educationalists and neuroscientists are understood. For instance, my critical discourse analysis of historical texts indicates that, from the late 19th century up until the mid-20th century, one tended to perceive

[115] As seen in Blakemore et al. (2004), Ansari and Coch (2006), Fischer et al. (2007), and Varma et al. (2008).

[116] In addition to these two views, one can also argue that there is a view which perceives the relations as education ≠ neuroscience, as it is deemed that neuroscience has nothing to do with the field of education. Such a view of the relationship between education and neuroscience often appears to take the form of apprehension, and one gets the impression that authors attempt to 'protect' education from cannibalisation, neurosciences, 'biologisation' of education, reductionism, and de-professionalization. Again, it can be argued that such apprehension and censure seems more like a reproach of over-enthusiasts, and not the discursive position of cautious optimism found in the majority of educational neuroscience discourse.

linkages between the brain, the mind, and behaviour (and later also education) in accordance with top-down models and, accordingly, one was also inclined to hold a top-down view where neuroscientists were, either explicitly or implicitly, deemed 'superior' and thus able to inform educationalists. Furthermore, analytical findings from the same period and in the same way, indicate how theories, ideas, and relational views appear to be *justified* and anchored in neuroscience. References demonstrating such justification, for instance, are statements such as "the neuroscientific evidence presented is reassuring", "recent neuroscientific discoveries also point to...", and "the neuroscientists have presented evidence here that..." (Chall & Mirsky, 1974b, pp. 371-372), in addition to statements such as "[n]ew understandings of the triune brain ... can carry school organization and practice to a far more sophisticated level and bring educators more enjoyable and satisfying conditions of work" (Hart in Sylwester et al., 1981). In the same way, later justifications of narrations, theories, ideas, and relational views found in texts from the 21st century, seem to have shifted in accordance with the shift in key perceptions within the discourse. Authors are now more inclined to understand the educational neuroscience endeavour as a complex task with bi-directional links between the brain, mind, behaviour, and the environment. Accordingly, key discursive narrations, positions, and an emphasis on reciprocal collaboration are justified by claims that educationalists and neuroscientists can inform *each other*[117].

Furthermore, and more importantly, my critical discourse analysis is also suggestive of another shift in justification during the last couple of decades − namely to a more prominent *neoliberal* and *political* justification, particularly within the educational domain. The argument for claiming that the educational neuroscience discourse appears to have more justification in *neoliberal political* aspects in the 21st century is based on a shift in argumentation found in the historical series of texts in the corpora. Such neoliberal notions are often found in how authors justify the educational neuroscience endeavour by bringing into play certain neoliberal buzzwords such as 'evidence based', 'efficiency', 'a science of education', 'scientifically grounded', 'what works', and other more market-oriented terminology (cf. Fairclough, 2010; Karlsen, 2006). Thompson (1986), for instance, demonstrates such neoliberal justification by claiming that:

> More generally, education, a multibillion dollar industry in the United States alone, strives to achieve the most effective and meaningful learning. The science most basic to all these conditions and

[117] As seen in Peterson (1984), Blakemore et al. (2004), Blakemore and Frith (2005b), Ansari and Coch (2006), Fischer et al. (2007), and Varma et al. (2008).

> endeavours is the neurobiology of learning and memory − how the brain codes, stores, and retrieves memories (Thompson, 1986, p. 941).

Additionally, in Ansari and Coch's (2006) article, one can find similar neoliberal undertones, as statements are made regarding "policymakers' call for 'scientifically based practice'", on how to "maximise eventual benefits", as well as direct references to the What Works Clearinghouse's political webpages, along the lines of, "More focused scientific analysis of popular educational approaches will not only lead to better understanding of 'what works' (Institute for Educational Sciences, 2013), but also an understanding of *why* and *how* it does or does not work" (Ansari & Coch, 2006, pp. 148-149)[118]. In Fischer and colleagues' article (2007), it is noted that this new approach of mind, brain, and education 'can inform effective practice' and 'optimise effective learning', and when talking about 'effectiveness of schooling' they state that:

> Empirical research on the effectiveness of schooling and education has become more common, thanks in part to international comparisons of schools' achievement and classroom practice ... Thanks to this kind of research, policy makers and practitioners can begin to base their decisions about educational practice and institutions on empirical evidence rather than opinions, fashions, and ideologies (Fischer et al., 2007, pp. 1-2).

References such as these do indeed demonstrate that many within the educational neuroscience discourse demonstrate traces of a neoliberal rationality in their argument and justification. However, even if certain narratives in the discourse of educational neuroscience appear to be justified in relation to certain neoliberal political aspects, it should be noted that neoliberal justifications are an *addition* to justifications of reciprocal collaboration, warnings against neuromyths, and an emphasis on cautious optimism. Moreover, and even more importantly, neoliberal tendencies do not solely appear in the educational neuroscientific discourse – quite the contrary. A neoliberal ideology appears to have flourished in society at large since the 1980s and 90s, and continues into the 21st century. Numerous authors have noted this general shift in political ideology and how it appears to affect disciplines such as medicine and education, as more focus is on efficiency, results, evidence-based practices, decentralisation, and other economic and market governed philosophies (Karlsen, 2006; Fairclough, 2010)[119]. This further demonstrates the intertextual and interdiscursive

[118] What Work Clearinghouse (WWC) was established in 2002 as an initiative of the Institute for Education Sciences (IES) at the U.S. Department of Education.
[119] Neoliberal and political tendencies in the discourse of educational neuroscience pertaining to the recontextualisation of educational neuroscience into, indeed, the political field, are further discussed in chapter 7

connections which can be drawn between the discourse of educational neuroscience and other discursive aspects in external fields − again emphasising the complexity of aspects relevant to understanding educational neuroscience's growth and development.

Summary of the critical discourse analysis and discussion

The aim of this chapter has been to critically analyse and discuss aspects pertaining to the emergence and development of the academic level of the educational neuroscience discourse. In order to fully elaborate on the ways in which educational neuroscience evolved from the late 19th century up to the present 21st century, I argue that relations *between* educational neuroscience and the field of prior discourses must be analysed, in addition to an analysis of relations found *within* the discourse. Regarding the former, it is noted that educational neuroscience is emerging from a field of prior discourses pertaining to what is known today as cognitive neuroscience, cognitive psychology, and education. I have further argued that certain critical discourse theories can be brought forth in order to explain this development process – in particular, theories on problematisation of discursive boundaries in the field of prior and external discourses, crossing of borderlines, negotiation of discursive elements, and a 'reweaving' and re-articulation of existent discursive elements into new discursive articulations. Attention in this chapter has also focused on certain individual and collective emergence strategies and how, for instance, different actors' narrations and justifications of central educational neuroscientific topics have contributed to the discourse's development. In light of discursive narrations and themes, I have further suggested that there are certain intertextual aspects that *recur* throughout the history of educational neuroscience, whereas other discursive elements have *changed* − such as the perception of the brain-mind-education relation. Whilst this chapter has analysed the emergence and development of educational neuroscience's academic level, the next chapter will continue by presenting a critical discourse analysis of the hegemonic relations found at this discursive level.

Chapter 6

Hegemonic relations in educational neuroscience

Whereas the previous chapter presents an analysis of how the academic level of educational neuroscience emerged from the 19th century to the present day, this chapter will present a critical discourse analysis of *hegemonic* relations pertaining to educational neuroscience's academic level. My analysis of hegemony will, in essence, examine whether or not certain representations, positions, ideologies, and practices are more dominant than others and, furthermore, consider the ways in which these discursive aspects are aligned in certain hegemonic relations. A critical analysis of hegemony is valuable, because this type of discursive investigation can reveal certain points of tension within the educational neuroscience discourse, and illuminate how different actors struggle to gain hegemony for specific discursive representations, ideologies, subject positions, or practices.

Hegemonic relations at educational neuroscience's academic level

In my analysis of educational neuroscience's hegemonic relations, attention is particularly paid to three major 'sites of struggles'. These sites of tension frequently appeared in my literature searches and are therefore viable points for a hegemonic analysis[120]. The respective sites of struggles are as follows:

- struggles between different levels of analysis.
- struggles between interpretations vs. representations.
- struggles between the academic level and policymakers and the public.

By focusing on 'sites of struggles' *within* the educational neuroscience discourse and *between* the discourse and other related fields, one builds an expedient foundation for discussing

[120] In my general literature search for the hegemony corpora, over a thousand academic texts were screened through the use of a set of review criteria, with the aim of mapping out certain general 'sites of struggles' – e.g. topics which are frequently discussed – in the educational neuroscience discourse. This is because sites of struggles in a discourse make viable points for entry when analysing hegemonic relations, since tension and debate can expose discursive hierarchies and power relations (Fairclough, 2010). Based on this general mapping of the discourse, a set of 29 texts representative of these sites of struggles were selected for the hegemony corpora (see appendix B).

aspects pertaining to hegemony. Not only will discursive 'sites of struggles' present a basis for critically discussing negotiations of discursive representations, 'sites of struggles' are also relevant when examining notions of authority, power relations, different actors' and groups' strategies, and other hegemonic relations within and between discourses. In order to give a comprehensive presentation and discussion of educational neuroscience's hegemonic relations, accounts of the three respective 'sites of struggles' are presented in the following section. Critical discourse theories are drawn upon in each account, in order to give a theoretical underpinning for the analysis and discussion of the respective hegemonic aspects.

Struggles between different levels of analysis

When analysing hegemonic relations pertaining to educational neuroscience's academic level, one particular, and rather obvious, 'site of struggle' is identified − namely that which I have labelled with the umbrella term *struggles between different levels of analysis.* This 'site of struggle' encompasses numerous points of tension, although each of these hegemonic tussles, in one way or another, are related to negotiations between different levels of analysis in the linking of neuroscience and education. To reiterate what was noted in the last chapter regarding changes in educational neuroscience's narrations, it was stressed that representations regarding 'different levels of analysis' are often used when indicating differences in theory, method, data, analysis, philosophies, language, and other dissimilarities between the fields of education, neuroscience, and psychology[121]. Figure 6.1 provides a model for clarifying the levels of analysis in educational neuroscience and the different research aspects to which each level pertains. Despite being a rather simplistic model, which only illustrates three rather general levels of analysis, the model shows that educational neuroscience research encompasses different levels of methods, theories, and data for each of the three academic disciplines.

Figure 6.1: Different levels of analysis relevant for educational neuroscience research.

Level of:	NEUROSCIENCE	BRAIN	e.g. observable neurobiological and neurochemical signals
Level of:	PSYCHOLOGY	MIND	e.g. hypothesis of cognitive functions, such as reading abilities
Level of:	EDUCATION	BEHAVIOUR	e.g. observable behaviour, such as improved reading skills

[121] As seen in Sylwester et al. (1981), McGuinness (1987), Bruer (1997), Byrnes and Fox (1998a), Berninger and Corina (1998), Ansari and Coch (2006), Varma et al. (2008).

Different levels of analysis complicate the endeavour to link education and neuroscience. Not only are there issues connected with different philosophies, theories, methods and data, but the levels of analysis also bring different *actors* onto the stage (e.g. researchers). Since these actors are from different disciplines, they are likely to have different scientific backgrounds and schooling, hold different research agendas, and even have different opinions and values with regard to the educational neuroscientific research endeavour. For example, a neuroscientist will focus on the role of glutamine and NMDA receptors in the hippocampus and how this can affect long-term potentiation relevant to memory performance (cf. Gazzaniga et al., 2009)[122], whereas an educationalist may be more interested in how a child's family background can be indicative of his or her likelihood of educational success (cf. Bernstein, 2000). It is therefore reasonable to think that different levels of analysis in educational neuroscience are connected with how different actors perceive and approach the discourse. One can further speculate that these differences result in disagreement, negotiations, and hegemonic struggles concerning the way in which the educational neuroscience endeavour should be perceived and pursued. For this reason, educational neuroscience's different levels of analysis constitute a central site of potential struggle in the discourse. To elaborate on this, in the following section I will present a range of struggles found between different levels of analysis, before discussing my analytical findings with reference to hegemonic relations.

My analytical findings show numerous 'points of tension' related to different levels of analysis, both *within* the educational neuroscience discourse and *between* the discourse and other related fields. In fact, all 29 texts in the hegemony corpora show traces of educational neuroscience's different levels of analysis, but the texts vary in:

- which different level of analysis they present;
- how implicitly or explicitly these 'points of struggles' are presented;
- the ways in which struggles are presented (i.e. if they have the form of negotiation, or if only one side in the debate is acknowledged).

[122] The brain area *hippocampus* appears to play a key role in memory and a central aspect here is long-term potentiation (LTP). LTP indicates the process of long-term strengthening of a synapse, which is of interest because changes in synaptic strength between neurons are the most likely mechanism for learning and memory. When it comes to the process of LTP, it is shown that N-methyl-D-asparate (NMDA) receptors are located on the dendritic spines of postsynaptic neurons that show LTP. It is further known that glutamate, the major excitatory transmitter in the hippocampus, can bind with NMDA receptors, and this makes glutamate relevant with regard to LTP (Gazzaniga et al., 2009, pp. 356-360).

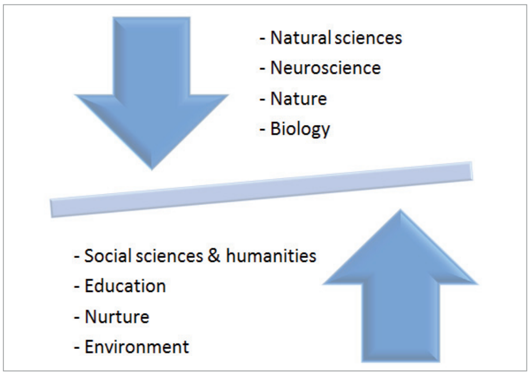
With regard to the first point, the different levels of analysis in a text focus on concepts such as: negotiations concerning 'individual cognition versus collective cognition'; debates concerning 'nature versus nurture'; or negotiations around 'natural sciences versus social sciences'. A more detailed account of the different struggles over levels of analysis found in the hegemony corpora of educational neuroscience is listed in the following table.

Table 6.2: Struggles over 'levels of analysis' found in the hegemony corpora.

Type of struggle identified	References of where it was found
Neuroscience *vs.* education	Anderson & Reid (2009); Ansari et al. (2012); Campbell (2011); Carew & Magsamen (2010); Christodoulou & Gaab (2009); Dekker et al (2012); della Chiesa et al. (2009); Ferrari (2011); Hardiman et al. (2012); Hook & Farah (2013); Hruby (2012); Kraft (2012); Mason (2009); Perkins (2009); Pickersgill (2013); Stein & Fischer (2011); Tommerdahl (2010); Varma et al. (2008); Willingham (2009).
Neuroscience & cognitive psychology *vs.* education	Ferrari (2011); Goswami (2008); Greenwood (2009); Pasquinelli (2013).
Cognitive neuroscience *vs*. cognitive psychology	Bruer (2006); Weisberg et.al. (2008).
Neuroscience *vs*. cognitive sociology	Cerulo (2010); Mercer (2013).
Neuroscience *vs*. cognitive neuroscience *vs*. psychology *vs*. educational theory vs. classroom	Tommerdahl (2010).
Social studies of neuroscience (constructivism) *vs*. empirical neuroscience (realism)	Choudhury et.al. (2009).
Nature *vs*. nurture	Gelman & Taylor (2010); Goswami (2008); Logan & Johnston (2007).
Biology *vs*. environment	Ansari et al. (2012); Goswami (2008).
The level of the brain *vs*. the level of mind and behaviour	Perkins (2009); Stein & Fischer (2011); Weisberg et al. (2008).
The level of the biological *vs*. the level of cognitive *vs*. the level of behavioural	Anderson & Reid (2009).
The brain (a part) *vs*. the body as a whole	Hruby (2012); Kraft (2012); Pickersgill (2013).
Individual cognition *vs*. social cognition	Mercer (2013).
Natural sciences *vs*. social sciences	Ansari et al. (2012); Cerulo (2010); Choudhury et al. (2009); della Chiesa, et al. (2009); Kraft (2012); Mercer (2013); Perkins (2009); Pickersgill (2013); Willingham (2009).
Natural science (descriptive) *vs*. artificial science (normative)	Choudhury et al. (2009); Willingham (2009).
Basic science (fundamental research) *vs*. engineering science and craft	Perkins (2009).

Table 6.2 shows the struggles and negotiations found in the hegemony corpora, and it is clear that the texts have somewhat different focuses of attention. However, even if the texts vary in their focus, they all touch on aspects concerning the different levels of analysis found between neuroscience and education − whether a large-scale focus concerning natural sciences as opposed to social sciences, or a smaller-scale focus of individual cognition as seen in contrast to collective cognition. By comparing these texts, one can also identify certain 'points of struggle' which are more frequently negotiated than others. Unsurprisingly perhaps, one of the most negotiated struggles detected in the corpora is between the discipline of neuroscience and that of education. This general point of tension, for example, can be detected in Anderson and Reid (2009), Christodoulou and Gaab (2009), Ferrari (2011), and Varma et al. (2008). Other central and frequently negotiated 'points of struggles' found in the corpora are debates regarding biological explanations and environmental explanations[123], nature versus nurture[124], and the more overarching topic of natural sciences as opposed to social sciences, the humanities and the arts[125]. Figure 6.3 is based on my findings and illustrates some of the most frequent struggles found at educational neuroscience's academic level.

Figure 6.3: Struggles between levels of analysis pertaining to educational neuroscience's academic level.



Struggles between academic disciplines

Considering that most of the texts analysed either implicitly or explicitly touch upon struggles over different levels of analysis between the disciplines of neuroscience and education, and/or related academic subdisciplines, a clarification of this hegemonic struggle is in order. What can be noted is that struggles between disciplines pertaining to the educational neuroscience

[123] As seen in Ansari et al. (2012), and Goswami (2008).
[124] As seen in Logan and Johnston (2007) and Gelman and Taylor (2010).
[125] As seen in Cerulo (2010), della Chiesa, Christoph, and Hinton (2009), Kraft (2012), Mercer (2013), and Perkins (2009).

endeavour appear to be fought from different approaches – it being from educationalists, neuroscientists, educational neuroscientists, cognitive neuroscientists, social cognitive neuroscientists, cognitive psychologists, cognitive sociologists, educational psychologists, etc. Negotiations can further be seen to target somewhat different hegemonic relations between disciplines or groupings of disciplines. For example, Weisberg, Keil, Goodstein, Rawson, and Gray (2008) argue that the neuroscientific discipline, with its neuroscientific explanations, tends to dominate over psychological explanations, whilst Ansari, De Smedt, and Grabner (2012) note that the disciplines of cognitive neuroscience and experimental psychology often have a dominant role over education. Choudhury and colleagues (2009, p. 73) similarly comment on "the widely assumed truth of reductionism in cognitive neuroscience ... perceived to be represented by authoritative brain scans", and Pickersgill (2013, p. 333) claims that "the power of neuroscience is evident in a variety of social realms". In addition, Tommerdahl (2010, p. 99) notes: "the impression that the brain sciences are declaring hegemony over a process that should be more holistic, encompassing the whole human instead of reducing the act of learning to change in a collection of neurons", and Cerulo (2010) argues that cognitive neuroscience dominates research and thoughts in numerous disciplines within social sciences, further noting that:

> Over the past 50 years, cognitive neuroscience has emerged as the dominant player in research on thought. In an effort to keep their voices heard, social psychologists, anthropologists, political scientists and even economists have joined cognitive neuroscientists in lively dialogue. But many sociologists are stubbornly clinging to the sidelines, honoring − and in some cases strengthening − rigid intellectual boundaries (Cerulo, 2010, p. 115 [sic.]).

Varma and co-workers (2008, p. 145) consider both scientific and pragmatic concerns relevant to bridging the disciplines of education and neuroscience, and they also note that "what is problematic is *eliminative reductionism* ... the doctrine that neuroscience explanations should replace − not just anchor or enrich − behavioural explanations". In the same way, it is argued by Kraft (2012) that "neurosciences dominate today's discourse" because:

> neuroscientific thinking seems to be able to dominate education rather easily and without great resistance, especially in the fields of early childhood education, instruction and learning − mainly by simplifying educational processes and by reducing the complexity of the educational task to a mere 'relationship problem' (Kraft, 2012, p. 386).

Other references to hegemonic ordering pertaining to the educational neuroscience endeavour can be found in Anderson and Reid (2009) and Bruer (2006). Whereas the majority of authors from the corpora argue that neuroscience and cognitive psychology overrun the discipline of *education*, Anderson and Reid (2009) and Bruer (2006) take another approach by claiming that it is *cognitive psychology* which is being ignored by both the cognitive neuroscience discipline and the discipline of education. Bruer's argument is that, on the one hand, neuro-scientists ignore psychology since cognitive neuroscience presupposes cognitive psychology; on the other hand, however, educationalists overlook psychological research because they are "fascinated with synapses and brain images" (Bruer, 2006, pp. 104-105).

Overall, findings from my critical discourse analysis of educational neuroscience's academic level indicate numerous references to hegemonic struggles between the disciplines of neuroscience, psychology, and education. Even if these textual references take slightly different approaches to the struggle, a majority of the texts seem to claim that the discipline of *neuroscience* holds a dominant role. However, as we will see from findings presented in the next section, neuroscience's dominant role is not necessarily attributable solely to the neuroscientific *discipline*.

Struggles between nature and nurture, between biology and environment

Findings from my critical discourse analysis identify a closely related and more overarching intertextual struggle regarding educational neuroscience's different levels of analysis − namely negotiations between nature and nurture, or, in other words, between biological explanations and environmental explanations. For instance, Logan and Johnston (2007, pp. 674-676) discuss the "wedge between nature and nurture" and argue that "the attempt to push either genes or experience to the foreground" can be seen as a result of "deep-seated tendencies to maintain strict separations between nature and nurture, instinct and learning, innate and acquired". Similarly, Stein and Fischer (2011) draw attention to the struggle between nature and biological explanations on the one hand, and nurture and environmental explanations on the other, and further link this to educational neuroscience:

> A seductive temptation in building MBE [mind, brain, and education] is *reductionism* in analysing phenomena that are studied at several levels of analysis or from different basic viewpoints. The tendency to offer unidimensional solutions to multidimensional problems is great − discussing a multi-level issue as if it can be reduced to one level, or treating a multi-viewpoint issue as if one viewpoint is

> essential and the other can be omitted or neglected. For example, the press commonly present findings from biological methods, such as genetics and neuroscience, as if they involve ‘harder’, more substantial, more scientific knowledge − privileged relative to psychological and cultural methods, which are marginalized as ‘soft’, needing to be reduced to biological ‘causes’ (Stein and Fischer, 2011, p. 59).

Stein and Fischer (2011) point explicitly to the struggle fought between education and neuroscience and how this can be related to hegemonic tussles existing between genetic and biological explanations of the ‘hard’ sciences set against the ‘softer’ explanations of nurture, environment, and social factors. The dominating role attributed to biological ‘causes’ in this combat is further evident in the statement that the standard conception is one “in which scientists hand over their results from on high to educators in the trenches” (Stein & Fischer, 2011 p. 59).

A related site of tension, which is also found in the hegemony corpora, is the struggle between ‘the brain as a part’ versus ‘the individual as a whole’. In this respect, it is noted by Kraft (2012) that over the last couple of decades, the brain has become ‘culturally charged’. In this statement, Kraft argues that “the brain becomes something like the ‘legacy of the subject’” (p. 387), because the qualities and functions of the individual as a whole become reduced to the brain as a part. Examples of what Kraft calls ‘a reduction of the whole to the brain’ are seen in proclamations such as “dehydration is bad news for your brain” (Wighton, 2007), “a good novel makes the brain smarter” (NRK, 2013) or “snack for the brain − this is the food that can protect your brain and help it think, perform, and remember better” (Dagbladet, 2011). These statements reduce the qualities of the subject as a whole to aspects of the brain, and are just as absurd as saying, ‘my brain went out shopping today’ or ‘my intestines are hungry’. With this tendency to conflate the organism as a *whole* to the *brain,* the complex brain “serves as a kind of medium for the reduction of complexity” (Kraft, 2012, p. 387). Negotiations regarding conflation of the brain (a part) to the individual (the whole) are further explained by Mercer (2013), when he argues that one can also find a common tendency to let a focus on individual cognition dominate over collective cognition:

> In recent years, researchers in evolutionary psychology and anthropology have proposed that the distinctive nature of human cognition is the product of our evolution as social beings; we are born with “social brains” that enable us to manage complex social relationships in ways other animals cannot ... However, I argue that its current conceptualization is too narrow and individualistic; the concept should be redefined to take account of the distinctive human capacity for thinking collectively ... and in particular to the social and cognitive processes involved in education (Mercer 2013, pp.148-149).

With his argumentation, Mercer (2013) indicates the tension and hegemonic relations found within levels of analysis between biological and natural explanations of cognition seen in relation to more collective and social explanations of cognition. Another pertinent article, from Choudhury and colleagues (2009, p. 71), points to “the dichotomy between nature and culture often apparent in neuroscience”. The problem with this dichotomy, as argued by the authors, is that:

> biological claims free the person from the social and cultural complexities surrounding her ... These kinds of reductionistic models confine mental [processes] to the individual, minimizing the role of social, cultural or political contexts surrounding the person (Choudhury et al., 2009, p.71).

Through such statements, Choudhury and her co-workers suggest a state of natural and biological dominion in the academic level of the educational neuroscience discourse, even referring to this tendency as a ‘colonialism’ of neuroscientific and biological claims into more social fields such as education. Overall, therefore these analytical findings from my hegemony corpora show that there are points of tension and hegemonic struggles between different levels of nature and nurture, the biological and environmental, and the individual and collective, pertaining to the educational neuroscience discourse.

Struggles between natural sciences and social sciences

Discourse analytical findings from my hegemony corpora also suggest a third struggle between different levels of analysis related to educational neuroscience’s academic level − namely the hegemonic struggle between natural sciences on the one hand, and social sciences, the humanities and the arts on the other. In regard to this, Willingham (2009) highlights certain issues in educational neuroscience arising from the distinctions between natural and artificial sciences:

> Natural sciences, like neuroscience, are descriptive; the aim is to discover principles that describe neural structures and functions, and in so doing to bring order and comprehensibility to data. Artificial sciences [like education] are normative. Their aim is not the description of the natural world as it exists, but the creation of an artefact, designed to serve a specific goal, within a particular environment ... The artefact to be created in education is a set of pedagogic strategies and materials (Willingham, 2009, p. 544).

Following this clarification of scientific distinction, Willingham asks how the natural and the artificial sciences are related, and answers his own question by claiming that “natural science can inform artificial science” (2009, p. 544). This informative status ascribed to natural sciences suggests a pre-dominant role in negotiations found in different levels of analysis between neuroscience and education. However, and as will be discussed in the next section, this informative status of natural science and neuroscience over education is not unproblematic and can lead to further tension and struggles regarding dissimilar goals, levels of analysis, and problems of translation (Willingham, 2009). Perkins (2009) also draws attention to struggles between the two fields of sciences, claiming the existence of differences between what might be called 'basic science' such as neuroscience, and 'engineering science' such as education. Distinctions between the two camps of science are further used in order to explain possible issues faced by educational neuroscience.

> It is argued here that to speak to the classroom, neuroscience has to shout across two gaps. The first and most familiar are different levels of explanation. The second concerns the epistemological contrast between explanation theories and action theories, roughly the contrast between basic science on the one hand, and engineering science and craft on the other ... [E]xplanation theories are claims about the world, true or false, and subject to disconfirmation in the Popperian tradition. Action theories are less claim-like and more tool-like ... Engineering science tends to be seen as playing second fiddle to basic science, with its fundamental research (Perkins, 2009, pp. 170-172).

Perkins (2009) is referring to a site of struggle found between education and neuroscience, which arises from deeper dissimilarities between the two fields of basic science and engineering science. The relation between these two fields of sciences is not balanced because neuroscience, as a basic science, appears to be more dominant than the engineering science of education. As a note about this imbalance, Perkins (2009) warns about the establishment of 'a pecking order' between neuroscience and education.

Overall, findings from my critical discourse analysis show that negotiations and struggles between different levels of analysis are frequently mentioned by authors working at the interface of educational neuroscience. However, the exact sites of tension vary from negotiation between i) disciplinary differences between, for instance, neuroscience, cognitive science, and education ii) nature set against nurture, in addition to biology as opposed to environment, and iii) struggles between the field of natural sciences, on the one hand, and social sciences, the humanities and the arts on the other. Different focuses of attention notwithstanding, there seems to be a general consensus amongst numerous actors that the field related to *neuroscience* is perceived to hold a more dominant role than the field of education[126]. In order to expound on this, the following sections move from a descriptive presentation of discourse analytical findings to a more critical discussion of hegemonic struggles over different levels of analysis between education and neuroscience.

Hierarchy between neuroscience and education: actualities or outdated ideas?

There are numerous hegemonic struggles between educational neuroscience's different levels of analysis and it is interesting to investigate the degree of impact these discursive tussles have within the academic level of discourse. For example, is there really a hegemonic struggle fought between nature and nurture, or is this negotiation over biological explanations versus environmental explanations about outdated ideas which have little relevance to the current discourse? One can similarly ask if neuroscience is correctly seen to hold a hegemonic power dominion over education, or if this impression is seldom actualised beyond mere *warnings* of potential dominance and reductionism? Is there a hegemonic ordering of levels of analysis at the academic level of the educational neuroscience discourse or not?

Traces of hegemonic relations

As previously shown, one of the most prominent hegemonic struggles identified in the hegemony corpus is the tussle between neuroscience and education. In this relationship, *neuroscience* is assumed to hold the most dominant status, although the amount of power and significance attributed to it varies amongst authors[127]. My argument that there is a tendency to designate a hegemonic status to neuroscience over education is supported by other research findings from literature reviews and other analyses of the educational neuroscience discipline. Samuels (2009, p. 45; p. 51), for instance, points to similar hegemonic ordering by claiming that "neuroscience has arguably taken the lead in this [mind, brain, and education] endeavour ... To date, the field appears to favour reports that foreground neuroscience, and treat education as background or context". Traces of neuroscientific dominion within the educational neuroscience discourse are also found in the emergence analysis – presented in the previous chapter – regarding changes in educational neuroscientific narratives and

[126] This is, for example, seen in the texts by Anderson and Reid (2009), Christodoulou and Gaab (2009), Perkins (2009), Willingham (2009), Stein and Fischer (2011), Ferrari (2011), Kraft (2012), and Mercer (2013).
[127] As seen in the text by Ansari et al. (2012), Cerulo (2010), Choudhury (2009), Kraft (2012), and Pickersgill (2013).

discursive positions, where it is argued that neuroscientists are often ascribed a more 'significant' and 'informative' role over education[128].

Representations of hegemony, where neuroscience is alleged to have a more dominant role over education, are apparent in the discourse's academic level and the ensuing critical question, therefore, is to ask *how* this representation is presented. Does the discursive convention of neuroscientific hegemony implicitly embody a certain set of knowledge or presuppositions, and does it include implicit meanings from discursive positions? In response to these questions I am inclined to answer *yes* − representations of a hegemonic dominance of neuroscience over education appear to embody certain sets of knowledge, presuppositions, and implicit meanings. One aspect of knowledge, which often implicitly or explicitly follows statements of neuroscientific hegemony, is accusations of *reductionism*, where neuroscience is considered to override educational explanations. It should also be noted that it is *warnings* against reductionism that are most strongly voiced in debates, and that these warnings are most commonly uttered by actors from the discursive position of 'cautious optimism'. This tendency of referring to reductionism, when warning against neuroscientific domination, is even seen in some of the text extracts shown in the previous sections[129]. If we look further at what these warnings against reductionism denote, it is generally argued that neuroscientific dominion can lead to a reductionist ordering between the levels of analysis found at the level of the brain (neuroscience), the level of the mind (cognitive psychology), and the level of behaviour (education). If we again demonstrate by the model of different levels of analysis, the reductionistic ordering favouring neuroscience at the top level, can be illustrated with downward lines of causation (as shown in figure 6.4). The issue at stake with such top-down hierarchic ordering of causation, is that education − with its educational theories, methods, explanations, language, philosophies, values and goals – becomes reduced under cognitive and neuroscientific power[130].

[128] For a more detail account see page 179-181 in the previous chapter of emergence.
[129] See the previous quotes by Willingham (2009), Stein and Fischer (2001), Pickersgill (2013), and Varma et al. (2008).
[130] As seen in the text by Willingham (2009), Stein and Fischer (2001), Pickersgill (2013), and Varma et al. (2008).

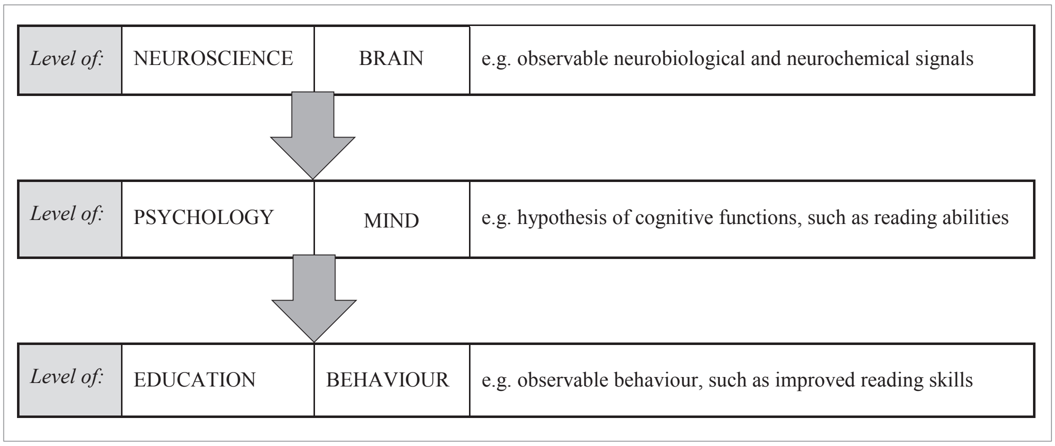


Figure 6.4: A top-down perspective on different levels of analysis.

Hegemonic and reductionistic ordering in the partnership between neuroscience and education can also be linked to a particular subject position, which in the previous chapter I labelled *apprehension*. The apprehensive often take a guarded and rather reluctant stand toward educational neuroscience, and they are often of the opinion that neuroscience 'has nothing to do within the realm of education' or that it is a bridging project too far or too immature[131]. Reluctance to take neuroscientific findings into consideration in educational matters is often due to arguments of neuroscientific dominance, reductionism, and conflation of different levels of analysis. By using similar reductionist perceptions as shown above, it is argued that educational theories, methods, philosophies, values, goals, and practices are at risk of being overrun by the neuroscientific field. It is often further argued that to prevent neuroscientific cannibalisation, educational *de*-professionalisation, and the complete ruination of the art of teaching, it is better in principle for education to avoid a partnership with neuroscience altogether (Schumacher, 2007; Davis, 2004). Based on such apprehensive standpoints, it is often noted by other actors that "education has been the more ambivalent partner" in the educational neuroscience project (Samuels, 2009, p. 45). And indeed, these assertions from the apprehensive position towards neuroscience explain why so many educationalists (and often educational theorists) are ambivalent and reluctant concerning educational neuroscience. It is debatable as to whether or not the position of apprehension is *overly* protective against new influences in education, and it should be noted that the position has indeed met with

[131] As seen by Bruer (1997; 2006), Davis (2004), Mayer (1998), and Schumacher (2007).

criticism for being too pessimistic and unwilling to adapt to novel knowledge[132]. However, these debates and censure notwithstanding, what is interesting to note from a critical discourse analytical perspective, is that the discursive position of the apprehensive takes a firm stand *against* the idea of a powerful and dominant neuroscience. Instead of arguing that neuroscience can *inform* education, this stance gives the impression of taking the opposite position, by claiming that neuroscience has nothing to do with the realm of education. The hegemonic struggles between neuroscience and education are therefore fought in both directions.

With regard to *how* ideas of hegemonic ordering between neuroscience and education are represented, another critical discourse analytical aim is to investigate if narrations of neuroscientific domination are represented indirectly or explicitly, deliberately or unintentionally. On this note, it appears that most of the texts analysed in the hegemony corpus present struggles between neuroscience and education explicitly and deliberately. Deliberate expressions of hierarchic ordering between neuroscience and education, for instance, are evident when authors specifically explain, argue, and negotiate about struggles fought between levels of analysis. In his account of critical discourse theories, Fairclough (2003) labels such dialogical statements as either *attributes* or *modalised assertions*, where the former indicates explicit quotes or expressions of other voices of possibilities in a debate, whereas the latter are statements open to other possibilities. Discursive ideas, concepts, and ideologies can also be expressed implicitly and even *unintentionally* by actors within the discourse. Implicit and subtle expression of representations should not go unnoticed, because subtle manifestations can either indicate a *strategy* to naturalise certain ways of being, thinking, and acting in the discourse, or, more importantly, they can indicate that a certain representation has *already* become naturalised within the discourse, since actors unintentionally talk and act along these lines of thought (cf. Fairclough, 2010).

Even if most of the texts analysed show dialogical negotiations of the struggle between neuroscience and education, there are some where a hegemonic ordering appears to be manifested somewhat implicitly and is non-modalised. An example of this is the text by Carew and Magsamen (2010), where one receives the impression that a hierarchic order is

[132] As seen in Varma et al. (2008) and Cerulo (2010). A similar reluctance towards natural scientific explanations in the educational domain is also noted by Haworth and Plomin (2011), who argue for bringing *genetics* and education together. They further note that "influential research will come from the integration of both genes and environments and their interplay to understand learning and achievement at school" (p. 553), but the integration has been slow, partly because educational research has largely disregarded the impact of genetic influences in educational aspects.

subtly manifested within the text. Again, it is neuroscience which is allocated the most dominant role in the educational neuroscience partnership, but in contrast to other texts in the hegemony corpus, Carew and Magsamen neither explicitly consider, nor discuss, the hierarchic dominion of neuroscience. Instead, the text conveys an assumption that neuroscience can, and should, "inform" and "help" education, which, in the view of Carew and Magsamen, is "good news, because more than ever, we need to figure out how to teach our children how to learn" (2010, p. 685). By frequent use of similar statements and the quote shown below, it is evident that neuroscience is designated a predominant role as a significant informer that can rescue educators and help them to 'finally' understand how to teach children to learn.

> The U.S. Secretary of Education, Arne Duncan, called the state of education in America a national public health crisis. American children are not excelling. Test grades show it. Innovation and creative thinking are not being taught, practised, or nurtured in children's lives. Industry and business are concerned that we are not producing engineers, mathematicians, scientists, and physicists ... And this is not simply a national problem: it is global ... How can neuroscience help? What can neuroscientists do about any of this? (Carew & Magsamen, 2010, p. 685).

What is problematic with allegations like these, firstly, is the implicit impression conveyed about teachers who have not yet been able to 'figure out' how to teach children − that is, until recently, when they have had help from neuroscientists. Secondly, it is problematic as to how the text makes use of statements suggested by authorities, such as the U.S. Secretary of Education and the industry and business' opinions, to underline certain arguments. Numerous statements are also generalised or presented as facts without necessarily being so, such as "American children are not excelling", "industry and business are concerned", and "it is a global problem"[133]. What also appears to be problematic with this text is the ways in which the authors present the "Neuro-Educational" endeavour. The blending of neuroscience, psychology, cognitive science, and education, is presented as a rather straightforward translation task, and there is not a single reference to issues related to cautious approaches, different levels of analysis, or other difficulties with regard to the brain−mind−education link. The following text extract demonstrates some of these implicit assertions:

> Imagine being able to use what we know about the rules of learning to design a classroom that actually made kids smarter ... [We could] imagine a million things that are all possible when fuelled by

[133] For instance, is the statement "American children are not excelling" generalised and exaggerated because, firstly, it does not indicate *some* children, but *American children* as an overall group? Secondly, "they are not excelling" indicates that overall they are inferior (in school), but surely, there are several aspects in which 'American children' are doing superbly.

> evidence-based rigorous neuroscience research that can be translated to practical application and tested for their efficacy through the creation of research schools, informal learning testing, and other measures. These game-changers for education and learning are within our reach (Carew & Magsamen, 2010, pp. 685-686).

According to Fairclough's theories on hegemony, these representations of a supreme neuro-science and neuroscientists' potential to help education are *non-modalised assertions* because the statements leave no room for other possibilities. Some statements in Carew and Magsamen's text even appear to be what Fairclough calls *assumptions*, since they are even less dialogical and simply take a vision for granted (cf. Fairclough, 2003). Implicit and non-modalised assertions, and assumptions of neuroscientific hegemony, are noteworthy, because they indirectly convey an idea of a discourse with little room for dialogical negotiations between the level of neuroscience and education.

Even if this example is based on a single text − which, in fact, is the *only* text in the hegemony corpus showing traces of strong non-modalised and non-dialogical assumptions − one must be aware that numerous other texts pertaining to the educational neuroscience topic exist which convey similar and less radical assertions of hegemonic ordering between neuroscience and education. Some of these examples, for instance, are found amongst those actors who enthusiastically claim that the linking of neuroscience and education produces a 'natural science of education'. Such statements subtly denote a predominant role to neuroscience by claiming that it is an "ideal basis from which to grow a *science* of education" or from which to "develop the *science* of teaching". Statements such as these appear to be quite common and can be found in authors working at the interface of education and neuroscience[134], and even the OECD's renowned project report on educational neuroscience bears the title *'Understanding the brain: The birth of a learning science'* (OECD, 2007a). I will argue that arguments for crafting 'a natural science of learning' are problematic and lean towards issues of reductionism, because statements like these give the impression that *learning* primarily can, and should, be explained by the natural sciences. Again we touch on the problem of conflating different levels of analysis between the brain, mind, and education, because more biological and neuro-cognitive causes seem to hold a sturdier and more 'scientific' explanation for learning than 'softer' social and environmental hypothesis of

[134] As seen in the texts Ansari et al. (2012, p.107), Greenwood (2009, p. 553), Tommerdahl (2010), and Pasquinelli (2011).

learning[135]. Since these texts, perhaps unintentionally, give a predominant role to the natural sciences − and also implicitly conflate the different levels of analysis between neuroscience and education with their calls for ‘a natural science of education’ − I will argue that they are at risk of conveying ideas of hierarchic ordering in the educational neuroscience discourse.

These examples are just some illustrations of subtle and indirect manifestations of a hierarchic ordering within the academic level of the educational neuroscience discourse. In my opinion, the important thing to remember is that one should be aware of such subtle, and perhaps unintentional, manifestations of a pre-dominant neuroscience within the educational neuroscience discourse. Not only will I argue that such implicit manifestations of hierarchic ordering inhibit open discussion and awareness of potential issues and possibilities in the endeavour to link the different levels of analysis between the brain, mind, and education. But I will also argue that representations such as these contribute to distributing and naturalising ideas of neuroscientific predomination and reductionism, to the disadvantage of education[136]. This is important because “naturalised discursive conventions are effective mechanisms for sustaining and reproducing cultural and ideological dimensions of hegemony” (Fairclough, 2010, p. 129).

Based on my critical discourse analysis, it appears that the field of neuroscience is often given a somewhat predominant role in the educational neuroscience relationship. The ensuing questions are: *why* is neuroscience so often considered to be powerful? How has it managed to gain a more hegemonic role in the educational neuroscience discourse and why does a ‘natural science of learning’ sound so appealing to some actors within the field? One explanation for this might be that the long-held assumption within the wider academic discourse that natural sciences with their ‘basic and fundamental explanations’ are more sound than explanations suggested by ‘softer’ fields within the social sciences, the humanities, and the arts (McChall, 1990; Perkins, 2009; Willingham, 2009). Similarly, because education is often believed to have “inherent weakness and neglect of evidence in the formulation of educational theory” the field is at risk of being swayed by actors who suggest

[135] This argument should be seen in relation to the critical realistic approach to educational neuroscientific research which I propose in chapter 2. My preliminary point in this respect is that a critical realistic perspective can help to illuminate how certain disciplines (e.g. neuroscience) are more ‘basic’ than other disciplines (e.g. education), but how one cannot reduce or conflate one ‘strata’ to another. As a means of combining research from different ‘strata’, critical realists propose a transdisciplinary mode of study – a mode which I combine with educational neuroscientific research in my final reflections in chapter 9.

[136] If a representation is frequently presented within a discourse, it will become common, less questioned, and thus more naturalised. What is of note with naturalised ideas is that they hold a relatively hegemonic position in the discourse, in that they have become so frequently represented that they appear obvious and almost beyond all doubt (Neumann, 2010).

more 'scientifically based' learning theories (Kraft, 2012, p. 392). These aspects are discussed in more detail later in the chapter, but for the moment it can be noted that a problem with educational neuroscience is that this linkage, at first sight, gives the impression that neuroscience can provide a more 'scientific' understanding of learning. The notion that some actors and groups working at the interface of education and neuroscience also convey implicit, and perhaps even unintentional, statements of hierarchic orderings and visionary ideals of 'a science of learning', can strengthen the idea that neuroscience holds a dominant role in the partnership. However, as shown above, one should be cautious about assumptions concerning a predominant and 'informative' neuroscience, because these ideas are at risk of conflating different levels of analysis.

A muddled discussion

Apart from frequent negotiations over the hegemonic dominion presumed to be held by neuroscience, my critical discourse analysis indicates another aspect worth noting − namely that the debate regarding different levels of analysis between neuroscience and education is confusing. This is because these hegemonic struggles are fought from the viewpoint of many disciplines − educationalists, neuroscientists, cognitive psychologists, educational neuroscientists, cognitive neuroscientists, social cognitive neuroscientists, educational psychologists, etc. My findings also show that hegemonic struggles conducted between these disciplines and sub-disciplines often end in disarray, due to confusion over which disciplines are included in the educational neuroscience endeavour and which are not. For example, this is apparent in the ways in which texts represent ideas of hegemonic dominance. Although numerous texts from the corpora note how *neuroscience* has a dominant role over education[137], other texts stress that it is neuroscience *and* cognitive psychology that dominate education[138], or that it is neuroscience and education which hold a dominant role over *psychology*[139]. The latter claim of hierarchic ordering is often stated by Bruer (1997; 2006), as he claims that both cognitive neuroscience and education tend to neglect the field of *cognitive psychology*. Bruer further argues that the endeavour to link education and neuroscience "is a bridge too far" (Bruer, 1997; 2006). When analysing the educational neuroscience discourse,

[137] As demonstrated in the text by Stein and Fischer (2001), Choudhury (2009), Cerulo (2010), Ansari et al. (2012), Kraft (2012), Carew and Magsamen (2010), and Pickersgill (2013).
[138] As seen in texts by Goswami (2008), Greenwood (2009), Ferrari (2011), and Pasquinelli (2013).
[139] As seen in texts by Bruer (2006) and Anderson and Reid (2009).

however, one receives the impression that the discipline tends to encompass the field of cognitive psychology. In fact, a majority of the authors in the corpora explicitly stress that cognitive psychology is a central part of the educational neuroscience collaboration, and that one cannot link the level of the brain with the level of behaviour without including the middle-step of the mind[140]. Bruer's argument against the educational neuroscience venture therefore falls short of its target because of confusion concerning which disciplines are included in educational neuroscience.

However, as well as the confusion over which disciplines to include in the educational neuroscience endeavour, the numerous perspectives and approaches taken in the struggles between different levels of analysis contribute to the uncertainty. As already mentioned, there is negotiation between nature versus nurture, between biological explanations set against environmental explanations, between the brain as a part versus a more holistic view of the individual, between individual cognition seen in contrast to collective cognition, and between the natural sciences as opposed to the social sciences, the humanities and the arts. Different approaches to educational neuroscience's levels of analysis, in addition to struggles over the hierarchic ordering found therein, make the discussion unclear and I will argue that the multifaceted debate often leads to unnecessary accusations and misunderstandings amongst educationalists, neuroscientists, and cognitive psychologists. For example, this could be the case with Bruer's (1997; 2006) accusations against educational neuroscience for neglecting cognitive psychology in its work − an argument which seems to run off target, because the discipline does indeed have a central enterprise which links the level of the brain (i.e. neuroscience), the level of the mind (i.e. cognitive psychology), and the level of behaviour (i.e. education)[141]. Misunderstandings over disciplinary objectives arise in educational neuroscience debates, and groups that initially appear to hold conflicting perspectives can actually hold relatively similar views. Comparable perspectives notwithstanding, some actors continue their quarrel due to confusion related to *unclear* educational neuroscientific objectives, configuration and aims − such as which disciplines and sub-disciplines are, or should be, accounted for in the educational neuroscience endeavour. This can lead to debates where the various groups fail to listen to each other.

[140] As seen in Goswami (2008), Anderson and Reid (2009), Ferrari (2011), Greenwood (2009), Pasquinelli (2013), and Tommerdahl (2010).

[141] As seen in Goswami (2008), Anderson and Reid (2009), Ferrari (2011), Greenwood (2009), Pasquinelli (2013), and Tommerdahl (2010).

Traces of warnings and outdated ideas

When reading articles on the topic of educational neuroscience, as the text extracts in the previous sections illustrate, one receives the impression of a hierarchic ordering where neuroscience holds a dominant role over education. In critical discourse analysis, however, it is important to look beyond explicit statements in an individual text, in order to grasp nuances of the larger context. An argument is seldom presented only in black and white, and this appears to be the case with concepts of a neuroscientific power dominion at educational neuroscience's academic level. The critical question worth asking is whether or not the complexity and reality of educational neuroscience has perhaps become condensed in claims of neuroscientific dominance. Do statements of hegemonic ordering within educational neuroscience reflect beliefs of *existing* power hegemony, or are they warnings against *potential* hegemonic outcomes? The difference may seem trivial, but when analysing the nature of a discourse, the line between rhetorical claims and the embodied meaning of these claims is essential.

To answer these questions, we need to look again at the hegemony corpora, and the ways in which texts represent ideas of struggles over hierarchic orderings of educational neuroscience's different levels of analysis. Moreover, even if numerous texts explicitly present *statements* of hierarchic dominion and reductionism, they do not necessarily convey the idea that a strict state of hegemony *actually* exists within the educational neuroscience discourse. Instead it appears that the texts either express:

- notions of outdated ideas, or
- warnings of potential hegemonic and reductionistic outcomes

Statements communicating '*warnings against'* or '*we are past such ideas now'*, are found in many tussles between different levels of analysis at educational neuroscience's academic level. One such example is identified in discussions where education and neuroscience are linked to the time-honoured debate between *nature* as opposed to *nurture.* When analysed more thoroughly, these negotiations often indicate that the 'either-or' struggle between different levels of analysis is outdated and that researchers today have moved away from a 'nature *or* nurture' perspective. As an alternative to this 'outdated either-or idea', several texts in the corpus convey an idea of 'nature *and* nurture' where biological explanations are not set in stark opposition to environmental explanations. For example, this is seen in Ansari et al. (2012), Goswami (2008), Logan and Johnston (2007), and in Gelman and Taylor (2010, p.

393). In the latter text, it is even noted how “The contrast between nature and nurture is powerful in its simplicity, yet every student of developmental psychology is quickly taught that framing the question as an “either-or” debate is too simple”. Such negotiations of hegemony between nature and nurture, biology and environment, imply that we are past ideas of ‘either one or the other’. The nature-nurture struggle is therefore perhaps more an echo of old debates rather than statements of existing order of a nature-hegemony in the educational neuroscience discourse.

This applies to other struggles found between levels of analysis in educational neuroscience, and the picture appears more nuanced when investigated in detail. Just as numerous texts convey that the question is not one of *either* nature *or* nurture, *either* biological *or* environmental explanations, one also receives the impression that actors within the discourse do not think along the lines of *either* neuroscience *or* education. This is of interest, as many of the texts analysed explicitly refer to both neuroscientific dominance and reductionism of education[142]. How, then, can these texts also convey ideas of a more balanced relationship? Analytical findings from my hegemony corpora show that numerous authors present statements of discursive hierarchies, neuroscientific dominance, and reduction of education as general *warnings* of possible discursive outcomes[143]. When writing texts, many authors follow a general argumentation structure along the lines of a problem-solution structure, where problems are presented, and warnings stated, before a solution is suggested. Similar lines of argumentation are found in my hegemony corpus, as several authors start by presenting the problem of different levels of analysis, continue by warning against top-down and reductionistic ordering between neuroscience and education, before suggesting a solution of reciprocal collaboration and bi-directional links between the level of the brain (neuroscience), the level of the mind (cognitive psychology), and the level of behaviour (education). This implies that even if a text explicitly mentions neuroscientific hegemony and reduction of educational explanations, these statements are mere rhetoric in a rhetorical argument, rather than expressions of belief that hegemonic dominance exists within the discourse of educational neuroscience. Such argumentative dispositions and rhetoric (exemplified below in table 6.5) are, for instance, seen in the texts by Varma and colleagues

[142] As seen in Stein and Fischer (2001), Choudhury (2009), Cerulo (2010), Ansari et al. (2012), Kraft (2012), Pickersgill (2013).
[143] As seen in Varma et al. (2008), Goswami (2008), Choudhury et al. (2009), Christodoulou and Gaab (2009), Tommerdahl (2010), and Stein and Fischer (2011).

(2008), Tommerdahl (2010), Choudhury and colleagues (2009), Goswami (2008), Christodoulou and Gaab (2009) and Stein and Fischer (2011).

Common line of argument:
Problem: Different levels of analysis between the brain, mind, and education.
Warning: Top-down and reductionistic line of causation between neuroscience and education.
Solution: Bi-directional links and reciprocal collaboration between neuroscience, psychology and education.

Table 6.5: Common line of rhetorical argument found in educational neuroscience debates.

From a critical discourse theoretical point of view, what is interesting is that by providing warnings over hegemonic neuroscientific dominance and reduction of education, certain aspects of the nuanced picture in the educational neuroscience discourse have been condensed in order to fit a problem-solution rhetoric. By this, I mean that the scenario of a top-down 'neuroscience → education' ordering does not necessarily correspond with how many actors understand the situation at academic level. Nevertheless, it seems that authors still warn against neuroscientific hegemony and reductionistic scenarios, because such rhetoric provides a good argumentative strategy for stressing the importance of reciprocal collaboration and cautious approaches to educational neuroscience's complex enterprise. This is because an argument against, and a *de*naturalising of, hegemonic orderings between neuroscience and education leads to an expectation that the author will present an alternative and 'better solution' to the problem – in this case, the 'solution' often being reciprocal and bi-directional bridges between education and neuroscience. Text-analytically speaking, a message presented by use of a problem-solution strategy may be more influential, since the author explicitly demonstrates how this 'solution' is better than others. Such argumentative strategies are also significant, because "a significant target of hegemonic struggle is the denaturalisation of existing conventions and replacement of them with others" (Fairclough, 2010, p.129). Even if the rhetorical 'outcome' of such argumentative strategies benefits these actors, because they support a balanced relationship between neuroscience and education, I will argue that such rhetorical strategies are ambiguous as they also convey a picture of a discipline 'ruled by neuroscience'. Actors working at the interface of educational neuroscience should be careful when using hegemonic scenarios in their 'problem-solution' argumentation, because this type of rhetorical strategy can reduce part of the complex concept of the educational neuroscience relationship.

In this respect, it should also be noted that ideas of bi-directional arrows were discussed in the previous emergence chapter, where it was argued that the educational neuroscience discourse has moved from the idea of top-down causation between '*neuroscience → education'* often held until the 1970s and 1980s, to a more bi-directional view of correlation between '*neuroscience ←→ cognitive psychology ←→ education'*. Thus, statements of hegemonic ordering, in addition to rhetorical argumentation, are also seen as notions that were more common decades ago. Overall then, it is apparent that instead of ideas of hegemonic ordering in the discourse, most authors in the contemporary debate perceive the different levels of analysis in educational neuroscience as being part of a complex set of dynamic relations, which are mostly in a state of *reciprocal collaboration* between education, cognitive psychology, and neuroscience[144]. Statements of hegemonic struggles and negotiations over levels of analysis are mostly used as rhetorical warnings and proclamations of outdated ideas, rather than representations of believed actualities.

What about educational practice and the voice of teachers?

Concepts of change and struggles over representation are central to any discourse analysis of hegemony. Even when there seems to be an apparent *lack* of discursive change and conflict, this can be significant, because lack of negotiations means that one discursive 'reality' has attained hegemonic dominance over other discursive representations (Fairclough, 2010). With regard to the academic level of educational neuroscience, findings from my analysis show that many actors acknowledge the complex set of relations found between its different levels of analysis, and that a common aim is to craft bi-directional links and reciprocal collaboration between neuroscience, psychology, and education. However, my findings further indicate that despite recognition concerning different levels of analysis in educational neuroscience, there is one level in particular which repeatedly seems to be neglected in the debate − namely *educational practice*. This neglect is surprising considering that 'the level of education' is such a central aspect of educational neuroscience. However, my findings show that

[144] As seen in Ansari et al. (2012), Greenwood (2009), Mason (2009), Christodoulou and Gaab (2009), Ferrari (2011), and Stein and Fischer (2011).

representations of ‘the level of education’ tend to encompass educational *research* and educational *theory*, but omit educational *practice* and the voice from educational practitioners, teachers, and students. This marginalisation of ‘the level of educational practice’ in the educational neuroscience debate is noteworthy and should be examined more thoroughly.

First of all, neglect of educational practice is demonstrated by the marginal role of the voice of teachers and other educational practitioners in debates at the academic level of the educational neuroscience discourse. Out of 29 articles analysed in the hegemony corpora, only *one* is written by a teacher − namely Greenwood’s (2009) article with the apposite title ‘*Where are the educators? What is our role in the debate?*’. It states that:

> By joining forces educators can develop a more precise research basis to improve their practice and not be dependant upon translators or others who do not have classroom expertise. Educators need to take an active role, bringing their expertise, along with those working in other disciplines, to develop the science of teaching (Greenwood, 2009, p. 553).

Although this is the only article actually written by an educational practitioner, some of the other texts also refer to the level of educational practice. For instance, there are references to educational practice in statements such as “mission of building bidirectional and substantive connections between practice and research” (Christodoulou & Gaab, 2009, p.556), and “a symbiosis between researchers and educators”, which are seen as being aligned with “the classical division of *theory* and *practice*” (Stein & Fischer, 2011, p.58). However, references to educational practice do not necessarily imply that the voice of teachers is actually heard and taken into consideration. In other words, one can easily put forward statements on behalf of teachers and educational practitioners. The question, however, is whether these statements are the author’s *presumption* of teachers’ opinions, or if they are actually based on dialogue with teachers themselves. Some articles in the corpora appear to make statements on behalf of teachers, without necessarily consulting with them. This is seen in Mason’s (2009) article where he discusses ‘frequent teacher misconceptions’ such as left-and-right brain teaching, and notes that such misinformation is often found in schools because it is attractive to “the practitioners of education, who need ‘broad brush messages’ and prefer to be told ‘what works’” (p. 548). Not only does such a statement present teachers in a poor light, it also makes prior judgments about their preferences, values, and opinions, since it is claimed that they prefer ‘broad brush messages’ and to be told ‘what works’ without even referring to a single teacher. Similar statements and prejudgments implicitly made on behalf of teachers are found in other texts as well[145]. The problem is that teachers' views do not necessarily correspond to those *ascribed* to them by educational researchers, psychologists, and neuroscientists. By presenting such prejudices in journal articles without including teachers and practitioners' actual opinions, the educational neuroscience debate amongst researchers can easily become unbalanced and biased against the level of educational practice.

However, it should be noted that some of the articles in the corpora do make an effort to explicitly include teachers and educational practitioners' voices in the debate at the academic level of the discourse. A study by Dekker, Lee, Howard-Jones, and Jolles (2012), for instance, investigates the prevalence of neuromyths in education by carrying out a large observational survey of 242 teachers. The argument for their research approach is that "[d]espite concerns regarding the rapid proliferation of neuromyths (...), not much is known about the prevalence of neuromyths among professionals in the field of education" (Dekker et al., 2012, p. 1). Another text in the corpora which also refers to teachers, is by Hook and Farah (2013). These authors similarly start their article by noting that relatively little of the debate regarding educational neuroscience has investigated teachers' expectations and views. Following this, they present in-depth interviews where they investigate educational practitioners' view regarding neuroscientific research. By directly addressing teachers in their surveys, both Dekker and co-workers (2012) and Hook and Farah (2013), draw attention to the more marginalised group of teachers and educational practitioners at the academic level in the educational neuroscience discourse. However, although some articles explicitly address the role of teachers, the majority of texts at the academic level of the discourse either completely neglect this role, or simply point to issues regarding educational practice without referring directly to teachers' opinions or views[146]. It is therefore evident that teachers themselves seldom enter, or are invited to enter, into the academic debate regarding educational neuroscience.

In addition to the marginalised voice of teachers, there is another group which appears to be even more neglected at the academic level of the educational neuroscience discourse – voices of *students.* In texts analysed in the corpus, there was scarcely a mention of students' role in the educational neuroscience enterprise. One of the few texts which explicitly mentions the role of students is the article by della Chiesa and colleagues (2009, p. 24), where in a footnote at the end of the paper they write: "It is interesting to note that students and

[145] As seen in Carew and Magsamen (2010), Pasquinelli (2011), and Goswami (2008).
[146] As seen, for instance, in Mason (2009), Goswami (2006), Carew and Masamen (2010), and Pasquinelli (2011).

parents generally remained uninvolved in the project most of the time, which could be ... because these groups are not used to being part of strategic planning in education context". The neglect of students' voices in the educational neuroscience enterprise, as della Chiesa and colleagues (2009) note, is not necessarily limited to the case of the educational neuroscience project per se, because it is a problem when designing educational programmes in general. However, even if neglecting students' expertise and opinions is a common problem in educational projects, this does not justify actors within the educational neuroscience discourse doing so as well. Indeed, I will argue that much benefit can be obtained from taking students' voices into consideration in the more practical and classroom-related side of educational neuroscientific work. One example which can illustrate is Wilson, Dehaene and colleagues' (2006) project about the learning computer game 'The Number Race' for remediation of dyscalculia. Based on neuroscientific and cognitive theories "of the cerebral representation of number and the hypothesis that dyscalculia is due to 'core deficit' in number sense or in the link between number sense and symbolic representations", the research group designed an adaptive game software for children with mathematical learning difficulties (Wilson et al., 2006, p. 1). Design of the educational software is underpinned by expertise in cognitive neuroscience of mathematics, educational learning theories by Vygotsky, and game design theories. *Children's* expertise and experience of the game, however, was not considered until the final stage of the project, when a group of nine children with mathematical learning difficulties tested the game[147]. As the researchers themselves admitted, results from testing the educational neuroscientific computer game showed that "children became bored with the software", and the "levels of the software were too easy for most children, and the software too slow to adapt to their initial ability" (Wilson et al., 2006, p.12). This demonstrates that even if the software game were successful *in theory*, it failed *in practice* since it did not manage to engage with its target group of children (Howard-Jones, 2010). Had there been more collaboration with children and their expertise throughout, the project could have prevented this poor and unengaging software design, and thus the example again underlines the importance of also taking the level of educational practice into consideration in educational neuroscientific work.

[147] It must be noted that the researchers used data simulation and learning algorithms during the design process, and that they "tested the design of [their] algorithm by developing a Matlab model which simulates a child playing the game" (Wilson et al., 2006, p. 8). However, it is debatable if technical data simulation of a child's knowledge and responses should be used instead of the experience of children themselves. Data simulation can, of course, be a significant aid in software designs, but it should not *replace* children's expertise.

I will argue that educational practice is an important level of the educational neuroscience endeavour, primarily because this is the level where educational neuroscience is ultimately manifested within the classroom. Even if numerous authors mention the theory-to-practice issue, and call for more reciprocal collaboration with educational practitioners, not many researchers *explicitly* incorporate the voices of teachers and students when working at the interface of educational neuroscience. This aspect is particularly important with reference to critical discourse theories, where it is stressed that exclusion from debates and negotiations can lead to a marginalised group of actors within the discourse (Fairclough, 2010). Furthermore, if voices of teachers and students are not considered, the level of educational *practice* is at risk of becoming conflated and reduced to the level of educational *theory.* Such a reduction is not beneficial, because there is a significant difference between educational theories and educational practice, since the practical side includes deeper practical knowledge regarding the 'art of teaching', pedagogical strategies, interaction between teachers and students, ethical considerations, and other essential aspects of real-world learning within the classroom. By neglecting the voices and the expertise of teachers and students, the educational neuroscience endeavour is at risk of crafting a hegemonic ordering where theory and research dominate over the life and practices of the classroom.

Reduction and marginalisation of educational practice is not advantageous, and an interesting ensuing question is *why* one can find such marginalisation of educational practice within the educational neuroscience discourse. What can possibly explain this hegemonic ordering, when the majority of actors within the discourse stress the importance of reciprocal collaboration and awareness of different levels of analysis? One possible explanation is that the conflict between theory and practice is ongoing within numerous disciplines in the larger academic and scientific discourse. For example, conflicts between theory and practice can be found within medicine, clinical psychology, business, engineering, social work, agriculture, public administration, journalism, and law (Hatasa, 2013; Van de Ven & Johnson, 2006). According to critical discourse theories, discourses are intertwined with one another, and aspects of one discourse are thus likely to affect aspects of another (Fairclough, 1992, 2010; Neumann, 2010). The resilient hegemonic struggle between theory and practice in the larger academic and scientific discourse is therefore also likely to affect and be reflected within the discourse of educational neuroscience. Conversely, seeing the durability of this theory-practice struggle one can indeed wonder why this conflict has not yet been resolved and why it even had a chance to be reintroduced to such a novel discourse as educational neuroscience.

I will argue that this issue can be partly clarified by the power *of* discourse, since certain discursive structures consolidate and institutionalise certain ways of acting, thinking and being in the world (cf. Fairclough, 1992, 2010; Neumann, 2010). This is also the case with the larger scientific and academic discourse, which subliminally naturalises and preserves certain hegemonic orderings just by the power of its discursive regularities and structures.

An example is the practice of publishing academic articles. Such a discursive practice implies that an author has research findings or expertise knowledge, which are deemed worthy of publication by a peer review board. Additionally, having academic articles published also implies that the author knows how to structure and write an academic article, such as using technical language, argumentative rhetoric, etc. As we can see, the mere act of publishing an article in a scientific journal requires specialised knowledge of which actors outside the academic research community may be unaware. By using this example, I am *not* implying that all teachers (or all students for that matter) lack the knowledge to publish articles within scientific journals. However, the way in which the scientific discourse is structured, organised, and institutionalised within academia, can make it more difficult for certain groups at the outskirts to get admission and access to the discourse[148]. In other words, these groups tend to become marginalised and unheard at the academic level, due to the subtle hierarchic ordering found within the structure of the discourse *itself*. This does not only apply to the publishing of academic articles, because it is not necessarily easy for people outside the scientific research community to even access research articles in scientific journals. Not only can journal articles be written in highly technical language with difficult theories and method-logical terms, many journals are also restricted or excessively expensive to get hold of by the public, with the exception of academic researchers who have free and easy access to millions of journal articles and library archives via their university or research group. Academic seminars, conferences, and other arenas can have similarly implicit discursive restrictions for people outside or on the margins of the academic level of the discourse. This can further prevent educational practitioners, teachers, students, parents, and others outside a confined academic discourse from making their voices heard in the academic educational neuroscience

[148] Even if voices from teachers (and also students and parents) are difficult to find within the academic level of discourse (where texts usually are published in peer-reviewed journals), it should be noted that voices relevant to educational practice are often found in other channels such as scholarly magazines. This is of note since it undermines the notion that voices from educational practitioners themselves are not likely to be heard within the academic level of the educational neuroscience discourse. This is also of note with respect to the literature search for my hegemony corpora, since criteria for this corpus were designed to locate texts solely from the *academic level* of the educational neuroscience discourse (and hence texts from grey literature such as scholarly magazines were excluded from the search).

debate. This, in turn, can make it difficult for researchers to comprehend the opinions of the practitioners often involved in their research.

Besides being a restricted discourse which makes it difficult for practitioners to be heard in the negotiations, another factor helps to explain why educational practice often becomes marginalised within educational neuroscience − the lack of a coherent body of practical educational neuroscientific applications. Numerous authors at the academic level stress that at the moment there is no comprehensive body of educational neuroscientific practices, and no intervention tools or teaching strategies which can be directly used in the classroom (Simmonds, 2014). The few concrete practical contributions which have been agreed on by educational neuroscientists are aspects such as ‘physical activity and exercise increase efficiency of neural networks and can thus appear to improve academic achievement’, ‘sleep is important for consolidating the day’s learning in long-term memory’, and that there appear to be some ‘negative effect of stress and anxiety on learning’ (Howard-Jones, 2014a). Numerous authors stress that “there is a scarcity of rigorous research from the neuroscience community that is readily translatable” and that this lack of practical applications is because of the discourse’s novelty, and that one still has to tread carefully when making links between neuroscientific theories and educational practice interventions[149].

Lack of a solid body of practical educational neuroscientific contributions can help to explain the marginalised role of educational practice within the academic level of discourse. Firstly, it appears that the theoretical link between neuroscience, cognitive psychology, and theoretical educational explanations, is easier to sustain than a connection to the next level, that of practical implications for teachers and students. As this last step actually takes *theoretical considerations* into *practical applications,* it is understandable that numerous researchers close off their discussions before even venturing into this ethical and practical minefield. The problem, as I will argue, is that by stopping short of the level of educational practice, a gap is left, vague and empty. Unfortunately, this gap is left for teachers or, even worse, for neuromyths and commercial “brain-based” learning programmes to fill.

This brings us to the concept of ‘neuromyths’, the second aspect which creates hurdles for the level of educational practice. Neuromyths is an umbrella term which encompasses misinterpretation, oversimplification, generalisation and other misconceptions with regard to neuroscientific findings. With reference to educational neuroscience, a neuromyth therefore

[149] As seen in Hardiman, Rinne, Gregory, and Yarmolinskaya (2012, p. 137), and Christodoulo and Gaab (2009).

often implies a misconception about an educational neuroscientific statement (Goswami, 2006). This happens when neuroscientific results are misunderstood and too hastily transferred directly from the level of the brain 'down to' the level of the classroom (cf. figure 6.4). What is so difficult about neuromyths is that they often have a grain of truth within them, but which has become distorted during the translation process from the level of neuroscience to the level of education (Howard-Jones, 2010). As such, they are often passed on as so-called "brain-based" facts about learning, without actually being 'facts'. In addition to neuromyths, there are 'edu-myths' within the educational neuroscience discourse (Hruby, 2012). These edu-myths, or behaviour-myths, are equally confusing and as big an issue at the level of educational practice as neuromyths, although here it is *educational* or *behavioural* characteristics that have become misinterpreted, oversimplified, or generalised. For example, this is seen in the enduring support for learning styles, despite the lack of quality research demonstrating any significant effect on student achievement (Hruby, 2012; Christodoulou & Gaab, 2009). Occurrence of educational misconception is also noted by Ansari and colleagues (2012):

> neuroscientists are frequently ignorant about progress that has been made in educational research and, consequently, will misrepresent or underestimate current research on learning and instruction ... Furthermore, neuroscientists are largely unaware of the current pedagogical approaches used in schools and, therefore, lack an actual overview of what is being taught in schools, how this is taught, and what expectations are being set by curricula etc. (Ansari et al., 2012, p.112).

Regarding edumyths, however, it appears that within the educational neuroscience discourse, occurrences and issues related to them are not as frequently considered as neuromyths. With references to hegemonic theories, this imbalanced attention to misconception is significant, and I will argue that misinterpretation of educational theories and practices is as severe an error as misinterpretation of neuroscientific theories.

What is problematic with neuromyths and edumyths is that they are most apparent within the level of educational practices (Hruby 2012). One reason for this may be that neuromyths and edumyths are often presented as clear applications, educational instructions, or teaching programmes. Consequently, they become much more useful and manageable in a classroom setting than, for instance, an educational neuroscientific research paper with technical language and vague practical recommendations. Another reason why neuromyths and edumyths are widely distributed within schools and classrooms is because of the commercial 'brain-based' learning industry. These commercial industries make a profit by targeting individual schools and teachers in order to sell teaching programmes, seminars, courses, and books which, arguably, offer effective 'brain-based' learning strategies (Fischer, Goswami, & Geake, 2010; Goswami, 2006)[150]. The problem, however, is that distribution of neuromyths and edumyths within the practical field complicates not only the role of teachers, but also how other actors working at the interface of educational neuroscience *regard* teachers and educational practitioners. This is evident in many texts in the hegemony corpora, and one often finds statements such as "a frequent teacher misconception is ..." (Mason, 2009 p. 548), "here apparently was a biological explanation for past educational failings and a scientific, neurological basis for educational reform that might satisfy their [teachers] many critics" (McChall, 1990, p. 888), and as the following extract from della Chiesa and his co-workers suggests:

> Practitioners ... were generally delighted by the outcomes of our project (sometimes even a little too much. [Often, they too quickly accepted hypotheses and transformed them into "facts", thus contributing to the development of new neuromyths, mostly without being aware of this]). (della Chiesa et al., 2009, p. 21 and the corresponding footnote set in brackets).

When analysing the academic level of the educational neuroscience discourse one receives the impression that a 'blame-game' is being played out concerning the distribution of neuromyths − and sometimes also edumyths. Usually, it is the 'naïve' teachers who are held responsible for 'expecting too much too fast' from the educational neuroscientific community, for having 'unrealistic expectations', or for falling prey to unscientific neuromyths and the so-called "brain-based" learning programmes[151]. Neuroscientists, cognitive psychologists, and educational researchers, on the other hand, are portrayed in a much more favourable light as they appear to be 'informers' who need to "better prepare *teachers* to be thoughtful" and "help educators interpret and apply these findings in classrooms" (Hardiman et al., 2012, p. 137). Statements referring to such hierarchic dominance between researchers and teachers may be articulated implicitly and even unintentionally, but one nevertheless gains an overall impression of teachers as being held in much lower esteem than the more 'scientific' research community. This implicit hierarchic ordering between 'naïve' teachers and 'helping' researchers further clarifies why teachers and educational practitioners have such a marginalised role within the educational neuroscience discourse.

[150] A more thorough account of neuromyths, edumyths, and the so-called "brain-based" learning industry can be found in chapters 7 and 8, where educational neuroscience's recontextualisation to public and political fields are analysed.
[151] As seen demonstrated in Ansari et al. (2012), Mason (2009), and Hardiman et al. (2012).

In my opinion, what is problematic with this tendency is that teachers are unfairly blamed for a situation which is not completely their fault. Firstly, it is unjust to call teachers 'naïve' when the scientific and academic level of discourse is often inaccessible to them. Secondly, implicit and deep-rooted hierarchic orderings between researchers and practitioners do not help in this matter, because the 'blame-game' can easily be turned the other way round, since the scientific research community seldom corresponds directly with teachers, students, and other educational practitioners. If the voice of teachers had been more frequently heard in the educational neuroscientific debate, then perhaps the research community would have been more attentive to their expectations, opinions, and misconceptions. A third point is that teachers are often in the direct crossfire between students and parents' expectations, directives and pressures from school administrators, political requests, and attention from the public media. Their role is therefore 'sandwiched' between the public community and the research community, with each party often having unrealistic expectations of the others. It is precisely this state of pressure which commercial 'brain-based' learning industries appear to thrive on, as they offer 'effective' and 'scientifically brain-based' learning programmes to schools and teachers. To render teachers as naïve and passive actors, therefore, is a perception based on a situation where the whole context has not been taken into consideration. There are both discursive structures and other discursive actors who are implicated in the state of educational practitioners, and I will argue that a neglect of teachers and students' voices worsens these issues rather than helps to solve them[152].

Struggles between representations and interpretations

Apart from struggles over different levels of analysis seen between neuroscience and education, my critical discourse analysis also identifies another site of tension within the academic level − conflicts between *interpretations* and *representations* of educational neuroscientific findings. Such conflicts are not so much a struggle played out between different actors per se − rather they are a matter of *incoherence* in the ways in which educational neuroscientific representations are presented, transferred, and understood at

[152] In chapter 9, I present some final reflections concerning the educational neuroscience discourse. Central in this respect are the different levels of analysis in educational neuroscientific endeavours, the marginalised role of educational practice which is often noted, and issues related to reductionistic perspectives. As an alternative way of approaching these matters (viz. the model presented in figure 6.1 and 6.4), I present a transdisciplinary model for understanding the educational neuroscience discourse (cf. critical realism and critical discourse analysis).

different stages and between different actors working at the interface of educational neuroscience. In the hegemonic corpora one finds numerous references to such tensions. Goswami (2008) and Hruby (2012), for example, talk of incoherence between correlational findings and causal interpretations, and Kraft (2012) similarly notes that there is a tendency to conflate neuroscientific cause and educational effect. Choudhury and colleagues (2009, p. 64) note that there are "discrepancies between what the science directly demonstrates and what the representations of science tell us", and della Chiesa and colleagues (2009) note how neuroscientists are often incapable of communicating their research findings properly to educationalists and politicians. Based on my findings from the hegemony corpora, I argue that discursive tension arises from disjointedness in what I call 'the line of transference'. This line, which I have illustrated in table 6.6, indicates how educational neuroscientific representations are usually transferred between different stages and different actors.

- What educational neuroscientific research *demonstrates*
  - The level of the brain (e.g. neuroscience)
  - The level of the mind (e.g. cognitive psychology)
  - The level of behaviour and the social (e.g. education)
- How educational neuroscientific research is *represented*
  - by scientists
  - by public actors (e.g. the media and the "brain-based" industry)
  - by political actors (e.g. policymakers and other interest actors)
- How educational neuroscientific research is *understood*
  - by other academics and researchers
  - by teachers and students
  - by the public
  - by policymakers and interest actors

Table 6.6: Educational neuroscience's line of transference.

The first stage in this model of transference includes *research* pertaining to educational neuroscience and what this research demonstrates. This stage will therefore also cover the different levels of analysis found between the brain, mind, and behaviour and the social. Negotiations concerning different levels of analysis have already been discussed in previous sections, where it was noted that translation problems can easily occur between neuroscience, cognitive psychology, and education, due to disciplinary differences in vocabularies, methods, data, theories, and philosophies[153]. Given that such disciplinary translation problems have already been discussed, and those pertaining to the political and public level of the discourse are thoroughly analysed in the next chapter[154], this section will not elaborate on each stage in the line of transference model. Instead, it will elaborate on some general characteristics which result in transference incoherence problems found in the hegemony corpora.

Parts of the discursive tensions which arise between what research demonstrates, how it is represented, and how this research in turn is understood by different actors at the interface of the educational neuroscience discourse, are interlinked with the problem of *correlation* set against *causation*. Many of the texts in the hegemony corpora implicitly touch on the correlation−causation issue[155], and the issue is explicitly discussed by Goswami (2008), Choudhury and colleagues (2009), Hruby (2012), and Kraft (2012). The problem is that there appears to be a tendency to conflate correlational findings to causational interpretations. In other words, researchers working at the interface of education and neuroscience often present their findings as *correlational data*, but when these correlational representations are passed along the line of transference, they sometimes become translated into *causational data.* However, although several authors from the hegemony corpora discuss this 'point of tension' in the educational neuroscience discourse, translational errors between correlation and causation occur more frequently at the interface between the academic level and other related fields (such as the public and political fields)[156], and not necessarily within the academic level *per se*.

Another aspect which highlights translation errors along educational neuroscience's line of transference, is that neuroscientists use a technical language which is often inaccessible to actors outside the neuroscientific discipline[157]. According to critical discourse theories, technical language, jargon, and vocabularies can make a field inaccessible to people outside the discipline. In previous sections it has been shown how this appears to be the case

[153] As noted in Willingham (2009), Varma et al. (2008), Tommerdahl (2010), and Ansari et al. (2012).
[154] Considering that the discourse of educational neuroscience is intertwined with other discourses and thus has a complex set of relations between different discourses, actors, institutions, and even across time and geographical space, I will inevitably encounter certain problems in my presentation, since one topic can be relevant with regard to hegemonic relations (presented in chapter 6), and to recontextualisation processes in other fields (presented in chapter 7 and 8). This is indeed the case at this point, since here one touches on certain hegemonic struggles and translation problems, which arise between the academic level of the educational neuroscience discourse and other related discourses such as public and political discourses. Thus, only the most relevant aspects related to the hegemony concept are presented at this point, whereas related recontextualisation aspects will be further discussed in chapter 7.
[155] As seen in Greenwood (2009), Weisberg et al. (2008), Perkins (2009), and Pickersgill (2013).
[156] For further analysis and discussion see page 273-280 in chapter 7.
[157] As noted in della Chiesa et al (2009), Willingham (2009), Tommerdahl (2010), and Perkins (2009).

within the educational neuroscience discourse. Regarding translational inconsistencies, the problem is therefore that translation errors are more likely to occur, since neuroscience's technical language makes it difficult for non-experts and actors from other disciplines to *re*-present neuroscientific narrations. This can be exemplified by brain images in neuroscientific research, since these models often result in translation errors when interpreted by non-experts unaware of the complex processes such neuroscientific models represent[158].

Yet another aspect is identified in the hegemony corpora with respect to incoherence between demonstration, representations, and interpretation of educational neuroscientific research − namely 'the seductive allure of neuroscientific explanations'. This phrase was originally suggested by Weisberg and colleagues (2008), when they showed how non-expert subjects tend to judge neuroscientific explanations more favourably than experts in cognitive neuroscience − arguably because the seemingly more 'scientific' and 'definite' character of neuroscientific data is more attractive than 'vague' interpretational data. The seductive appeal of neuroscientific explanations has become entrenched within the academic level of the educational neuroscience discourse. In my hegemony corpora, 20 per cent of the texts explicitly refer to neuroscience's appeal[159], and many others implicitly refer to this by mentioning the dominant and fascinating appeal that neuroscientific explanations have within academic and social fields[160]. For instance, Pasquinelli (2011) talks of a 'neuromania', which affects sciences and the general public, noting how 'the brain-hype' and fascinating brain images seem to enthral part of the educational community, the public society and popular culture. Also, Cerulo (2010, p.115) notes that "[t]he brain is hot ... and cognitive neuroscientists have it. These specialists want to teach us about it − even help us tour the brain via fMRIs, PET scans, and other "tangible" images". Hardiman and colleagues (2012, p. 137) further note that this seductive appeal of neuroscientific explanations is often manifested in popular media where, unfortunately, "subtle details and carefully stated conclusions may be overshadowed or ignored in order to generate attention-grabbing headlines". Based on these and similar references from the critical discourse analysis, it appears that the appeal of neuroscientific explanations is also a point of struggle found within the educational neuroscience discourse and, particularly, between different stages of the discourse's line of transference.

[158] As noted in Weisberg et al. (2007), Pasquinelli (2011), and Pickersgill (2013).
[159] Seen in Goswami (2008), Ferrari (2011), Pasquinelli (2011), Dekker et al (2012), Hardiman et al (2012), and Hruby (2012).
[160] As seen in Varma et al. (2008), Cerulo (2010), and Pickersgill (2013).

If one considers the seductive power neuroscience apparently has, it is understandable that difficult neuroscientific explanations can easily lead to translation errors when being transmitted between different stages within the educational neuroscience discourse. This type of translation error, arising from the appeal of neuroscience, is found, for instance, at the level of educational practice. In a study by Dekker and colleagues (2012), a large observational survey was designed in order to investigate misconceptions and neuromyths amongst 242 primary and secondary school teachers. The results show that teachers answered correctly 70 per cent of the general knowledge statements regarding the brain, and that they believed in 49 per cent of the neuromyths presented to them in the study. Dekker and colleagues research further indicates that:

> [m]ore general knowledge also predicted an increased belief in neuromyths. These findings suggest that teachers who are enthusiastic about the possible application of neuroscience findings in the classroom find it difficult to distinguish pseudoscience from scientific facts. Possessing greater general knowledge about the brain does not appear to protect teachers from believing in neuromyths (Dekker et al., 2012, p.1).

These findings correspond with the survey carried out by Weisberg et al. (2008), which suggests that non-experts, whether laypersons or even students in cognitive neuroscience, tend to evaluate explanations with neuroscientific information more favourably than is justified. The enthralling appearance of neuroscientific explanations therefore appears to seduce teachers as well − and particularly those interested in the brain (Dekker et al., 2012). This is significant with regard to translation inconsistencies in educational neuroscience, because the implications of neuroscience's fascination can help to clarify occurrences of misinterpretations, misconceptions, and neuromyths at the level of educational practice. However, when discussing occurrences of misinterpretations of educational neuroscientific research, I will again argue that one should be careful not to censure teachers too hastily. As previously mentioned, this is the level where educational neuroscientific research and theories ultimately become manifested in recommendations and practical applications for teachers and students. There is, therefore, a significant 'transference distance' between what researchers *demonstrate*, how it is *represented*, and how this is finally *understood* amongst teachers. Translation fallacies may emerge at different stages, and because of different actors in the transference process, one should guard against blaming teachers for errors, which may have occurred before the translated material appeared in the classroom. For instance, it is said that neuroscientists generally lack the ability to present their research findings to actors outside their own field, as noted by della Chiesa and his co-workers in their analysis of a collaborative project on educational neuroscience:

> Most speakers [brain researchers] were not very effective at communicating their knowledge because they rarely considered the audience and/or purpose. Accordingly, their presentations were too technical, cutting edge, and therefore mainly incomprehensible for lay persons ... As a result, neuroscientists often provided masses of information relevant only to their peers, in effect drowning findings significant for educators in a flood of technical information ... Neuroscientists were often not willing to sacrifice their own professional goals to promote a more fruitful exchange with the education community (della Chiesa et al., 2009, p.20).

Some responsibility for the problems regarding transference inconsistency should therefore also rest on the shoulders of the researchers who *represent* these findings in the first place. This can also be seen in light of the issues related to hegemonic struggle over theory and practice, educational practitioners' marginalisation in discursive negotiations, and what can appear as a rather closed research community with difficult vocabulary and inaccessible expertise knowledge.

A related translation error, which also helps to explain translation inconsistencies, is the notion that some neuroscientists appear to make education-related assumptions without necessarily referring to educational theories or research[161]. Kraft (2012) elaborates on this when he states that a conflation of cause and effect can be found in educational neuroscientific work where neuroscientists make unjustified assumptions with regard to educational theories and practical implications of their findings.

> [W]e see the typical logic of neuroscientific texts dealing with classroom education and schools, namely the conflation of cause and effect. The cause is encoded in neuroscience and is stated in neuroscientific terminology, while the effect is stated in everyday language with no reference to the results of research in pedagogy and education. This leaves us with the impression that it is possible to proceed directly from neuroscience to pedagogy, making the pedagogical conclusions seem grounded in neuroscience (Kraft, 2012, p. 393).

According to Kraft (2012), conflation of neuroscientific cause and pedagogical effect readily occurs if neuroscientists make assumptions about possible implications of their research for the level of educational practice. I therefore further argue that tendencies to make assumptions without educational references can be linked to what previously is noted concerning hierarchic struggles between the 'hard sciences' of neuroscience and the 'softer' and more 'hypothetical' field of education. First of all, one receives the impression that education

[161] As noted by Ansari et al. (2012) and Kraft (2012).

sometimes functions as a platform where neuroscientists discuss ethical questions, such as social implications of neuroscientific findings − perhaps because the 'softer' field of education, with its reliance on interpretational data, has a less stringent tradition in its peer-reviews than the 'hard' peer-reviews in neuroscience. Secondly, one receives the impression that education, in contrast to neuroscience, is a concept to which almost everyone can relate − for instance, most of us have been in school for at least thirteen years, and thus have some personal experience of 'good' and 'bad' teaching strategies. Accordingly, one gains the impression that neuroscientists sometimes make educational assumptions based more on a lay person's idea of education than on educational and pedagogical research (cf. edumyths). The problem with this, as already mentioned by Kraft (2012), is that causation becomes encoded within the neuroscientific representations, whilst educational practices become conflated with neuroscientific effects. Again one can find intertextual and interdiscursive relations to hegemonic struggles between neuroscience and education, theory and practice, and natural science versus social science and the art of teaching.

My findings indicate that there is an over-emphasis on neuroscientists as 'transmitters' and an under-representation of educational voices in the educational neuroscience discourse. In addition to the explanations presented above, I will present critical discourse theories regarding hegemonic power relations in order to elucidate this tendency further. I have previously shown how neuroscience appears to dominate within the discourse and that natural scientific and neuroscientific narrations are often considered to be more 'scientifically valid' than other representations[162]. Of note in this respect is how critical discourse theories claim that hegemonic representations of the world are *less* problematised than other narrations − often because their discursive conventions have become naturalised within the discourse (Fairclough, 2010). The somewhat naturalised 'scientific authority' often ascribed to the neuroscience discourse, illuminates why neuroscientific explanation is often judged more favourably, why it has a fascinating and seductive appeal, and why it is *less* likely to be questioned than other explanations. Additionally, other hegemonic power relations can contribute to the explanation. For instance, a 'closed' educational neuroscientific research community − with its technical vocabulary, complex explanations, and difficult methodologies – can contribute to explaining translation issues. This is because research communities which are inaccessible to practitioners at the margins of the discourse can

[162] As seen in Anderson and Reid (2009), Christodoulou and Gaab (2009), Perkins (2009), Willingham (2009), Stein and Fischer (2011), Ferrari (2011), Kraft (2012), and Mercer (2013).

contribute toward maintaining translation inconsistences and misinterpretations, since relatively little communication and knowledge distribution occurs between the 'inside' and the 'outside' of the academic discourse. However, problems related to poor knowledge communication between actors, are not only relevant for researchers and practitioners, because educational neuroscientific research is also picked up by actors from other disciplines. This is evident, for instance, in how research findings are interpreted − and in turn represented − by actors within domains such as the public media discourse, the political discourse, and also the field of the 'brain-based' learning industry[163]. Again, the problem is that these fields are not necessarily experts in either neuroscience or education, and thus there is a potential risk of translation errors. What makes matters even more problematic is that actors within the media, political organisations, or 'brain-based' learning industries often aim to spread these 'research findings' to a substantial public audience − in catchy popular-scientific articles, in political reports, or in commercial 'brain-based' learning programmes[164]. Research pertaining to educational neuroscience is therefore liable to be incorrectly interpreted by non-experts, before these (mis)interpretations are presented to a wider audience. Popularisation of neuroscientific ideas about learning may lead to misconceptions and 'neuromyths' within the public discourse (Haridman et al., 2012), and, if frequently presented, these (mis)representations can be circulated within the public discourse as accepted common knowledge regarding 'brain facts' (cf. Fairclough, 1992, 2010; Neumann, 2010). Mass circulation of popularised neuro-ideas is problematic, since it spreads inaccurate 'brain facts' within the public discourse. Distribution of educational neuroscientific misconceptions also complicates the situation for educational practitioners since "the popularisation of neuroscientific ideas about learning − sometimes legitimate, sometimes merely commercial − poses a real challenge for classroom teachers who want to understand how children learn" (Hardiman et al., 2012 p. 135). Again we see how different discourses pertaining to educational neuroscience are intimately entwined with one another, and how aspects within one discourse (e.g. popularisation of 'brain facts' within the societal discourse) may influence and strengthen issues within a related discourse (e.g. misconceptions regarding educational neuroscientific narrations within educational practice). Since educational practitioners often occupy a position in between research communities and the public discourse, teachers may be

[163] As noted in Hardiman et al. (2012), Dekker et al. (2012), Ansari et al. (2012), and Pickersgill (2013).

[164] Further elaboration on these aspects will be presented in the next chapters, where a critical discourse analysis of educational neuroscience's recontextualisation to the public level and the politic level is presented.

subjected to translational errors from both the academic community and from actors within the public discourse.

Even if there are discursive tensions regarding transference inconsistencies between what educational neuroscience demonstrates, how this is represented, and how this in turn is interpreted and understood, my analytical findings also show that many authors suggest ‘solutions’ to these translation issues. The majority of these solutions are in line with a cautious and optimistic approach, such as the following quote from Goswami:

> When evaluating neuroscience research, it is important to be vigilant: correlations are still correlations ... it is of course critical to check the quality of the science cited ... and to distinguish correlational data from causal data (Goswami, 2008, pp. 386-396).

In line with such critical awareness and optimistic caution, one can also find a recurring emphasis on the importance of mediators, translators, and middlemen who can aid the translation process of educational neuroscience[165]. It is additionally noted that the establishment of educational neuroscientific courses and communities also helps to build more expertise in transferring educational neuroscience between different stages and levels within the educational neuroscience discourse[166]. However, and in line with critical discourse analysis, I also argue that it is important to be vigilant about hegemonic and dominant tendencies when attempting to build research schools and mediators. It appears that educational neuroscience is still encumbered by its previous history of neuroscientific and theoretical power domination. Educational practice, however, repeatedly appears to be marginalised in discursive negotiations, and the inaccessibility of the educational neuroscientific research community may increase this research-theory gap. Educational neuroscientific research schools and the training of mediators and middlemen can therefore benefit from more dialogue with teachers and students. This can help the research community to gain insights into the way in which transference inconsistencies occur, and how to improve their communication with teachers, media, policymakers and other actors at the margins of the academic field. In addition, reciprocal dialogue between practitioners and researchers can also strengthen teachers’ expectations of what educational neuroscience can contribute in the classroom, in addition to strengthening their ability to critically read and expose misconceptions of ‘neuromyths’ or ‘edumyths’ at the level of educational practice.

[165] As seen in Christodoulou and Gaab (2009), Choudhury et al. (2009), and Hardimann et al. (2012).
[166] As seen in Ansari et al. (2012), Campbell (2011), and Dekker et al. (2012).

Overall, it appears that inconsistencies along educational neuroscience's line of transference occur due to numerous factors − from technical and inaccessible neuroscientific vocabulary to the resonance of a domination of 'hard' and 'robust' natural sciences over more vague educational 'hypothesis' concerning the art of teaching. This explains why there are struggles and confusion within and between different stages of educational neuroscience's line of transformation. To prevent circulation of translation errors within and between the discourses, I argue that better communication between each stage of educational neuroscience's line of transference is essential. It is not only the responsibility of non-experts to improve their neuroscientific knowledge to achieve better communication. Research communities should also take more responsibility for clarifying their representations. Again we touch on the notion of breaking down hierarchic relations, in order to create more equal bonds between researchers, practitioners, and other actors working at the interface of educational neuroscience.

Struggles between the academic level and policymakers and the public

In my critical discourse analysis of the hegemony corpora, another site of struggle is identified − namely struggles between the academic level of educational neuroscience on the one hand, and the political and public level on the other[167]. Della Chiesa and colleagues (2009, p. 18), for instance, suggest that the learning society "places high demands on education systems. At the turn of the century, breakthroughs in neuroscience brought brain research to the centre of research on learning, and educational policymakers are looking to this new research to shed light on critical issues in education policies and practices". Pasquinelli (2011) also elaborates on the increased political and public demands for education and claims that education is in need of reform:

> Knowledge- and evidence-based approaches to education put forward the fact that educational systems are inadequate to provide an answer to the challenges of the 21st century and claim that education should be guided by scientific principles rather than by intuition and professional wisdom only (or, worst, by tradition) ... The time has come for a new science of learning to rise, which is structured

[167] This point of tension, as with inconsistencies arising along educational neuroscience's line of transference, is located at the interface between the academic level of educational neuroscience and related fields of policymakers and the public. Aspects found at this merging point are relevant, both with regard to hegemonic relations (viz. the current chapter) and educational neuroscience's recontextualisation processes (viz. chapter 7 and 8). The following section will therefore present findings related to this 'site of tension' as represented in my hegemony corpora, whereas related discussions in the recontextualisation chapters will touch upon these aspects by use of representations found in political and public fields.

around cognitive and neuroscience, investigates topics that stem from educational problems, and rest on rigorous forms of in-laboratory and in-vivo evaluation (Pasquinelli, 2011, p.186).

The "potential of neuroscience to serve as a platform for evidence-based education" and how "neuroscience creates an ideal basis from which to grow a science of education" is also noted by Ansari and colleagues (2012, pp.106-107). On account of this, they claim that "neuroscience is one of the fields of inquiry that funding agencies and policymakers have turned to for answers to large-scale educational problems". Tommerdahl (2010, p. 107) uses similar neoliberal and political rhetoric for a "foundation of the new science of evidence-based education", Goswami (2008, p. 396) notes how cognitive neuroscience "enables an evidence base for education in which mechanisms of learning can be precisely understood", and Carew and Magsamen (2011, p. 658) appeal to political neoliberal ideologies by claiming that Neuro-Education can create more effective teaching methods, better curricula, and ultimately inform and transform educational policy.

> Neuro-Education initiatives can help frame issues and make the case for far-sighted education policies that make evidence-based sense for children's development. The bottom line is that everyone wins ... For each young mind served by Neuro-Education knowledge, all societies have the opportunity to regain lost ground − and build the potential for better academic achievements and opportunities for both young people and society at large (Carew & Magsamen, 2011, p. 687).

One therefore receives the impression that many authors from the hegemony corpus make use of a rhetoric containing traces of neoliberal ideologies, which calls for evidence-based education and an effective 'science of learning'[168]. However, one can also identify actors within the academic level of the educational neuroscience discourse who take a contrasting standpoint on such neoliberal ideologies. Hardiman et al. (2012), for instance, claim that:

> While educational policies and practices continue to focus strongly on the *product of learning* (mainly through standardized testing), our experience with teachers demonstrated that they tend to be more concerned with the *process of learning* ... As we have chased the shortsighted goals of No Child Left Behind, our focus has shifted away from children as learners and toward school and teacher accountability based on standardized testing. The neuroeducation movement − which is sharply focused on *how* children learn − works against this fixation on test scores (Hardiman et al., 2012, pp.138 & 142).

[168] The neoliberal ideology has its origins within the economic discourse, as it has been seen to denote economic principles related to effectiveness, market individualism, free trade, and market competition (Olssen, 2006). In recent years, however, the neoliberal ideology has experienced a renaissance amongst politicians and principles, because economic market-management has also been transferred to other areas such as medicine and education. This has led to a paradigm change in education, since neoliberal ideas of market individualism, privatisation, decentralisation, competition, efficiency, and accountability, focus on test results, and new public management has become more prominent in the 21st century's educational discourse (Karlsen, 2006). See chapter 7 for further analysis and discussion of relevant political texts.

Similarly, Choudhury and her co-workers (2009, p. 68) note that "scientists are working at a time of unprecedented politicization through commercialization of research", whilst Hruby (2012, pp. 17-18) claim that "educational neuroscience requires ... a commitment to preserving the integrity of its work against misuse by marketers, policymakers, and polemicists". Thus, after analysing texts in the hegemony corpora, one receives the impression that the discursive negotiation between the academic level of educational neuroscience and the public and political level is not a clear-cut struggle with two distinctive sides. First of all, one finds a struggle between what society at large *expects* from education and the nature of the educational enterprise. Secondly, one also finds a struggle over ideological perspectives *internally* within the academic educational neuroscience discipline. As these struggles touch on the next chapter's main topic of educational neuroscience's recontextualisation into public and political fields, only the most central aspects pertaining to hegemonic relations are presented in the following section.

Struggles concerning society's expectations of education

If we start by looking at struggles concerning policymakers and the public's expectations of education, it is argued that society's expectations of education rose after the introduction of the 'knowledge society' in the 21st century. Increased focus on human capital as a significant factor for individual and national success in the 21st century's global market has, accordingly, increased pressure on education. Many policymakers call for effective and high quality educational systems, business entrepreneurs claim that education systems do not produce enough highly skilled engineers, media broadcast PISA results demonstrate poor student performances and educational practitioners' lack of quality teaching strategies, and parents call for better teachers for their children's education[169]. Calls for high quality educational systems put pressure on educational communities, and one receives the impression that society's *expectations* of education have turned into political and public *requests* to raise the standards of education[170]. This is of interest to discursive hegemonic relations because it appears that society at large has gained a significant power dimension in educational discourse during the 21st century. By linking this tendency with the discourse of educational neuroscience, I argue that increased public and political attention to the educational system

[169] As argued by Pasquinelli (2011), and della Chiesa et al. (2009) from the hegemony corpora, and as shown by other authors such as Karlsen (2006), OECD (2007b), and VG (2013).

[170] These notions are underlined by findings from the recontextualisation corpora, as presented in chapter 7 and 8.

has put actors at the academic level of educational neuroscience in a rather ambivalent position in the struggle. On the one hand, it is often alleged by the public and policymakers that *education* and the educational system do not satisfy society's rising expectations for schooling in the 21st century's knowledge society[171]. On the other hand, however, it appears that *neuroscience* is perceived as a 'remedy' for reversing falling standards in education by crafting an 'evidence base for education' and a 'new learning of science'[172]. Consequently, the discipline of educational neuroscience appears to have taken centre stage in the social-political and neoliberal debate regarding education, through being suggested as an almost tailor-made solution for creating effective, evidence-based learning strategies for use in classrooms.

From a critical discourse theory perspective, there are a number of aspects concerning hegemonic relations and power dominion which are worth mentioning with regard to political and public interest in education. It can be argued that public and political actors have gained a significant degree of power when it comes to educational considerations during the 21st century (cf. Karlsen, 2006; OECD, 2007b). Accordingly, society's expectations for education appear to have more influence over the way in which education is organised and structured, which expectations teachers and school administrators strive to fulfil, and which educational values, ideas and ideologies are implicitly being suggested over others. Without going into the detail of these tendencies, it should be noted that the power possessed by political and public actors has certain implications. Education is an academic profession, which must consider numerous aspects concerning the individual as a learner, social aspects of learning, practical pedagogical strategies, curriculum edicts, and directives from school administrators and the national government. Education is therefore a complex social practice, which is liable to change in accordance with alterations in political ideologies, public values, and educational philosophies and ideas. I argue that there should be a power balance here, and that a hegemonic dominance where political ideologies and public requests impose too heavily on education, will reduce educational insights to trivialities. The education community − both practitioners and researchers − have valuable educational and pedagogical knowledge, and it is important that these voices do not become marginalised in the discourse. The education profession has expertise in educational and social thinking which can contribute to significant perspectives when shaping educational goals, whilst educational practitioners can help by

[171] As noted by Carew and Magsmen (2011) in the hegemony corpora and by other actors such as OECD (2007b).
[172] As seen demonstrated in the text by Pasquinelli (2011), Goswami (2008), and Ansari et al. (2012).

adjusting policymakers' and the public's expectations so that they are more in line with what is achievable in education. Together, this can contribute towards a more beneficial relationship between the public, policymakers, and the education profession. Considering that education, public expectations, and policymakers' requests is a significant aspect of educational neuroscience as well, the endeavour to turn these hegemonic struggles into a balanced dialogue is also highly relevant for the educational neuroscience discourse.

Struggles over ideological perspectives within the academic level

Related to the above, are the struggles one finds between different ideological orientations *internally* at the academic level of educational neuroscience. What becomes clear after analysing the hegemony corpora is that the use of neoliberal argumentation and demands for more efficient educational systems is not confined to actors within the public and political level of discourse − actors pertaining to the *academic* discourse also have traces of neoliberal rationalities in their argumentations. This is already evident both implicitly and explicitly in texts, for instance when the importance of educational neuroscience is stressed by arguing for 'more evidence base', 'new science of learning', 'effective teaching strategies', 'improved education policies and curricula', 'improved student results', and other similar neoliberal arguments[173]. One therefore finds a neoliberal ideological orientation amongst numerous actors within the academic level of the educational neuroscience discourse. However, even if many authors within the educational neuroscience discourse − deliberately or unintentionally − make use of neoliberal idioms in their argumentation, one can also find authors within the discourse who appear to take a stand *against* this market-political management ideology. Instead of arguing for more evidence-based and effective teaching strategies for improving students' learning outcomes, these actors emphasise the importance of 'the children as learners'[174]. The argument used is that educational neuroscience is concerned with the *process of learning* and this has to be acknowledged as a highly complex process: Not only should learning encompass individual neurobiological and cognitive aspects, the process of learning should also encompass societal, pedagogical, interactional, and ethical considerations of education.

[173] Seen in Carew and Magsamen (2011), Tommerdahl (2010), Pasquinelli (2011), Ansari et al. (2012), and Goswami (2008).
[174] As seen in Hardiman et al. (2012), and Hruby (2012).

I argue that this hegemonic struggle is highly significant and it is important for actors within the academic level of educational neuroscience to be aware of what this ideological struggle implies. By following neoliberal argumentation for 'effective teaching strategies', 'rigorous test regimes', and 'better student results'[175], we are at risk of submitting a one-sided version of *how* people learn, dominated by ideas around 'hard evidence' and 'science of learning'. Actors within educational neuroscience's academic level should therefore be careful not to take such reductionistic steps, because neoliberal argumentation has the potential to undermine central aspects concerning the more educational, social, human, and ethical side of the learning process. Moreover, considering that a majority of people within the academic level of educational neuroscience argue for a reciprocal collaboration between neuroscience and education[176], authors should be wary of which ideological orientation they (perhaps unintentionally), adopt. Based on my analytical findings I will argue that awareness of ideological orientation is particularly important, because there is confusion and hardly any negotiation over which ideological orientation should be held within the academic level of the educational neuroscience discourse. Some authors convey a 'taken for granted' notion that educational neuroscience adheres to the ideology of neoliberalism[177]; others convey the view that educational neuroscience holds an ideology more in line with socialisation and solidarity[178]; whereas others make no explicit claim of ideological orientation but nevertheless appear to have implicit ideological undertones which stray in different directions[179]. This implicit struggle and confusion over ideological positions suggests that the discourse of educational neuroscience has not yet settled on a clear ideological affiliation. These findings also suggest that ideological orientations have not yet received much attention, and ideologies relevant to educational neuroscience have therefore not been made an explicit site of debate and negotiation within the discourse. Bearing in mind the struggle to craft reciprocal collaboration between neuroscience and education, I consider it essential that actors within the academic level of educational neuroscience become aware of the subtle political and ideological struggle played out within the discourse.

[175] As seen in the texts by Carew and Magsamen (2010), and Pasquinelli (2011).
[176] As seen in Ansari et al. (2012), Greenwood (2009), Mason (2009), Christodoulou and Gaab (2009), Ferrari (2011), and Stein and Fischer (2011).
[177] As seen demonstrated in Carew and Magsamen (2010), and Pasquinelli (2011).
[178] As seen demonstrated in Hardiman et al. (2012).
[179] As seen in the texts by Tommerdahl (2010), Goswami (2008), and Ansari et al. (2012).

Summary of the discussion

This chapter has considered sites of negotiation and struggle, notions of power, dominance, marginalisation, and hegemonic relations related to the academic level of the educational neuroscience discourse. With reference to my critical discourse analysis of the hegemony corpora, three major sites of hegemonic struggles are identified. The first conflict is struggles fought out at different levels of analysis between neuroscience (the level of the brain), cognitive psychology (the level of the mind), and education (the level of behaviour and the social). The second site of hegemonic struggle is inconsistencies and conflicts between what educational neuroscience research demonstrates, how research is represented, and how these representations in turn are interpreted and understood. The third site is struggles between the academic level of educational neuroscience and political and public fields. The fact that there are hegemonic struggles within and between the academic level of educational neuroscience and other related fields, and the fact that these discursive issues and combats are unresolved and still up for negotiations means that the educational neuroscience discourse is, in other words, in a continual state of change.

Considering that educational neuroscience is a relative young discipline, hegemonic struggles are to be expected. In fact, I argue that negotiations are crucial in the work of establishing a discourse since these debates contribute to shaping the structure, organization, aim, values, practices, and knowledge of the educational neuroscience discourse. However, it must be remembered that the larger order of academic and societal discourses encompasses certain hegemonic relations, which easily can be conveyed into the academic level of the educational neuroscience discourse. Such hegemonic relations can for instance be found between the ‘harder’ natural sciences and the ‘softer’ social sciences, humanities and arts, between theory and practice, between representations and interpretations, between academic communities and the public and policymakers’ requests of academia, and also between neoliberal ideologies and other ideologies in the society. Even if these hegemonic struggles are an issue, since they readily can become naturalised and replicated within educational neuroscience’s discursive structures and regularities, I argue that there is indeed room for negotiations and resistance. The academic level of educational neuroscience has an advantage in its novelty, since the entire discourse is in a state of adjustment. Discursive representations, values, relations, and practices are continually being shaped by discursive transgression, re-articulation, and negotiations, and thus also *old* and institutionalised academic, philosophical, and societal 'ways of thinking' are open for debate. Instead of uncritically reintroducing old discursive conventions, which implicitly embody certain hegemonic relations, actors within the discourse of educational neuroscience should view these 'naturalised' discursive conventions with a critical eye. Our overall academic and societal discursive boundaries will ultimately confine the way in which we understand and perceive concepts pertaining to educational neuroscience, but I suggest that this is an opportunity for actors at the academic level to transgress old discursive boundaries for thinking. Take, for instance, the time-honoured boundary between the natural sciences and the social science found within the larger, academic, scientific and philosophic discourse. Will not this categorisation between natural sciences and social sciences restrict how we perceive disciplines such as education and neuroscience, and will not this categorisation also affect how we think about educational neuroscience? Bearing in mind the relentless hegemonic negotiations and struggles resulting from this scientific classification, one can indeed wonder if this way of representing reality offers the best possible way of thinking. In saying this, I do not argue that one should abandon all familiar ways of understanding scientific classifications. Rather, I suggest that certain inconsistencies and struggles fought over, for instance, educational neuroscience may be due to unprofitable and more deep-rooted discursive categorisations and structures within a larger academic and/or societal order of discourse. I think educational neuroscience has already made a major leap across discursive boundaries by linking neuroscience, cognitive psychology, and education, and this has been due to, and also contributed to, significant changes in the way we perceive aspects of nature, nurture, brain, mind, education, and learning. However, I will argue that critical thinking and constant caution as regards 'naturalised' and 'unprofitable' discursive representations can help to bring hegemonic relations of power up for negotiation in the educational neuroscience discourse.

Chapter 7

Recontextualisation over structural borders

Educational neuroscience is a growing international discourse within academia, but the topic is not restricted to the academic sphere alone − also other and external fields appear to have caught interest in the linkage between education and neuroscience. For instance have numerous policymakers and intergovernmental interest actors commissioned projects on the linkage of education and the brain (e.g. OECD, 2007a; TeacherNet, 2007; US Department of Education, 2010). There is in addition a growing body of media articles and pop-scientific books on the topic of learning, education, and the brain (e.g. BBC, 2013; The Guardian, 2004), and an array of commercialized 'brain-based' learning programs such as Brain Gym®, Brainboxx, and Starskills are promoted on the international market. Also video-game companies such as Nintendo (2014) have started to sell brain training games such as *'Big Brain'* and '*Brain Age: train your brain in minutes a day!',* and there has even become an international market for cognitive enhancers such as smart drugs and smart foods proclaiming to improve learning and memory (Nootropics: Smart Drugs, 2014). Considering that previous chapters have focused on the academic level of the educational neuroscience discourse, the following chapter will focus on how educational neuroscience also is in interaction with fields *outside* academia. The concept of *recontextualisation* is thus apposite, since this discourse analytical notion is concerned with how a discourse is distributed, internalised, re-articulated and *re*-contextualised within other fields (Chouliaraki & Fairclough, 1999; Fairclough, 2010). Aims in this chapter are, accordingly, to investigate how, where, and how extensive the academic level of educational neuroscience has become recontextualised over structural borders and into public and political fields. The chapter will first provide accounts of some general findings from the literature search and discourse analysis, before recontextualising principles and strategies are more thoroughly compared and discussed. Overall, this will contribute to an outline of how the academic level of educational neuroscience is interactively linked to other public and political fields.

Educational neuroscience recontextualised to public and political fields

A fundamental question for this chapter is whether or not educational neuroscience is distributed to other discourses. The answer to this question is '*yes*' and, indeed, it was quite obvious from the onset that my research findings would show traces where educational neuroscience is recontextualised over structural borders and into public and political fields. For instance did my different key word searches result in over 364 million hits related to educational neuroscience in the public internet search engine Google, where news articles, policy reports, blogs, governmental and organizational webpages, commercial learning programs and businesses, pop-scientific books and courses are featured[180]. The amount of texts related to education and neuroscience found in public spheres becomes even more apparent if one comperes these 364 million hits with the 123 000 hits showing in academic literature searches for the emergence and hegemony analysis (e.g. in academic library catalogues and Web of Science). Based on these findings it is evident that aspect from the educational neuroscience discourse are taken up by other social fields − findings which also concur with other authors such as Corballis (2012), Ritchie, Chudler, and Della Sala (2012), and O'Connor, Rees, and Joffe (2012). However, this general finding is not particularity informative by itself and questions which ought to be answered is *where* and *how extensive* educational neuroscience has become recontextualised to other areas: Which fields are significant when it comes to topics related to education and neuroscience outside the academic field? Is the linkage of education and neuroscience just a brief footnote to the academic sphere, or has this discourse been taken up more extensively within public and political fields? Findings from my literature search and critical discourse analysis indicate four areas in particular where educational neuroscience is recontextualised, namely:

- in brain-based educational products
- in the media
- amongst policymakers
- amongst intergovernmental organizations and other interest groups

These four areas are not exhaustive in showing traces of educational neuroscience, and other fields within the public and political field can also be relevant for a recontextualisation analysis. Nevertheless, the areas of media, brain-based learning industries, policymakers, and

[180] Most of the hits related to education and neuroscience in the public search engine *Google* are from year 2000 and onward, strengthening the hypothesis from the emergence chapter that the 1990s and 2000s are the decades where educational neuroscience became more firmly established as a discipline (and discourse).

interest groups appear to be of analytic value since together they cover a substantial proportion of the public and political domain. They also seem appropriate, since they frequently appear in my literature searches. Thus, I will focus my critical discourse analysis on these four defined areas in order to better analyse educational neuroscience's recontextualisation to the public and political level of the discourse.

Apart from noting where and how extensive educational neuroscience is recontextualised across structural borders, it is also interesting to investigate *how* this process occurs. How is educational neuroscientific articulated and set in relation to 'old' representations in new discourses? Is the new field colonized by the academic level of educational neuroscience, or do actors within these public and political fields actively adapt and make use of educational neuroscience within their own area? Which internalisation processes can be found and can traces of changes in discursive and social practices be found? The following sections will elaborate upon these questions, as analytical findings related to the recontextualisation process for the four topics of brain-based learning industry, media, policymakers, and other interest actors are presented. However, it must be noted that the ways in which these four groups represent educational neuroscience are likely to vary. This has already been indicated by the findings from my general literature search, as these results show not only that representations vary *between* groups, but also that representations of educational neuroscience differ *within* groups. A text from the media can, for instance, bear a closer resemblance to texts by policy actors than to other media texts, and vice versa. What this implies is that one should be careful to not to generalise across the group as a whole, because there are indeed similarities and variations within and between the four topic-areas. Nevertheless, the texts analysed appear to have some broader discursive similarities, and the first part of the analysis will therefore focus on some overall tendencies in the respective fields of brain-based learning industries, media, policymakers, and interest groups. Next, a comparison of the fields is provided, where particular attention is paid to how the discourse (and practices) of educational neuroscience are colonised and/or appropriated within each field. The last section provides more critical discussion of educational neuroscience's recontextualisation processes, as links are drawn between manifestation of ideological rationalities, texts, and discursive and social practice.

The brain-based learning industry

One of the areas within the public field to which educational neuroscience has been recontextualised is brain-based education. The scale of this dissemination can, for instance, be shown by the results from the general internet search conducted, which gave a total of 287 million hits with the specific key word combination of 'brain-based learning' and 'brain-based education'. It can further be noted how the field appears to have grown substantially during the last decades, and even the 'brain-based education' label appears to encompass an array of different texts − covering everything from educational theories based partly or entirely on neuroscience, to educational material and products more loosely inspired by principles related to neuroscience (Sylvan & Christodoulou, 2010). Here, I will investigate the area often referred to as the 'brain-based learning industries' and thus Sylvan and Christodoulou's (2010, p. 2) definition of *brain-based educational products* is appropriate, since this sub-categorisation of the brain-based education 'brand' focus on "products [that] are generally available for purchase and marketed toward educators with claims of explicit connections between the program and neuroscience". Based on this definition, a literature search was conducted and a total of six brain-based learning industries and their respective educational programs were chosen for the critical discourse analysis − namely Brainboxx (2014), Brain Gym® (2014), Starskills (2014), Scholastic (2014), Kagan (2014), and LearningRx (2014)[181].

When it comes to the question of *how* the brain-based learning industries represent, incorporate, and recontextualise the educational neuroscience discourse, the first thing to be noted is that these brain-based educational programs make a point of stressing that their programs and learning techniques are based on science (particularly brain science), and 83 per cent of the texts use phrases like "research has shown", "compelling brain research concludes", and "brain science proves that ..."[182]. A second and related finding from my analysis is that a majority of the brain-based educational programs tend to represent neuroscientific and educational research rather generally, simplistically, and/or out of context, while the learning techniques themselves are meticulously explained[183]. The 'brain based'

[181] It must be noted that I do not intend to evaluate the educational and neuroscientific validity of these six brain-based educational programs *per se*, since my focus of attention is to critically analyse *how* these commercialized programs recontextualise the educational neuroscience discourse within their field.

[182] As seen demonstrated in Brainboxx (2014), Brain Gym® (2014), Starskills (2014), Kagan (2014), and LearningRx (2014).

[183] Seen in Brainboxx (2014), Brain Gym® (2014), Scholastic (2014), Starskills (2014), Kagan (2014), and LearningRx (2014).

aspect, which these programs advertise, is, in other words, vaguely expressed or entirely sidestepped. The following extract from Kagan illustrates this:

> Compelling brain research concludes that music has the power to reduce stress, enhance cognitive functioning, and improve productivity and creativity. The human brain is an amazing instrument that can be tuned to perform optimally with the right kind of music. **Music for the Mind™** is a collection of beautifully-orchestrated compositions that resonates with listeners of all levels, enhancing mental performance (Kagan, 2014).

In this extract from Kagan's educational product *Music for the Mind™,* brain research is used to justify the effect of music on mental performance. However, no references to cognitive neuroscientific or educational neuroscientific research are offered, and no explanation of the exact reason *why* music can enhance cognitive functions is presented. Even if it is stated elsewhere in the webpages that "music at 60 beats per minute such as the *Music for the Mind* series and the *Brain Boosters* series helps calm and focus students" (Kagan, 2014), the exact neuroscientific basis for Kagan's "brain boosting music" is general and sparse. A similar and perhaps more convincing 'brain based' explanation is found in the text by LearningRx. The webpage to this brain-based learning program has an appealing and high-quality appearance to it, flourishing with fancy brain images, and the argumentation behind LearningRx's brain training program gives the impression of rather accurate representations of educational neuroscientific research:

> The brain's ability to adapt and grow − reorganizing neural pathways and even creating new ones − is called "neuroplasticity". Neuroplasticity is the science behind brain training and the basis of each of the LearningRx Brain Training programs ... LearningRx brain training exposes each student to a customized series of intense mental workouts. To perform these workouts, the brain is forced to strengthen, reorganize and even create new neural pathways. In other words, brain training "rewires" the brain to perform more efficiently than ever before (LearningRx, 2014).

The problem is that these educational neuroscientific representations are taken from a much more complex scientific context, providing only a rather general presentation of the concept of neuroplasticity and learning. This general presentation of educational neuroscience further makes it possible for LearningRx to jump straight to a specific recommendation of their brain training program − seemingly without any contradiction to the concept of neuroplasticity. If one consults more scientifically-sound literature on neuroplasticity and learning, however, a different picture emerges. It is generally accepted within neuroscientific and educational neuroscientific communities that learning and neuroplasticity are related, because learning involves changes in the patterns of neural connectivity – whether involving synaptic strengthening (or weakening) between neurons, or even development of neural connections through the growth of synapses and/or axons (Blakemore & Frith, 2005a; Gazzaniga et al., 2009). What is also accepted, but is missing from LearningRx's explanation, is that changes in patterns of neural connectivity can occur due to different kinds of experience and can lead to short-term or long-term changes (Gazzaniga et al., 2009). What this implies is that various experiences − such as navigating a taxi in a big city (Maguire et al., 2000), playing video-games (Owen et al., 2010) or learning how to juggle[184] (Draganski et al., 2004) − can lead to changes in neural connectivity. How long these changes last varies depending on training and further practising of the skill, because unexploited neural pathways often undergo synaptic weakening and 'pruning' in order to cut back on infrequently used connections[185] (Blakemore & Frith, 2005a). Moreover, changes in neural connections are often task-specific, meaning that neural changes due to, for instance, juggling will mainly lead to changes in task-specific brain regions such as areas associated with storage and processing of complex visual motion (Draganski et al., 2004). This implies that LearningRx's claim that their brain training programs "rewire the brain to perform more efficiently than ever before" is misleading, since the same also can be said of juggling, navigating a taxi, learning to knit, flying a kite, or playing a video-game. Brain training may indeed lead to changes in neural connections, but the essential question is whether these programs lead to long-term changes, and whether efficiency benefits in one specific brain area can be translated into other, dissimilar tasks, or lead to improved general cognitive functions (Owen et al., 2010; Ritchie et al., 2012). Considering that LearningRx (2014) does not offer any scientific evidence of long-term and improved cognitive functions beyond the training tasks, their promise that "brain training physically reorganizes neural pathways, creating faster, smarter brain for a lifetime!" appears to be unwarranted.

Another finding from my critical discourse analysis is that much of the science represented in brain-based educational programs is presented as 'facts' and 'truths'. The brain-based learning texts thus suggest that 'this is just how it is'[186]. Such suggestions can, for instance, be seen in statements using vocabulary with non-modalised assertions and

[184] Draganski and colleagues (2004) found that individuals who learned how to juggle showed structural changes (bilateral expansion in grey matter) in brain areas associated with storage and processing of complex visual motion. The changes were however selective and passing, because after three months without practicing juggling the grey matter in these respective brain areas had decreased.

[185] This process is captured by the phrase 'if you don't use it, you lose it', although, it must be stressed that this phrase may be misleading, because weakening of synaptic connections are important parts of natural brain development and learning throughout our lives (Bruer, 1999; Gazzaniga et al., 2009).

[186] As seen in Starskills (2014), Scholastic (2014), Kagan (2014), and LearningRx (2014).

assumptions that leave no room for other possibilities (cf. Fairclough, 2003), as exemplified by the following quote from Scholastic:

> [O]ur own "neurological style" influences the way we teach. Each one of us has a left-, a right-, or a middle-brain preference ... For instance, if you are right-dominant, it is your intuitive, emotional right hemisphere that guides the decisions you make throughout the day. If you are left-brain dominant, it is your sequential, time-oriented left hemisphere which tells you how to think, what to believe, and what choices to make (Scholastic, 2014).

Modalised markers − such as 'neurological style *may* influence the way we teach' or 'each of us *can* have a left-, a right- or a middle-brain preference' − leave statements open for dialogue and alternative perceptions on the matter (cf. Fairclough, 2003). When Scholastic chose to exclude such modalised markers, however, they convey the idea that 'this is just how it is' by simply taking the assumption of a left-, right-, and middle-brain style for granted. What further makes this non-modalised statement problematic is that the educational neuroscientific 'fact' that is established is in fact a *neuromyth.* Even if our brain can be anatomically categorised into a left and a right hemisphere, it is commonly agreed within the educational neuroscientific community that one cannot talk of hemispheric dominance in people. This is because we make use of numerous parts of the brain simultaneously when we perform cognitive tasks, and not just parts allocated to one of the hemispheres (Alfernik & Farmer-Dougan, 2010; Corballis, 2012; Gazzaniga et al., 2009; Geake, 2008; Howard-Jones, 2010; Ritchie et al., 2012). To categorise people according to statements of left- or right-brain learning styles is therefore an overly simplistic representation of neuroscientific research.

All brain-based educational programs analysed in this study, as the examples above illustrate, represent educational neuroscientific research generally, simplistically, out of context, as 'undisputed facts', and/or inconsistently with representations of research at the academic level of educational neuroscience discourse[187]. Lack of scientific evidence to support their educational programs is also evident in all the texts analysed, and thus the entire brain-basis of these businesses becomes dubious. In order to counteract this, though, it appears that actors in this field use a strategy of presenting simplistic scientific explanations and/or using non-modalised vocabulary. A common tendency in all programs analysed is for instance a jump directly from an *(educational) neuroscientific statement X* to the *effects of a learning program Y*, but this is done without providing an accurate explanation for why the

[187] Seen in Brainboxx (2014), Brain Gym® (2014), Scholastic (2014), Starskills (2014), Kagan (2014), and LearningRx (2014).

brain-based educational program is effective[188]. Considering these rather vague, simplistic, and incoherent links to brain science, one can further suggest that it is difficult for users to see precisely which aspects of the learning program are (supposedly) based on neuroscience and whether or not this neuroscientific basis is in agreement with representations found in educational neuroscientific research communities.

Considering that sound scientific evidence for brain training programs is difficult to come by (Owen et al., 2010), then why does this industry still choose to promote their programs as being *based in brain science*? Why does this field have an interest in educational neuroscience, what appears to be the motive behind the incorporation of educational neuroscience, and who do brain-based learning industries attempt to reach with their programs? Findings from my analysis indicate that a motive for incorporating educational neuroscientific representations into these programs is to sell a product[189]. All six texts analysed appear to use a 'brain-base' in order to gain credibility for the product they are selling − whether brain-friendly teaching tools, books, DVDs, brain-boosting music CDs, personalised brain trainers, or courses with tuition fees up to $ 650. These agents' interest in educational neuroscience therefore appears to be a commercial one, because they all seek to make a profit by selling products. When it comes to *who* the brain-based learning industry targets, I will argue that a chief audience is *teachers* and *parents.* This is evident in statements such as "Teaching is so much easier and more successful when you do it the brain-friendly way ... Become a brain-friendly teacher with these tools, tips, and structures!" (Kagan, 2014), "If your child is experiencing recurring struggles with grades, reading, homework, or attention, you need a brain trainer" (LearningRx, 2014), and "Starskills provides quality early learning resources for educators of babies, toddlers, pre-schoolers, Kindy and K-3 children" (Starskills, 2014). It thus appears that the industry's interest in educational neuroscience is to use it to construct a seemingly 'valid' brain-basis to help sell learning products to teachers and parents.

Other significant findings relate to how the brain and children/individual's learning are represented in brain-based programs. All texts suggest that one can optimise the brain just by being exposed to the right kind of stimuli − whether VAK learning styles or brain-boosting music[190]. This is also apparent in Brain Gym® (2014), when they claim that their 26 Brain

[188] Seen in Brainboxx (2014), Brain Gym® (2014), Scholastic (2014), Starskills (2014), Kagan (2014), and LearningRx (2014).
[189] As seen in all of the 'brain-based' learning text, as referred to in the previous footnote.
[190] As seen in Brainboxx (2014), Scholastic (2014), Starskills (2014), Kagan (2014), and LearningRx (2014).

Gym® movements will "often bring about dramatic improvements in areas such as: concentration and focus, memory, academics [such as] reading, writing, math, test taking" (Brain Gym®, 2014). Stimuli recommended by Brain Gym's 'learning through movements' program include crawling, yawning, drawing symbols in the air, pushing so-called 'buttons' on the body, and doing the thinking-cap movement, described here by Khalsa, Morris, and Sifft (1988) and Sifft and Khalsa (1991)[191]:

> *Positive points:* The positive points are neurovascular holding points on the frontal eminences found halfway between the eyebrows and the hairline. When lightly held, by oneself or another, these points are thought to be helpful to repattern conditioned responses to emotionally charged thoughts about people, places, memories, tasks, and environmental factors (Khalsa et al., 1988, p. 54).
>
> *Thinking cap:* Individual gently unrolls the folds of the outer ear three times from top to bottom (Sifft & Khalsa, 1991, p. 1013).

Cognitive enhancement stimuli suggested by the different brain-based learning programs all appear to be rather easy-to-do activities[192]. Simple learning techniques − where it is promised that 'pushing brain buttons' and listening to 'brain-boosting music' will optimise cognitive functions − can understandably be seen as tempting selling points for learning programs. The problem, however, is that these representations reduce complex cognitive learning processes to simplistic activities. What my discourse analysis shows is that the individual as a whole tends to be conflated to his or her brain[193]. The brain is also frequently presented as something mechanical, objectified and almost separated from the child/individual (see table 7.1). Notably, this view of the individual−brain relation often co-occurs with views that it is parents' or teachers' task to improve children's brains[194]. This can be seen in statements such as "we can actually *grow* better brains in our children" (Kagan, 2014), "Starskills will help parents and educators to *activate* your child's cognitive development" (Starskills, 2014), and "...helping educators *create* more cooperative, interactive classrooms that *produce* smarter, more caring and cooperative students" (Kagan, 2014) [my italics]. These tendencies are discussed in more detail later in the chapter, but for now it should be noted that such presentations conveys rather simplistic ideas of the brain, the individual child, and the learning process.

[191] The developers of Brain Gym® own the copyright for the Brain Gym movements, preventing me from describing them in detail. Thus, the report from Khalsa et al. (1988) and Sifft and Khalsa (1991) is used to illustrate some of the activities.
[192] Seen in Brainboxx (2014), Brain Gym® (2014), Scholastic (2014), Starskills (2014), Kagan (2014), and LearningRx (2014).
[193] As seen in Scholastic (2014), Kagan (2014), and LearningRx (2014).
[194] As seen in Brain Gym® (2014), Starskills (2014), Kagan (2014), and LearningRx (2014).

Table 7.1: Examples of how brain-based learning industries represent educational neuroscience [my italics].

Representations where the individual is conflated to his/hers brain	**Representations of the brain/cognition as something mechanical, objectified or detached from the individual**	**Representations regarding children's learning, success, and parents responsibility to ensure this**
"Dr. Kagan's extensively-researched book distils the world of brain science into 6 essential principles that will align your teaching with how your students' *brains* naturally learn ... When we understand how brains best function, we can align how we teach with how *brains* best learn" (Kagan, 2014). "[T]eaching is generally a delightful experience when we focus on activities that students' *brains* enjoy doing" (Kagan, 2014). "Brain training physically reorganizes neural pathways, creating a faster, *smarter brain* for a lifetime!" (LearningRx, 2014). "If you are left-dominant, *it is your* sequential, time-oriented *left hemisphere which tells you how to think*, what to believe, and what choices to make" (Scholastic, 2014). "Train the *brain*. Get smarter" (LearningRx, 2014). "With over 200 sports, games, activities, and energizers, they [Kagan's learning games] vary greatly. Many are *brain breaks* you can use in the classroom" (Kagan, 2014).	"Train the brain. Get smarter" (LearningRx, 2014). "[W]e can actually *grow* better brains in our children" (Kagan, 2014). "Starskills will help parents and educators to *activate* your child's cognitive development" (Starskills, 2014). "The human brain is an amazing instrument that can be tuned to perform optimally with the right kind of music" (Kagan, 2014). "Don't "settle" for the brain you think you were born with. Whatever your age or situation, you really can experience the life changing benefits of a faster, smarter brain" (LearningRx, 2014). "[T]his assessment will give you a detailed look at what's going on in your child's brain" (LearningRx, 2014). "Brain Buttons: This free brain exercise increases blood flow to the brain. The extra blood flow, the extra water, *switches the brain ON*, improves attention required for learning & performing" (Brain Gym, 2014). "... how to *boost* your child's intelligence by creating a home environment conductive to learning" (Kagan, 2014). "He [Dr. Kagan] has dedicated his life's work helping educators *create* more cooperative, interactive classrooms that *produce* smarter, more caring and cooperative students" (Kagan, 2014). "The tracks on each CD are selected and arranged specifically for their tempo and composition too boost brainpower and promote peak performance" (Kagan online, 2014).	"LearningRx brain training − done one-on-one in a coaching environment − raises IQ by an average of 15 to 20 points, which statistics link to higher salaries. In fact, a study by the US Department of Labor Statistics showed that a gain of even 10 IQ points can result in a $ 9,000 to $18,000 increase in annual earning ... LearningRx brain training is proven to increase IQ by an average of 15 points or more. That means for every dollar spent on brain training, there's a return of $127 over a client's lifetime" (LearningRx, 2014). "The Starskills 40 Weeks Program is designed for children aged 0-5. It is a weekly program that provides a literacy and numeracy introduction and focus ... After nearly 50 years of research, there is evidence − both quantitative (data-based) and qualitative (reports of parents and teachers) − that early intervention increases the developmental and educational gains for the child, improves the functioning of the family, an reaps long-term benefits for society" (Starskills, 2014). "*Raising smarter children* − creating an enriched learning environment. There are many ways to be smart. And there are many ways to enrich your home to develop your child's multiple intelligence ... [W]e will focus on how to boost your child's intelligence by creating a home environment conductive to learning. Think of it as *Feng Shui* for the brain" (Kagan, 2014). "If you are missing some resources in the key categories of intellectual development, you may want to take this imbalance into consideration as you select your next gift or plan *your next investment in your child's education and brain development* (Kagan, 2014). "Starskills is unique in that it aims to make the most of these CRITICAL times of learning for children to give children the start they need to set them on the road to success" (Starskills, 2014).

The media

Another area to which educational neuroscience is recontextualised is the media. In order to find media texts with a significant readership, I focus on texts from some of the largest newspapers in the UK and USA. Accordingly, target-specific searches and following of reference cues for news stories related to education and neuroscience were conducted across international media agencies such as BBC, The Times, and The New York Times. The wide dissemination of educational neuroscience can be seen from internet searches on (e.g.) 'education, neuroscience', which produced over 6 500 hits directly related to news articles in the media[195]. Based on my literature search related to the recontextualisation of educational neuroscience, a total of ten media texts were selected for critical discourse analysis (see appendix B-D).

What first can be noted concerning the ways in which media represent educational neuroscience is that journalists also stress that their texts are based on science (particularly brain science)[196]. Findings further indicate that neuroscientific and educational neuroscientific research is simplistically and generally represented in 70 per cent of the media texts[197]. The use of generalisations and simplistic accounts may not be surprising, considering that media articles often have a limit of only one or two pages, and the story thus has to be short and to the point. Nevertheless, this lack of explanatory scientific accounts is problematic, because journalists can easily end up twisting or quoting research out of context and thus create representations inconsistent with common understandings at the academic level of educational neuroscience. This can occur when journalists leap from a scientific hypothesis to faulty conclusions. Where educational neuroscientific explanations are sparse and no reference to original scientific research is offered, it can also be difficult for readers to spot inadequate interpretations of scientific research. As an illustration of representations not in line with those found at the academic level, the article *'How music can boost your child's brainpower'* states:

> [N]euroscience is now proving [that] music gives a child's brain a massive boost, and it appears to be the only activity that can actually increase their biologically determined IQ ... especially if it's done between birth and seven years old. This is the period when the brain is at its most malleable − what

[195] Additional literature searches with different key word combinations, such as 'classroom, learning, brain, neuroscience', further increased the number of hits relevant to the topic.

[196] As seen in BBC (2013), Carey (2009), Carlyle (2014), Hammond (2013), James (2014), Jha (2012), The Guardian (2004), Whipple (2012), and Wighton (2007).

[197] In BBC (2013), Carlyle (2014), James (2014), Jha (2012), The Guardian (2004), Whipple (2012), and Wighton (2007).

> scientists call “plastic” − when neural connections and pathways are being made for the future. Like most parents, my wife Clair and I didn’t want to be pushy with musical instruments for our five children ... But now I’ve looked at the research I realise we really should have been making them play piano in their nappies − 7, when they are ready to hold an instrument, is almost too late for the cognitive benefits of music to work their magic (James, in The Times, 2014).

Based on neuroscientific research which ‘proves’ that music increases children’s ‘biologically determined IQ’, James argues for early music training for 0-7 year olds and that music should be a compulsory subject in the educational curriculum (James, 2014.). I argue, however, that too hasty conclusions are drawn in this media article[198]. Even if some researchers have shown that there is a correlation between significant music training (such as playing the violin) and structural changes in the organization of the human brain (Elbert et al., 1995; Hutchinson, Lee, Gaab, & Schlaug, 2003; Schlaug, Jäncke, Huang, Staiger, & Steinmetz, 1995)[199], I doubt that any scientists would readily say that they have proven a link between early music training and increase of biologically determined IQ. Firstly, both the word ‘proof’ and the phrase ‘biologically determined IQ’ are expressions most authors within the educational neuro-science discourse would avoid. This is partly because ‘proof’ and ‘determined’ denote a strong degree of absoluteness, which many educational neuroscientists are cautious in claiming. Caution is also necessary because concepts of IQ and intelligence are often perceived more as a social construct, rather than a single process or faculty which biologically determines an individual’s intelligence, as distinct from other human faculties such as learning and memory (Mackintosh, 2011). Secondly, whilst numerous researchers have found changes in the human brain due to music training, these are often changes in cortical organization that reflect our nervous system’s plastic ability to acquire and retain a new skill (Gazzaniga et al., 2009). Changes in cortical organizations and larger cortical areas do not, however, automatically imply ‘increased IQ’. Thirdly, this media article suggests that music training early in a child’s life − i.e. before the age of seven and preferably ‘when they still are in their nappies’ − also refers to the issues of early training, critical periods, and enriched environment. Within the educational neuroscientific research community there is a common consensus that the notion of ‘critical periods’ in a child’s cognitive development has inspired

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[198] Considering that James does not list any scientific references, it is difficult to know exactly where he gets his assertions from – the following evaluation is therefore based on selected literature from the educational neuroscientific community.

[199] The study by Elbert et al. (1995) on violin players found that these musicians had a larger cortical area dedicated to representing sensations from the fingers than non-musicians. The size of the cortical representations did also seem to be larger for those who began training before the age of 12 years. Structural changes in the brain were also noted by Schlaug et al. (1995), when they found that professional musicians who had begun musical training before the age of 7 had larger anterior corpus callosum than non-musicians. The researchers further suggested that the data indicate a difference in interhemispheric communication and a possible hemispheric asymmetry of sensorimotor areas.

spurious recommendations for early training and enriched environment (Anderson & Della Sala, 2012; Blakemore & Frith, 2005a; Howard-Jones, 2010). Indeed, there is a common agreement amongst educational neuroscientists that synaptogenesis and synaptic pruning (i.e. the making, strengthening, and weakening of synaptic connections) occur in the early period of a child's life. But this early time is commonly understood as a time of *sensitive* periods (not critical periods) in a child's cognitive development. This means that there appear to be subtle alterations in the brain's ability to be shaped by environmental factors, and thus there may be some optimal phases for a child to learn certain aspects and skills (such as playing the piano). Rather than closing windows of time where a skill has to be learned, however, these phases are flexible and one can also learn such skills later in life − but perhaps with a bit more effort (Anderson & Della Sala, 2012). It can therefore be argued that calls for early learning and enriched environment in order to ensure that children do not miss any 'critical' periods of learning are (scientifically speaking) unwarranted recommendations. Additionally, educational neuroscientific work has never conclusively demonstrated the beneficial effects of *enriched* environments, but has shown that *deprived* environments and lack of stimulation can have negative effects on cognitive development[200]. Any child brought up in normal conditions will encounter the necessary experiences for optimal learning (such as learning to speak a language), because our social environment provides us with the stimuli we need to interact with our social world (Anderson & Della Sala, 2012; Blakemore & Frith, 2005a; Howard-Jones, 2010). Overall, it can therefore be argued that this media article − which recommends parents to teach children 'in their nappies' to play a music instrument since this will increase a child's 'biologically determined IQ' − includes representations out of line with the views of the academic community of educational neuroscience.

As well as generalising and quoting research out of context, my findings also show that many journalists construct their texts as if they are 'neutral reports' which merely echo what researchers themselves say. Journalists frequently use phrases such as 'neuroscientists say', 'brain imaging reveals', 'neuroscience is now proving' or, as in these two statements:

[200] The research upon which much of the 'hysteria' for enriched environment and early learning is based, is studies by Diamond et al. (1987) and Greenough, Volkmar, and Juraska (1973) where it was showed that rats in enriched environments had better cognitive development than rats raised in deprived environments. A number of issues arise when one transfer these results to children, though. Firstly, these studies were conducted on *rats* and can thus mainly say something about rats' environments and cognitive development. (It would be unethical to conduct similar studies on human participants, particular children). Secondly, the deprived rat-group in these studies were in cages with no stimulations whatsoever, whilst the so-called 'enriched' environment were fabricated laboratory settings which by no means were more 'enriched' than rats' natural habitat in the wild. These studies therefore say more about the effects of *deprived* environments on cognitive development and learning, rather than effects of enriched ones (Howard-Jones, 2010).

"Intensive exercise improves the academic performance of teenagers, according to new research" (BBC, 2013), and "The larger the canvas, the more it develops the creativity side of the brain, especially in scholarly children, according to Professor Joan Freeman" (Carlyle, 2014). It appears that journalists protect themselves by using these (seemingly) neutral formulations, because this strategy helps to shift the responsibility of the statement over to the scientist rather than the journalist − after all, it is not the *journalist* who claims that drawing on larger canvases develops the creative side of the brain, but the scientist. Moreover, this strategy not only makes it possible for journalists to hide behind 'what researchers say'; frequent references to science also add scientific validation and a notion of 'authority' to media stories. What complicates the matter further is that journalists often seek sensational stories with attention-grabbing headlines, and thus rather far-fetched studies may be promoted. A text illustrating this is '*How to boost the brain*' by Wighton published in The Times in 2007. With reference to the looming exam period for students taking GCSEs, A levels and university finals, Wighton (2007) presents research which shows "the best ways to increase intelligence". In addition to tips such as "feed your brain [with] omega-3 fatty acids", "the smell of lavender boosts concentration", "say yes to smart drugs" and "a cup of cocoa before bedtime boost your IQ", one can also find references to the beneficial effects of chewing gum:

> Chewing gum seems to improve people's memory and ease exam stress, say researchers at Reading University. The study based on 75 people found that those who chewed gum performed better on memory tests than those who did not. Another study, at Texas University, shows that the marks of students allowed to chew gum were on average three per centage points higher compared with those who did not. Some studies suggest that chewing gum can increase blood flow to the brain by 25 per cent (Wighton, 2007).

Throughout this media story there are numerous research references, which, on the face of it, support the 'brain-boosting activities' presented. The scientific validity of these studies can, however, be disputed. Take, for instance, the claim that chewing gum improves people's memory. This idea appears to have it basis in studies on chewing gum and cognitive skills, like the one by Wilkinson, Scholey, and Wesnes (2002). Numerous researchers have attempted to modify or replicate the original studies (Baker, Bezance, Zellaby, & Aggleton, 2004; Tucha, Mecklinger, Maier, Hammerl, & Lange, 2004), whilst other authors working at the interface of neuroscience and education have been more critical to claims related to gum-chewing and cognition (Allen, Norman, & Katz, 2008; Ritchie, Chudler, & Della Sala, 2012; Smith, 2009). Findings from these studies on the cognitive effect of chewing gum are, however, inconclusive. Some researcher found no effects of chewing gum on memory tasks (Allen et al., 2008), whilst findings from other studies suggest that chewing gum increase jaw activity which, in turn, may increase blood flow to the brain (Onozuka et al., 2002), but there is disagreement if this further leads to enhanced cognitive cognition. Inconclusive findings notwithstanding; it has been noted by Ritchie et al. (2012) that none of these studies are conducted *outside* a laboratory context and that none of them assess the effects of chewing gum on *children's* learning. The scientific validity of the beneficial effects of chewing gum and improved learning in students can therefore be deemed dubious.

My findings also show that non-modalised articulations and assumptions are frequent in media presentations of topics related to educational neuroscience. This strategy can, as previously noted, close texts from dialogue, because non-modalised vocabulary leaves no room for other possibilities and thus creates the impression that the representations are indisputable facts (cf. Fairclough, 2003). Compared to brain-based learning industries, though, these journalists are more moderate in their use of non-modalised markers − a tendency amongst media texts is usage of non-modalised words in the headline and abstract, before presenting a more moderated and nuanced picture throughout the article[201]. This can be demonstrated by The Times article ‘Pre-school learning *gives* teenage brains a boost’, where it in the abstract further is stated that “Pre-school children who visit the zoo and have access to books and other cultural activities *have* more developed brain as teenagers, scientists said yesterday’ (Whipple, 2012 [non-modalised words in italics]). The text recites a study concerning the early years of children and their cognitive development, where children are revisited at age 18 in order to measure the thickness of different parts of their brains. It is then stated that children who had more intellectual stimulation early in their lives (aged four) had thinner cortex as teenagers “− implying, perhaps counterintuitively, it was better developed” (Whipple, 2012). Only in the last paragraph is another, and more cautious, account presented, as it is noted that “Bruce Hood ... said the research was interesting, but he would like to see more evidence of a knock-on effect in behaviour and intelligence aged 18, rather than just physical brain size” (Whipple, 2012). The view presented by Professor Hood is a significant aspect with relation to educational neuroscience's academic level, because it reflects a more nuanced and cautious view on the correlation between brain size and intelligence (Hood, 2014). What is noteworthy, though, is how this perspective is only acknowledged by a brief insertion at the bottom of the media article. Consequently, a significant and much more

[201] As seen in BBC (2013), Carlyle (2014), Jha (2012), The Guardian (2004), Whipple (2012), and Wighton (2007).

cautious aspect related to environmental, genetic and epigenetic factors in cognitive development and intelligence is neglected from media's presentation. Even more significantly, with respect to lack of cautious perspectives, is that no references are made to the academic educational neuroscientific literature, which warns about overly simplistic presentations of young children's cognitive development, frenzy for 'critical' periods and, as previously argued, unwarranted recommendation of enriched environment (cf. Anderson & Della Sala, 2012; Blakemore & Frith, 2005a; Howard-Jones, 2010). What is problematic with such unbalanced presentations in the media, I will argue, is that catchy headlines and simplistic accounts of learning and the brain are given more salience than nuanced and more scientifically based representations of educational neuroscience.

My findings also show how certain 'catchwords' and phrases reappear amongst media texts. This notion of intertextuality − i.e. that texts builds upon other texts (Fairclough, 2003) − can be seen in how the brain, the individual/child, and the process of learning tend to be presented (see table 7.2). The phrase 'brain boost' is used by 60 per cent of the media texts analysed[202], references to the brain and IQ/intelligence occurs in 50 per cent[203], and the catchword 'brainpower' is found in 40 per cent of the articles[204]. Apart from intertextuality in the form of explicit words, one can also find recurrences of certain expressions that convey rather incongruous perspectives of the brain, the child, and the learning process, such as phrases where characteristics of the individual as a whole are conflated to his or her brain[205]. Another frequent representation is of the brain and/or cognition as something objectified − a mechanism which can be 'boosted' or 'empowered' to 'generate' higher IQ and cognitive benefits just by the right kind of food, hobbies, music, or other environmental stimuli[206]. This can also be linked to media audiences, as many media texts communicate to parents and/or learners[207]. An illustrative example is Carlyle's article *'10 fun ways to boost your child's brain power'* in The Times (2014), where parents are encouraged to make their children try "IQ-enriching hobbies" such as playing the violin, running, playing with gender-opposite toys, cooking, or playing video-games such as Grand Theft Auto[208]. These activities will, arguably, "produce shiny, happy children" and can "generate often surprising cognitive benefits" (Carlyle, 2014). Expressions like these are noteworthy since perhaps

[202] As seen in BBC (2013), Carlyle (2014), Hammond (2013), James (2014), Whipple (2012), and Wighton (2007).
[203] As seen in Carlyle (2014), Hammond (2013), James (2014), Whipple (2012), and Wighton (2007).
[204] As seen in Carlyle (2014), Hammond (2013), James (2014), and Wighton (2007).
[205] As seen in Caryle (2014), Jha (2012) and Whipple (2012).
[206] As seen in Carlyle (2014), James (2014), The Guardian (2004), Whipple (2012), and Wighton (2007).
[207] As seen in Carlyle (2014), Hammond (2013), James (2014), The Guardian (2004), Whipple (2012), and Wighton (2007).
[208] A video game which has received particular attention and critique for being a too violent and controversial action game for kids.

unintentionally, they over simplify the complexity of the brain, the individual child and the learning process.

Almost every media article analysed (80 per cent) seems to present neuroscience and/or education simplistically, out of context, or inconsistently, compared to representations found at the academic level. They also have few, if any, complete references to original scientific research[209]. Journalists are more likely to refer to other media texts (often within the same media agency), rather than referring to primary scientific sources. A problem when journalists 'borrow' from other media texts is that stories can move further and further away from the original source, and thus the likelihood of misinterpretation of scientific findings increases. Consideration of some phrases within a chain of media texts (connected by their references to one another) can reveal the ways in which journalists end up twisting statements. A case in point involves two New York Times articles from the literature search, where the title *'How exercise could lead to a better brain'* (Reynolds, 2012, 18 April) has ended up in the spin-off headline *'Jogging your brain'* (Parker-Pope, 2012, 20 April). The former title is a more modalised representation, whereas the latter spin-off title is closer to absurdity than anything else − surely, you cannot go out 'jogging your brain' like you go out walking your dog.

The media thus convey some rather unscientific representations of educational neuroscientific concepts, and one might think that the number of media presentations inconsistent with the academic level would decrease in accordance with time of publication − the newer the article, the more we have come to know about the linkage of education and neuroscience, and hence there should be fewer misrepresentations. However, it appears that the time of publication, whether 2004 or 2014, does not correlate with the scientific accuracy of the media articles. It should also be stressed that, even if most of the texts analysed have inaccurate scientific representations of educational neuroscience, there are some media articles with a more critical, nuanced and cautious representation[210], particularly is the article '*Beware 'brain-based learning'* in The Times (S. Rose, 2013), in line with educational neuroscience's academic level. Ironically, this article is not written by a journalist but by a professor in neuroscience − a note which may explain the scientific accuracy of Rose's representation of concepts related to educational neuroscience. Nevertheless, and based on my

[209] BBC (2013), Carey (2009), Carlyle (2014), James (2014), Jha (2012), The Guardian (2004), Whipple (2012), Wighton (2007).
[210] As seen in Hammond (2013) and S. Rose (2013).

findings, many media texts appear to incorporate and recontextualise the academic level of educational neuroscience in order to create and 'sell' a sensational story to their readers.

Table 7.2: Examples how the media represents educational neuroscience [my italics].

Representations where the individual is conflated to his/hers brain	Representations of the brain/cognition as something mechanical, objectified or detached from the individual	Representations regarding children's learning, increase of intelligence, success, and parents/the learners responsibility to ensure this
"*Studying young minds, and how to teach them* ... The findings, mostly from a branch of research called cognitive neuroscience, are helping to clarify when *young brains* are best able to grasp fundamental concepts" (Carey, 2009). "...by preschool, *the brain* can begin to grasp informal geometrical definitions" (Carey, 2009). "Here's the latest health research to help you give your *brain* the maximum gain ... Feed your *brain* ... A short daytime nap can also keep your brain sharp" (Wighton, 2007). "Drink water. Our brains are 80 per cent water, so dehydration is bad news for your *brain*" (Wighton, 2007). "A cup of cocoa before bedtime could boost your IQ ... They [scientists] said this could be especially beneficial to older *brains*" (Wighton, 2007). "Pre-school learning gives teenage *brains* a boost" (Whipple, 2012). "[M]usic gives a child's *brain* a massive boost" (James, 2014).	"Exercise 'boosts academic performance' of teenagers" (BBC, 2013). "Music may be absolutely the best all-round activity to *produce* shiny, happy children but, if they struggle with violin practice, there are other hobbies that can *generate* often surprising cognitive benefits" (Carlyle, 2014). "10 fun ways to boost your child's brain power" (Carlyle, 2014). "How to boost the brain" (Wighton, 2007). "How music can boost your child's brainpower ... [N]euroscience is now proving [that] music gives a child's brain a massive boost, and it appears to be the only activity that can actually increase their biologically determined IQ" (James, 2014). "Does listening to Mozart really boost your brainpower?" (Hammond, 2013). "We are all a unique mix of individual preferences, and research suggests we learn best or *"switch on"* to learning when our dominant preference is met" (The Guardian, 2004). "Listening to a good tune can boost your learning and concentration" (Wighton, 2007). "Pre-school learning gives teenage brains a boost ... Pre-school children who visit the zoo and have other cultural stimulation have more developed brains as teenagers" (Whipple, 2012).	"Violin, running, meditation, Grand Theft Auto ... these are the IQ-enriching hobbies your children should be trying ... Neuroscientists say the most valuable activities improve "executive function" − the ability to plan, concentrate, focus and remember. It's these abilities, rather than raw IQ scores, that research suggests are the best predictors of academic and life success" (Carlyle, 2014). "They [the authors of the study] claimed that since every 15 minutes of exercise improved performance by an average of about a quarter if a grade, it was possible children who carried out 60 minutes of exercise every day could improve their academic performance by a full grade − for example, from a C to a B, or a B to an A" (BBC, 2013). "Drama lessons don't raise IQ as music lessons do, a study in Toronto among six-year-olds showed. But they do have other positive cognitive benefits, particularly in social interaction and adaptability" (Carlyle, 2014). "There is a way in which music can make a difference to your IQ, though ... Jessica Grahn, a cognitive scientists at Western University in London, Ontario says that a year of piano lessons, combined with regular practice can increase IQ by as much as three points" (Hammond, 2013). "But, for me, the biggest revelation was the fact that several studies over the past few years have found that early music training can increase a child's IQ by as much as 7.5 points when you start by the age of 2 and continue with it for six years. Even one year's worth can give them an extra three points" (James, 2014). "With exams looming, what are the best ways to increase intelligence? ... Here's the latest health research to help you give your brain the maximum gain; Get sweaty, feed your brain, rock on, go lavender, take a break, say yes to smart drugs, relax your body, sleep on it, learn a skill, chew gum, drink water, lay off the technology, take testosterone, think global, don't see red" (Wighton, 2007).

Policymakers

Apart from the media and brain-based learning industry, the academic level of educational neuroscience is recontextualised to the field of governmental policymakers. As with the two former fields, the political field is also a complex area of study and only a fraction of it can be analysed in this research. The following analysis is therefore based on policy documents by English and American policymakers wherein one can find traces of education and neuroscience. By use of literature search based on recontextualisation criteria, the texts by Allen MP and Smith MP (2008) [UK], Federal Register (2001) [USA], Government Office for Science (2012) [UK], TeacherNet (2007) [UK], and US Department of Education (2010, 2012) are chosen for the corpora, since they seem to provide an adequate assortment of the ways in which educational neuroscience's academic level is disseminated to the field of policymakers. As with the previous two recontextualisation analyses, my aim is not to analyse the educational and neuroscientific validity of political texts *per se*, but rather to examine how educational neuroscience is distributed and recontextualised within the field of policy agents and policymakers.

The first question to be answered is to *what degree* educational neuroscience is recontextualised to the political field. Findings from my literature search show significant traces of educational neuroscience amongst policymakers, even if dissemination to the political domain appears less common than within the field of media and brain-based learning industry. Within the political field in the US a key words search related to 'education, neuroscience' in US Department of Education gave 2 702 hits, while a similar search in UK Department for Education gave a total of 136 hits, both resulting in texts in form of conferences, presidential speeches, political blogs, national strategy plans for education, and initiatives related to brain research on cognitive development and early learning and childcare[211]. An example from the UK is the summer school programme for disadvantaged pupils in 2011, where it in the announcement by Deputy Prime Minister Nick Clegg is said how "the extra 'brain training' will include catch-up classes such as literacy and numeracy boosters ... This is £ 50 million-worth of extra brain training giving tens of thousands of disadvantaged pupils a flying start at secondary school" (Department for Education, 2012). A similar political intervention with reference to education and neuroscience is seen in the

[211] Examples from the US are BRAIN Working Group (2014), Brenchley (2011), Bush (1990), Fowler (2013), US Department of Education (2011), and US Department of Health & Human Services (2014), whilst examples from UK are Allen MP (2011a), Department for Education (2013a, 2013b), and Department for Education and Teather MP (2011).

music project *Astar,* where the Scottish Government and Royal Scottish National Orchestra gave out free classical CDs to every new-born child in Scotland with the aim of "helping your baby's brain develop" (Royal Scottish National Orchestra, 2012; The Scottish Government, 2013). It is therefore evident that educational neuroscience is recontextualised to the political field, and it is therefore relevant to ask how educational neuroscience is represented, articulated and related to previous aspects within the political discourse.

When it comes to how policymakers represent educational neuroscientific topics, my findings show that many of the texts make references to neuroscientific research and scientific evidence. This can be seen in how 66 per cent of the political texts use phrases akin to 'research has shown'[212] and 50 per cent use the words 'scientific evidence'[213]. What further is of note is that *all* texts use a vocabulary echoing certain neoliberal ideas[214]. I argue that this latter finding is of particular interest, as a neoliberal ideology, in relation to educational policy, is distinguished by its logic of globalised and knowledge-driven economy. In such neoliberal rationality, particular emphasis is put on effectiveness, profitable input-output measurements, evidence-based and scientific knowledge of 'what works', in addition to underlying notions of the importance of education, knowledge and innovation for the success of individuals, companies, and the national state (Becker, 2006; Chiapello & Fairclough, 2002)[215]. In my textual analysis, traces of neoliberal ideology can be identified by the way in which policymakers articulate their messages and by use of certain 'buzz-words' associated with neoliberal perspective. Table 7.3 show some excerpts where traces of neoliberal rationality can be seen, and in addition the following extract from Allen and Smith (2008) demonstrates how traces of neoliberalism are manifested in a political text related to education and neuroscience:

> We hope that [this publication] offers a clear, *evidence-based* analysis followed by *proven* and practical actions to improve our society *more effectively* and *less expensively* than current policy allows ... It *costs* far more to help a teenager who has become entrenched in the kind of disadvantage described above, caught up in negative and destructive cycles of behaviour, than it would to stop him or her from falling behind in the first place by helping his or her family at the earliest stage of its development ... The Early Intervention policy pragmatism started to meet *scientific and evidence-based* analysis as around this time more and more work was becoming evident to me and many others on what happens to children's

[212] In Allen and Smith (2008), Government Office for Science (2012), TeacherNet (2007), and US Department of Education (2012).
[213] Seen in Allen and Smith (2008), Government Office for Science (2012), and US Department of Education (2012).
[214] As seen in Allen and Smith (2008), Federal Register (2001), Government Office for Science (2012), TeacherNet (2007), US Department of Education (2010), and US Department of Education (2012).
[215] See the glossary for further elaboration on neoliberalism.

> brains between the years of 0-3. An *evidence base* was beginning to accumulate on the fantastic ability of the brain to expand in the very early years (Allen & Smith, 2008, pp. 4-17 [my italics]).

A neoliberal rationality is even more evident if one considers the overall argumentation and logic used in Allan and Smith's political report, as it is stressed how neuroscientific research on early brain development provides an 'evidence base' for childcare and educational practice. This neuroscientific evidence can, it is argued, ensure 'cost-effective' intervention which will benefit the individual, families and our society in how it "enables young people ... to achieve much more of their potential at school, obtain qualifications and jobs, build their own happy and functional families and reduce the likelihood of a lifetime on benefit, in expensive drug rehabilitation or being dealt with by the criminal justice system" (Allen & Smith, 2008, p.17). Concerning neoliberalism, it indeed appears that Allan and Smith (2008) use the logic of knowledge-driven and evidence-based economy in their argumentation for early intervention.

Other traces of neoliberal rationalities in political texts can be seen in the roundtable event hosted by the UK Government Office for Science (2012), where the links between (neuro)scientific evidence and (educational) policy-making are stressed in terms like "it [is] crucial that evidence and insights from the behavioural sciences make an effective contribution to policy making" (p. 2), and "the co-sponsors emphasised the need for government to continue raising its game on testing and evaluating interventions so that it can really understand what works, and if something does not work, why it does not" (p. 2). The importance of neuroscience in education, in addition to the establishment of universal design in education, is similarly stressed by the US Department of Education (2010, p. 1) when noting that "[t]he challenging and rapidly changing demands of our global economy tell us what people need to know and who needs to learn. Advances in learning sciences [i.e. cognitive science and neuroscience] show us how people learn". These and similar findings give the impression that there is manifested a neoliberal ideological undertone in all the political texts analysed (see table 7.3). Many texts also appear to connect the benefit of a neuroscientific 'evidence-base' with 'what works', more efficient learning, improved academic outcomes, cost-efficient policy interventions, and success for individuals and society. However, I argue that the linkage of educational neuroscience with neoliberalism within the political field is not that surprising. If one considers recontextualisation principles in critical discourse theories, it is notable how discourses become re-contextualized and re-articulated as 'new' concepts are set in relation to 'the old' discourse's principles (Fairclough, 2010). In this case, the 'old' political discourse has long been seen as influenced by neoliberal ideology (Fairclough, 2005; Lauder, Brown, Dillabough, & Halsey, 2006), and thus it is to be expected that policymakers may appropriate the 'new' discourse of educational neuroscience into their own political fields by relating these academic representations to neoliberal rationality. It may be interesting to ask about the implications of this political strategy of connecting educational neuroscientific aspects with neoliberal rationality − an inquiry further pursued in the chapter's last section.

When it comes to the ways in which educational neuroscience is recontextualised within the political field, findings from my discourse analysis show that most policymakers seem to use educational neuroscience in order to create an 'evidence-base' or a 'scientific grounding' for their political suggestions. Strategies using educational neuroscience in order to craft an evidence-base appear to be linked to an underlying intention to 'sell' political arguments[216]. This motive for using educational neuroscience in political arguments can further be seen in relation to the audience these policymakers target, because findings indicate that political texts often appealed to other political actors (i.e. 50 per cent of the texts[217]) or to teachers and schools (i.e. 33 per cent of the texts[218]). Another finding reveals that policy-makers are a bit more careful in their statements and use more modalised words in their texts than brain-based learning programs and many of the media articles analysed. Many of the political texts (i.e. 50 per cent of the texts[219]) are more modest in their statements, using phrases such as "can be", "may be", or even providing other perspectives on a matter. However, even if some political texts use modalised statements concerning educational neuroscience, this does not necessarily imply that their statements are in line with the academic level of the discourse. My findings show that 50 per cent of the political texts have representations inconsistent with the academic level[220], whereas the other 50 per cent appear to have representations more in line with the academic level of educational neuroscience[221]. Furthermore, time of publication does not correspond with the scientific accuracy of the educational neuroscience representations in political texts, and both scientific and unscientific representations are therefore found regardless of publication date. Examples of

[216] As seen in Allen and Smith (2008), Government Office for Science (2012), TeacherNet (2007), US Department of Education (2010), and US Department of Education (2012)
[217] As seen in Allen & Smith (20089, Government Office for Science (2012), and US Department of Education (2012).
[218] As seen in TeacherNet (2007) and US Department of Education (2010)
[219] As seen in Federal Register (2001), Government Office of Science (2012), and TeacherNet (2007).
[220] As seen in Allen and Smith (2008), TeacherNet (2007) and US Department of Education (2012).
[221] As seen in Federal Register (2001), Government Office of Science (2012) and US Department of Education (2010).

representations more in agreement with the academic community of educational neuroscience can be found in the US Federal Register (2001), where it is stressed that there is a need for more research to link neuroscientific theory with educational practice. Even if this political text is from 2001, a time when educational neuroscience was barely established as an academic discipline, the same caution, and calls for more research, can be found at the current academic level (Blakemore & Frith, 2005a; Varma, McCanliss, & Schwartz, 2008). In the political text from the UK roundtable discussion regarding behavioural science and policy making, one can also find more academically consistent and cautious representations of educational neuroscience. Even if one gains the impression that neoliberal ideas are accepted (such as the importance of efficiency, what works, and focus on evidence), the "appropriate role for neuroscience evidence for government educational policy" is open to "lively discussion" (Government Office of Science, 2012, p. 6). Similar cautious approaches are seen in the more academic level of educational neuroscience, where it is often stressed that caution is needed when drawing links from neuroscientific findings to recommendations for educational practice and policy (cf. Bruer, 1998; Goswami, 2006).

Such academically consistent representations of educational neuroscience do not, however, compensate for the fact that *half* of the political texts analysed present ideas that do not correspond with educational neuroscience's academic level[222]. An example of such representation is provided by the teaching and study materials posted at UK government's information page TeacherNet (2007)[223]. The aim of TeacherNet is to supply teachers with "guidance material [that] contains what could be termed essentials of good practice, generic to all phases of education ... [introducing] some of the research that underpins current thinking on effective teaching and learning" (p. 1). Research references are then drawn to neuroscience and cognitive psychology:

> [I]deas about the brain, learning, and how to promote it, are developing rapidly and teachers cannot easily keep track of changing ideas ... "The learning gap is the difference between what we know about effective learning and what is currently happening in the classroom" (Mike Hughes, 1999, p. 17). The challenge is to try to close that 'learning gap' and search for ways to teach pupils and structure their learning that are as effective as we can make them (TeacherNet, 2007).

[222] As seen in Allen and Smith (2008), TeacherNet (2007), and US Department of Education (2012).

[223] The respective information under 'Supply Teaching/Study Materials' (TeacherNet, 2007) was found in UK government's National Archives with the note "A new UK Government took office on 11 May [i.e. 2010; Cameron ministry]. As a result the content on this site may not reflect current Government policy". The text was nevertheless easily accessible from UK government's website by a general internet search at the time I conducted my critical discourse analysis in May 2014.

Following this note, a presentation of ‘effective’ classroom and behavioural management is made and different learning styles such as accelerated learning, the VAK model, and multiple intelligences are offered (TeacherNet, 2007). The problem, however, is that these practical learning principles are criticised by numerous educational neuroscientists as *neuromyths* (Alfernik & Farmer-Dougan, 2010; Franklin, 2006; Howard-Jones, 2010; Sharp, Bowker, & Byrne, 2008). Accelerated learning, the VAK model, and multiple intelligence, in varying degrees, build on ‘learning style theories’ and Howard Gardner’s multiple intelligence theory (MI theory) where a central nexus is that individuals have different preferred learning or thinking styles (Dunn & Griggs, 2000; Gardner, 1983). Take, for instance, the VAK model − a model based on the idea of sensory modalities and that our neurological ‘wiring’ predisposes us to learning styles which correspond to visual, auditory, or kinaesthetic inputs (Dunn & Griggs, 2000). In accordance with this, the UK government’s TeacherNet states:

> The VAK model emphasises the preferences individuals have for visual, auditory or kinaesthetic learning. VAK characteristics:
>
> - **Visual** - learners prefer to see information: they like reading text or looking at diagrams.
> - **Auditory** - learners prefer to hear information: they like listening, talking.
> - **Kinaesthetic** - learners prefer to learn by doing: they like moving, manipulating, touching.
>
> ... This has important implications for teaching − teachers should acknowledge and cater for the distribution of preferred styles amongst learners (TeacherNet, 2007).

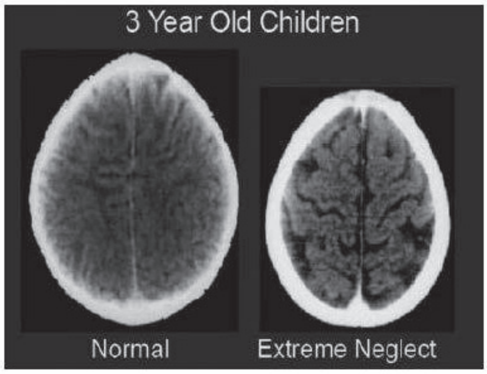
The idea of VAK learning styles is, however, not compatible with educational neuroscientific research. First of all, categorisation of children into visual, auditory, or kinaesthetic learners is usually done in form of limited questionnaires where an individual’s dominant learning style is identified based on a total scores of V, A or K’s on options such as “On a long journey I like to look at the scenery or read a book [V]; On a long journey I can’t wait until we stop so I can walk around [K]; On a long journey I like to listen to music or talk to the other travellers [A]” (Brainboxx, 2014). The categorisation of children based on such unsophisticated questionnaire designs is questionable; to further implement learning styles accordingly is even more dubious (Howard-Jones, 2010). Secondly, in educational neuroscientific research it is commonly agreed that multiple strategies for learning are beneficial, because this can provide a child with numerous strategies for problem solving and learning across environmental settings. To focus on *one* particular ‘style’ rather than a broad set of learning skills may therefore be more of a disservice than an aid when it comes to learning (Alfernik & Farmer-Dougan, 2010). Besides, even to talk of singular processing and learning styles is paradoxical, since there is a consensus within the educational neuroscience research community that one should be careful in isolating a task (such as listening to lectures) into a single brain function (hearing) and a corresponding brain area (such as primary auditory cortex). Our brain is complex, and when we perform cognitive tasks we make use of interconnected and parallel processing modules where numerous parts of the brain are activated simultaneously (Gazzaniga et al., 2009). Thirdly, no evidence has as yet emerged from neuroscience or educational research of any benefits in categorising and teaching students in accordance to their sensory modality (Howard-Jones, 2010; Sharp et al., 2008). Based on these arguments, it is therefore significant that the VAK learning model has gained a widespread popularity amongst teachers and how some schools have even decided to label their student in V, A, or K t-shirts and badges according to a child's preferred learning style (Franklin, 2006; Geake, 2008). The fact that this unwarranted use of learning styles also has been promoted at the UK government's information page for teachers is, perhaps, even more surprising. Even though the text published at UK government's TeacherNet website only provides a brief account on the 'effective and good practice' of the VAK-model, and even if it is noted that "all learners can benefit from multi-sensory approaches to learning" (TeacherNet, 2007), the fact that neuromyths such as VAK learning styles, accelerated learning and multiple intelligence are promoted through this political channel is worthy of criticism.

Another text worth mentioning for its unscientific use of educational neuroscientific representations is *'Early Intervention: Good Parents. Great Kids. Better Citizens'* by MPs Allen and Smith (2008). This political report argues for the importance of the social policy 'Early Intervention', and references to neuroscience are used to argue that the 0-3 age range is the vital period for early interventions, because "the more positive stimuli a baby is given, the more brain cells and synapses it will be able to develop" and "the structure of the developing infant brain is a crucial factor in the creation (or not) of violent tendencies". The result of an early intervention policy "will be a pro-social child who is likely to be happier, healthier and more intelligent than one who has been deprived of these essentials for positive growth", it is argued, and this will benefit the individual child, the family, and the society at large (Allen & Smith, 2008, pp. 57-58). However, issues arise due to emphasis on children's cognitive development and what the authors call "the significance of 'sensitive windows'"[224]. This can

[224] I will argue that the phrase 'sensitive windows' is paradoxical, because on the one hand it seems to indicate '*sensitive* periods', while it on the other hand indicates 'closing windows' adherent to *critical* periods. (Besides, the idea of a 'sensitive' window is contradictory, since the window metaphor usually describes something as either open or closed – not sensitive.) Within educational neuroscience's academic level it is agreed that cognitive development should be seen as sensitive periods rather than critical periods and closing windows of time wherein a certain skill must be learned (Blakemore & Frith, 2005a).

be demonstrated by Allen and Smith's example on the suggested consequences of extreme neglect of children:

> [The image] illustrate the negative impact of neglect on the developing brain. The CAT scan on the left is from a healthy three year old child with an average head size (50th per centile). The image on the right is from a three year old child following severe sensory deprivation neglect in early childhood whose brain is significantly smaller than average and has abnormal development of cortex (cortical atrophy) and other abnormalities suggesting abnormal development of the brain (Allen & Smith, 2008, p.59).



(Source: Perry, BD, 2002, Childhood Experience and the Expression of Genetic Potential: What Childhood Neglect Tells Us About Nature and Nurture, *Brain and Mind* 3 79-100)

The brain image is taken from Perry's (2002) study on Romanian orphans, and the consequences of these orphans experience of physical neglect and sensory deprivation is said to be shown in the CAT scan. The problem, though, is that this brain image which compares a 'normal' and an 'extremely neglected' child is somewhat questionable in its validity. Gillies (2013) notes this and argues that the journal where Perry's article was published was short lived and was, indeed, a "scientifically dubious journal". Moreover, the article itself is of poor quality "providing next to no details of the methodology pursued or the clinical history of the children scanned" (Gilles, 2013, p. 9). Consequently, the image of the two children's brains is problematic as evidence, because no explanation of what conditions are defined under 'normal' or 'extreme neglect' is provided. Besides, no measurement scale is provided in the picture, which makes comparison of the two brains difficult to validate. Overall, then, the frequently cited brain image, which originally derives from Perry's (2002) article, is not a scientifically valid image regarding the relation of extreme neglect and brain size[225]. In addition to this, issues arise due to Allen and Smith's (2008) mis-representation of neuroscientific research on synaptogenesis and synaptic pruning (viz. 'sensitive windows') in

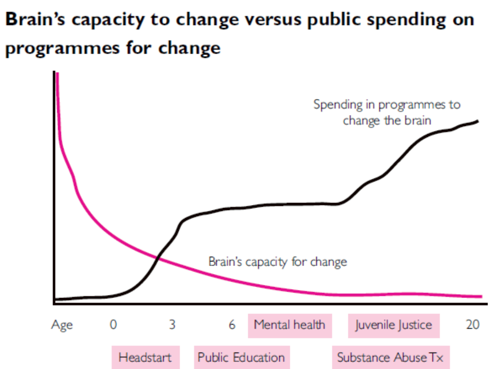
[225] What further is worth mentioning is that this simplistic picture has become a well-cited picture within the political and public field – particularly in text where it is argued for the importance of early intervention strategies (e.g. Reilly, 2012; Sinclair, 2007). Allen has for instance made the same (and scientifically dubious) picture a cover illustration in the political follow-up reports *'Early Intervention: The Next Steps'* (Allen MP, 2011b) and *'Early Intervention: Smart Investment, Massive saving's* – this time the 'shrunken brain' image is coupled with gold-bars representing the cost taxpayers have to pay for ineffective early childcare and education interventions (Allen MP, 2011a). Again the problem is that the argumentation leans towards misinterpretations of scientific findings, wherein one can see an exaggerated frenzy over a child's early stages of life when it comes to cognitive development.

their argument for early learning, positive stimuli and enriched environments in a child's early phases of life. As previously noted, is it a common agreement within the academic educational neuroscientific community that normal upbringing within normal social environments is sufficient for normal cognitive development, and that it is more correct talking of *sensitive* periods rather than critical ones (cf. Anderson & Della Sala, 2012; Blakemore & Frith, 2005a; Howard-Jones, 2010). Allen and Smith (2008) are not alone in this misrepresentation and references to the critical early years of children's life can also be seen in many other political texts arguing for social and educational interventions[226].

What is also of note regarding Allen and Smith's (2008) political report is how they couple their argument for early intervention with economic models for effective investments. Particularly is Allen and Smith's early intervention argument based on the economic model of human capital investments by James Heckman and a model recited from Wave Trust:

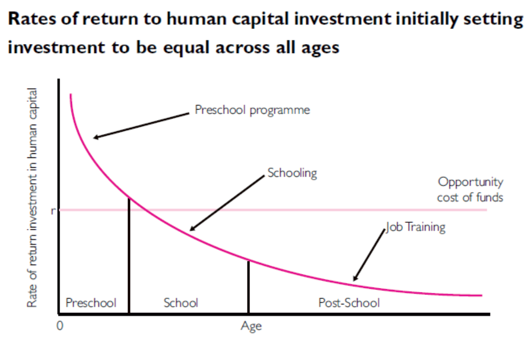
> The picture strongly suggests that an investment fulcrum lies in 'primary prevention' focused on 'at risk' groups under the age of three [graph 1] ... The following graph from the Nobel prize-winning economist, James Heckman, tells a similar story by showing the return on investment in learning, by age [graph 2] ... The messages contained in these graphs are hardly surprising in light of the fact that the human brain has developed to 85 per cent of its potential at age three (and 90 per cent at age four). The financial investment is of course important, but only insofar as it maximises the investment in personal attention from the caregiver to the 0-3 (Allen & Smith, 2008, pp.46-48 [see graphs below]).

Graph 1:



Source: Wave Trust

Graph 2:



So urce: Cunha F, Heckman J J, Lochner L and Masterov D V. , 'Interpreting the Evidence on Life Cycle Skill Formation', *NBER Working Paper Series*, National Bureau of Economic Research, Cambridge, MA, USA, May 2005

[226] As seen in US Department of Education (2012), Department for Education (2013b), Department for Education and Teather MP (2011), Leadsom MP (2012), The Scottish Government (2013), and US Department of Health & Human Services (2014).

One the face of it, this input-output reasoning of brain development and political investments may seem plausible, particularly when such illustrative graphs are used. The problem is that the validity of the 'brain-base' for these two models, and thus also Allen and Smith's argument, can be disputed. Based upon concepts of critical and sensitive periods of brain development, Heckman (2008) makes a graphical expression using basic economic models which show a significant decrease for public investment after the age of three. The conclusion, as argued by Heckman and colleagues, is that "at the youngest ages, it is possible to form ability and create the complementarity that characterizes late adolescent and early adult human capital investment processes. Thus early interventions targeted toward the disadvantaged [those that do not provide enriched environments for their children] can be highly effective. Later investments are not" (Cunha, Heckman, Lochner, & Masterov, 2006, p. 800).

The problem with this, as argued by Howard-Jones (2014b), is that the graphical expression of human capital investment (shown by the down-sweeping curve in graph 2) is based upon an assumption that the brain is a constantly developing and unitary entity. This is, however, a *mis*representation of educational neuroscientific research, because scientists say that cognitive development in humans occurs at different rates up to early adulthood, sometimes occurring in an irregular fashion, and that learning arises from a range of neural interconnections covering numerous cognitive skills. Heckman's model is also a *mathematical* graphical expression, not a graph plotted on the basis of empirical data. This is problematic since the entire model, and the respective theory, is based on premises of mathematical functions concerning brain development and investment expenditure that are not correlated with empirical data on children's cognitive development (Howard-Jones, 2014b). The neuroscientific underpinning of the model on early investments in 0-3 year olds is therefore sparse. I will suggest that similar critique applies to graph 1, since presumably this model is also based on identical over-simplifications of research on cognitive development[227]. It can therefore be argued that Allen and Smith's (2008) report has an unwarranted basis in educational neuroscientific research; and additionally that Allen and Smith contribute to 'the myth of three' by using these models in argumentation for early intervention policies. This is important considering the authority and potential influence of

[227] No references to the primary paper are given in Allen and Smith's (2008) report, and it is therefore difficult to locate the original source which this model is taken from. The two graphs are, however, strikingly similar in their appearance.

these authors in their status as policymakers, particularly in view of the number of other policy actors who refer to Allen and Smith's report[228].

Overall, my analysis indicates variation in how educational neuroscience is presented in political texts: some policymakers suggest representations in agreement with academic communities, whereas other present simplistic accounts more resembling neuromyths (see table 7.3). A common tendency is that they all re-articulate educational neuroscience within a neoliberal rationality. These findings are discussed later in the chapter, as attention is paid to issues arising due to policymakers' influential power as premise contributors to other sectors.

Interest actors and interest groups

The last field to be addressed is that related to larger intergovernmental actors and interest groups. With this category I attempt to capture larger groups of actors, independent institutions, and organizations with an interest in educational neuroscience, but which are neither governmental policymakers nor profit-based companies such as brain-based learning industries. Interest groups and organizations can play important roles in shaping discourses and it is therefore interesting to investigate how educational neuroscience is recontextualised within this field. Based on literature searches related to selection criteria for the recontextualisation analysis, five interest groups and their respective texts have been selected − namely CfBT Education Trust (2014), EU (2012), OECD (2007a), The Royal Society (2011b), and Wellcome Trust (2014).

If we start by looking at the recontextualisation of *how* educational neuroscience is articulated within the field related to interest actors, findings from the discourse analysis show that there are frequent references to topics related to educational neuroscience. All the documents use the phrase 'research has shown' (i.e. 100 per cent of the texts[229]) and almost all of them use the word 'evidence' (i.e. 80 per cent of the texts[230]). In every text analysed, representations of educational neuroscience appear to be nuanced, cautious, and accurate, and the texts therefore seem to have a close resemblance to educational neuroscience's academic level. There is a predominance of representations in line with presentations from the academic

[228] References are for instance found in The Centre for Social Justice (2011), Department for Education's Munro review of the child protection system in England (Munro, 2011), and MP Leadsom's '*Two is Too Late*' conferences (2012), whereupon numerous also have recited variations of the (flawed) models and/or the (flawed) brain scan of the 'neglected child' shown above – for example is Heckman's model also used by UNICEF and the European Social Observatory (2011).
[229] As seen in CfBT (2014), EU (2012), OECD (2007a), The Royal Society (2011b), and Wellcome Trust (2014).
[230] As seen in CfBT (2014), OECD (2007a), The Royal Society (2011b), and Wellcome Trust (2014).

Table 7.3: Examples of how the policymakers represent educational neuroscience [my italics].

Representations wherein one can see a neoliberal vocabulary	**Repr. where neuroscience is used as a political argument**
"...implement learning assessment systems, and ensure program effectiveness and accountability" (US Department of Education, 2012). "We hope that it offers a clear, *evidence-based* analysis followed by proven and practical actions to improve our society more *effectively* and *less expensively* than current policy allows" (Allen & Smith, 2008. p.4) "It *costs* far more to help a teenager who has become entrenched in the kind of disadvantage described above, caught up in negative and destructive cycles of behaviour, than it would to stop him or her from falling behind in the first place by helping his or her family at the earliest stage of its development" (Allen & Smith, 2008, p.12). "An *evidence base* was beginning to accumulate on the fantastic ability of the brain to expand in the very early years ... it seemed ever more obvious that if we could equip the parents or parent to optimise (usually) maternal responsiveness and their impact on their 0-3 year-old children, we would be laying secure and strong foundations for all of the work that the public sector did thereafter – in the pre-school, primary and secondary and teenage years. Crucially, it would *enable public expenditure to become developmental and not just remedial"* (Allen & Smith, 2008. p.16) "It was crucial that evidence and insights from the behavioural sciences made an effective contribution to policy making ... In addition, the Co-sponsors emphasised the need for government to continue raising its game on testing and evaluating interventions so that it can really understand what works, and if something does not work, why it does not" (Government Office for Science, 2012, p. 2). "There then followed a lively roundtable discussion on the appropriate role for neuroscience evidence for government education policy: ... The important role that long-term economic modelling and statistical evidence can play in government policy making was mentioned, for example, to determine the real world outcomes of investment in early learning" (Government Office for Science, 2012, p. 6). "This section is based on the basic premise that *effective teaching leads to effective learning* ... [Chapter 3] looks at the issue of behaviour and *behaviour management* in the light of recent research ... It offers practical advice in the *management* of pupils with emotional and behavioral problems in the classroom and considers how to *maximise* their learning" (TeacherNet, 2007). Principles and guidelines have been established for *universal* design in education based on decades of research and are known as *Universal* Design for Learning (UDL). The UDL principles reflect the way students take in and process information. Using them to develop goals, instructional methods, classroom materials, and assessments, educators can *improve outcomes* for diverse learners by providing fair opportunities for learning by improving access to content ... The definition of UDL that appears in the Higher Education opportunity Act of 2008 (103 U.S.C. § 43) has come to dominate the field because of its broad applicability and its *research foundation* in the learning sciences, both cognitive and neuroscience" (US Department of Education, 2010, p.7) "Department will promote initiatives that increase access to high-quality programs, improve the early learning workforce, build the capacity of states and programs to develop and implement comprehensive early learning *assessment systems*, and ensure program *effectiveness* and *accountability*" (US Department of Education, 2012). "David Willetts highlighted the importance of understanding behaviour in order to develop sound public policy, particularly in a world where resources are tight and policy making is inevitably about trade-offs. Picking up on earlier discussion about the role of *neuroscience evidence* on development in early years had played in public debate on education policy and allocation of funds, he emphasised how important it is for the external behavioural science community to input to government policy making and to challenge government decisions if they believe they are not *based on evidence* or based on partial evidence. He concluded by challenging the behavioural science community to further engage with government and communicate what they know *more effectively*" (Government Office for Science, 2012, p.7).	"...improving learning in the earliest years. The years from birth through 8 are the most critical for brain development, and significant evidence from research and evaluation demonstrate that participants in high-quality early learning programs will lead to both short- and long-term positive outcomes for all children" (US Department of Education, 2012) "It is identified in the chart below, which graphically reveals the correlation between *age* at the point of intervention and ease of bringing about change in the human brain (...) The blue line shows the very young brain's enormous capability for change, and how this rapidly diminishes well before the child starts school. The red line shows where we spend our money to change human behaviour" (Allen & Smith, 2008). "Neuroscience has drawn attention to ... Therefore, the most effective learning experience are..." (U.S. Department of Education, 2010). "The United States cannot prosper economically, culturally, or politically if major parts of our citizenry lack strong educational foundation, yet far too many students are not served by our current one-size-fit-all education system. The learning sciences [i.e. cognitive science, neuroscience, education, and social science; p.5] and technology can help us design and provide more effective learning experiences for all learners" (US Department of Education, 2010, p.7). ***Other:*** "Human infants arrive ready to be *programmed* by adults" (Allen & Smith, 2008, p.56).

community of educational neuroscience in all the interest actors' texts, in contrast to what is found in texts within the field of policymakers (where 50 per cent of the texts have more academically consistent representations), media (viz. 10 per cent), and the brain-based learning industry (viz. 0 per cent). In relation to this, it can also be noted that texts from interest groups are in general larger in scope and more comprehensive than texts from the other fields. That is to say, four of the interest groups (cf. OECD, CfBT, Royal Society, and Wellcome Trust) have instigated extensive projects (with subsequent analysis and reports) related to the topic of education and neuroscience. In the course of these projects, actors from interest groups have actively engaged and collaborated with researchers from the academic discourse. This is seen in the instigation of project-related research workshops, transdisciplinary networks, seminars, collaboration with researchers to analyse and write reports[231], or as noted in the foreword of OECD's report "The purpose of this novel project was to encourage collaboration between learning sciences and brain research on the one hand, and researchers and policymakers on the other hand" (2007, p. 3). Dialogue and collaboration between interest actors and academics can further be seen in the ways in which educational neuroscience is articulated, and helps to explain why the representations presented in interest actors' texts bear closer resemblance to values, ideas, and knowledge found at the academic level of the educational neuroscience discourse. This is seen in articulations such as "We believe that a constructive balance between enthusiasm and scepticism, combined with better knowledge exchange between scientists and practitioners…" (Royal Society, 2011b, p. 2), "We conclude that teachers' desire to implement interventions based upon neuroscience is evident, but it is running ahead of the evidence base" (Wellcome Trust, 2014, p. 1), and as demonstrated in the following extract from the OECD:

> With such a strong focus on cognitive performance − in countries and internationally − there is the risk of developing a narrow understanding of what education is for. Far from the focus on the brain reinforcing an exclusively cognitive, performance-driven bias, it actually suggests the need for holistic approaches, which recognise the close interdependence of physical and intellectual well-being, and the close interplay of the emotional and cognitive, the analytical and the creative arts (OECD, 2007, p.154).

Emphasis on cautious approaches and reciprocal collaboration between educational neuro-scientists and policymakers is prominent in the academic discourse, in contrast to the fields of brain-based learning industries, media, and policymakers. In the field of interest actors however, and as the above quotes demonstrate, these notions of caution and collaboration are

[231] As seen in CfBT (2014), OECD (2007a), Royal Society (2011b), and Wellcome Trust (2014).

more detectable. The only exception is the CfBT report (2014) where my discourse analysis suggests a notable lack of educators' view regarding educational neuroscience. The same goes for the brief text on an EU webpage (EU, 2012) where some academically inconsistent references are presented regarding early stimulating environments, brain development, and the critical first three years of a child's life.

My analysis further indicates another tendency − namely interest actors' tendency to couple educational neuroscience with neoliberal rationalities. 80 per cent of the texts analysed appear to have a neoliberal vocabulary[232], which in turn may be a manifestation of an underlying neoliberal rationality found amongst these groups. Just like texts from policy-makers, the combination of educational neuroscience with neoliberal rationalities is a *re-*articulation where the 'new' academic level of discourse (i.e. educational neuroscience) is set in relation to 'old' discursive rationalities in the field of interest actors (i.e. neoliberalism). As with policymakers, these interest groups can be seen to be influenced by neoliberal ideas in the form of political engagement and/or economic interests (cf. Guile, 2006; Karlsen, 2006; Rizvi & Lingard, 2006). Demonstration of interest actors' re-articulation of educational neuroscience in a neoliberal phrasing can for example be seen in CfBT Education Trust's text (2014) where frequently reoccurring expressions such as 'school effectiveness', 'evidence for education', 'the best effect', 'the value of randomised control trials' and emphasis on the 'hard science' of neuroscience are given. The latter can be seen in the report's reoccurring representations regarding 'nature of intelligence' (where is the social aspect?), the claim that computer programs can be more cost-effective teachers than human teachers (2014, p. 12; p. 14), and that no educators or teachers are used in CfBT's research. The neglect of educational and social perspectives, and the promotion of 'hard-science' as an evidence base for cost-effective educational interventions, are interesting, particularly considering that CfBT is an *educational* trust. Other examples of neoliberal vocabulary can be seen in table 7.4 and in the following statement:

> We are looking for interventions or approaches that use understanding from neuroscience research about the mechanisms of learning to improve education ... Successful proposals will build on the existing evidence about effective teaching and learning practices, and explain how these practices could be made more effective or efficient using evidence from neuroscience (Wellcome Trust, 2014).

In this extract, it is apparent that neuroscience is seen as an 'evidence base' and 'the scientific base' for education. This is noteworthy, since an emphasis on evidence-based practice and

[232] As seen demonstrated in CfBT (2014), EU (2012), OECD (2007a), and Wellcome Trust (2014).

policy is a recurring theme in neoliberal ideologies, as revealed in the neoliberal idea "that there is 'one best way' of doing things revealed through the 'science' of society" (Lauder et al., 2006, p. 3). Moreover, the neoliberal agenda in education has increasingly become focused on effectiveness, outcome measurement, and ultimately social efficiency and social benefits (Fairclough, 2005; Rizvi & Lingard, 2006). This neoliberal rationality is also manifested in these interest groups' texts and a recurring argument seems to be that:

i) neuroscience can be an evidence-base for education, which in turn,
ii) can provide answers to the mechanism of learning (cf. 'what works'), that sequentially,
iii) can craft more effective classroom strategies and improved student outcomes, which overall,
iv) will lead to wider social benefits.

Further, and more critical, discussion of this neoliberal rationale set in relation to the educational neuroscience discourse will be presented later in this chapter.

If we move to questions as to *why* these interest actors have an interest in educational neuroscience, it appears from my analysis that interest actors think that the linkage of education and neuroscience could be an important dimension of the study of learning and education. The general aim, accordingly, appears to be to *inform* the public, teachers, and, particularly, policymakers with regard to the potential benefits of neuroscience in education. Information is chiefly offered by providing comprehensive reports, often written in collaboration with scientific communities[233]. Besides providing information to the public at large, another explicit aim of these texts is to create dialogue between researchers and policy-makers, to help in making evidence-based policy relevant for education[234]. These aims can be demonstrated by the following quote from the Royal Society's Brain Wave project:

> In the module, 'Neuroscience, Education and Lifelong Learning' we aim to: i) develop a framework to better communicate advances in neuroscience research to policy makers and the teaching community; ii) facilitate a dialogue between neuroscientists, policy makers and the teaching community; iii) identify current and future impacts of neuroscience research, including wider societal/ethical perspectives and to describe these in terms of policy and teaching outcomes (Royal Society, 2011b, p. 27).

Considering that many of these interest groups have an agenda closely related to a neoliberal rationality, one wonders if an underlying, and more ideological, motive for their interest in educational neuroscience is to create a socially effective educational system, beneficial for knowledge-driven and evidence-based economy within the global marketplace. This notion

[233] As seen in CfBT (2014), OECD (2007a), Royal Society (2011b), and Wellcome Trust (2014).
[234] As seen in CfBT (2014), OECD (2007a), EU (2012), Royal Society (2011b), and Wellcome Trust (2014).

will, however, be the topic of more critical reflection in the next section, where discussion of the previous analytical findings is presented.

Table 7.3: Examples of how the policymakers represent educational neuroscience [my italics].

Representations wherein one can see the linkage of educational neuroscience and neoliberal rationality
"We are looking for interventions or approaches that use understanding from neuroscience research about the mechanisms of learning to improve education. The interventions or approaches should aim to improve pupil attainment, especially that of disadvantaged pupils. Successful proposals will build on the existing evidence about effective teaching and learning practices, and explain how these practices could be made more effective or efficient using evidence from neuroscience." (Wellcome Trust, 2013, online).
"The aims of the Wellcome Trust's Education and Learning Strategy 2010–20 include 'to explore how neuroscience is being used to inform teaching and learning', 'to evaluate the strength of the evidence' and, where possible, 'to develop further investigations into how neuroscience can improve the quality of education'" (Wellcome Trust, 2014, p.1)
"Educational neuroscience is generating valuable knowledge to inform educational policy and practice: On many questions, neuroscience build on the conclusion of existing knowledge and everyday observation but its important contribution is in enabling the move from correlation to causation − understanding the mechanisms behind familiar patterns − to help identify effective solutions" (OECD, 2007, p.17).
"Growing understanding of the neurological basis of learning could help most individuals to become fulfilled and productive members of society who can respond with resilience to changing circumstances in their lives" (Royal Society, 2011, p. 19).
"The report contains important information for teachers, schools and policymakers about where to position neuroscience knowledge for best effect in the system and where not to over-emphasise its importance" (CfBT, Elwick, 2014, p. 4).
"The [neuroscience] workshops were delivered in two ways, to explore the effectiveness of each method. Delivering workshops by computer is a cheaper alternative to training and using ASTs [Advanced Skills Teachers] and for budgetary reasons may be favourable to schools" (CfBT, Elwick, 2014, p. 12).
"But the neuroscientific contribution is important even for results already known because: i) it is opening up understanding of "causation" not just "correlation"; and moving important questions from the realm of the intuitive or ideological into that of evidence. ii) by revealing the mechanisms through which effects are produced, it can help identifying effective interventions and solutions" (OECD, 2007, p.153).
This [educational neuroscience] needs to be a reciprocal relationship ... to sustain the continuous, bi-directional flow of information necessary to support brain-informed, evidence-based educational practice ... practitioners should systematically examine their effectiveness and provide classroom results as feedback to refine research directions (OECD, 2007, p.158).
At the same time, neuroscientific considerations continue to be only marginally present in policymaking ... integrating the result of recent scientific breakthroughs in the field could help design more effective policies for reducing poverty and social exclusion, but could also be incorporated into policies for public health, education and juvenile justice (EU, 2012, p.2).
Strengthening the science base for education: It [neuroscience research] is therefore a tool for science-based education policy, which can help assess the performance and impact of different educational approaches. In addition, neuroscience can provide knowledge of how education offers wider policy benefits, in health, employment and wellbeing (Royal Society, 2011, p.19).

Critical discussion of educational neuroscience's recontextualisation

This chapter has so far presented findings from my critical discourse analysis, with the aim of describing and discussing the ways in which the academic level of educational neuroscience is represented, rearticulated and recontextualised within the fields of brain-based learning industries, media, policymakers, and interest actors. The remaining sections of this chapter will take the analysis and discussion one step further. To start with, the four fields' different recontextualisation processes are seen in relation to one another. Following this, I discuss central findings from the analysis in relation to a critical discourse theoretical framework. Attention is particularly given to the relationship of educational neuroscience with neoliberal ideology, in addition to issues related to representations of education, the learning process, and the individual child.

Comparison of colonisation-appropriation dialectics

Recontextualisation of a discourse into other fields can occur through different processes, because fields may have dissimilar discursive and structural premises and their social agents may act differently when new discourses are incorporated. When investigating how fields represent educational neuroscience we can compare their representations in terms of how concretely or generally, how scientific or unscientific elements are articulated, what motives the actors seems to have with their texts, as well as characteristic ways of arranging, explaining, and legitimizing statements (cf. Fairclough, 2003; 2010). Furthermore, and in order to capture the nuances of these recontextualisation processes, one can make use of the concept Chouliararki and Fairclough (1999) term 'colonisation-appropriation dialectic'. Here the ambivalent character of the process is captured by focusing on how recontextualisation:

- can be seen as the *colonisation* of one field by another − in this respect, whether educational neuroscience appears to have colonised public and political fields;
- can also be seen in how the 'old' field *appropriates* the new discourse − for example, whether public and political fields appear to actively adopt and incorporate educational neuroscience into their fields.

The colonisation-appropriation dialectic is essential in a recontextualisation analysis, because it accentuates the discourse theoretical notion that there is *interaction* between discourses. Recontextualisation of the academic level of the educational neuroscience discourse should therefore not be seen as a direct transmission from academia and to other societal fields, because these fields (with their discursive structures and social actors) hold power to change, adapt and appropriate aspects of a new discourse into their own. The degree of colonisation and appropriation will therefore vary across each and every recontextualisation process − sometimes it is the 'new' discourse which colonise the 'old', or the 'old' discourse which appropriates the 'new', unless, of course, the recontextualisation occurs in a more interactive colonisation-appropriation dialect between the 'new' and the 'old' discourses. Due to this, the concept is further useful as a node for comparison in my analysis, since gradation of colonisation-appropriation in recontextualisation processes will also depend upon the relation between agents of the 'new' educational neuroscience discourse and agents of the 'old' recontextualising fields (Fairclough, 2010).

Findings from my discourse analysis show that educational neuroscience is recontextualised in both similar and different ways in the fields of brain-based industries, media, policymakers, and interest actors. A common tendency within all the four fields is references to science, and particularly neuroscience. The majority of these references occur by use of phrases like 'research has shown' (found in 85 per cent of the texts in corpora), albeit, exact literature references to original research papers are seldom provided. Such similarities notwithstanding, the *academic accuracy* and the *motive* for re-presenting educational neuroscientific accounts seem to differ amongst the four fields. Findings show that the brain-based learning industry has the most inaccurate presentations of educational neuroscience − evident from the large amount of general, simplistic, unscientific and non-modalised educational neuroscientific statements found in *all* of the brain-based educational programs analysed. Following brain-based educational programs in its academic inaccuracy is the media, where 80 per cent of the texts represent educational neuroscience unscientifically or partly unscientifically − often by use of sensational headlines and simplistic accounts. Texts by policymakers have a more serious appearance than media texts, but one can also here find representations in 50 per cent of the texts that are not in line with the academic community of educational neuroscience. Of the four fields it is interest actors who have most academic accuracy in their presentations, since all texts have representations consistent with representations from the academic level of educational neuroscience.

Difference in academic consistency can further be related to what seems to be the actors' *motive* for incorporating educational neuroscience and who the texts' *audience* appear to be. When it comes to brain-based learning industries, I have previously suggested that their motive for using educational neuroscience is to build authority, validation, and a 'brain-base' for their educational products − which they attempt to sell to parents and teachers. I argue that a similar motive is found in many media texts, as educational neuroscience seems to be used in order to justify sensational stories, which media 'sell' to a public audience. When it comes to policymakers, it can appear that topics related to educational neuroscience are used as political tools in order to validate statements. This time, however, I will suggest that the aim of this educational neuroscientific justification is often to 'sell' a political argument and/or to mobilise public support − whether political arguments to other political actors or justification of political initiatives to the public. The motive for interest actors' use of educational neuroscience differs from the three other fields, because it appears that interest actors neither use science in order to build validation, nor do they use scientific authority to 'sell' arguments, products or stories. Instead, it looks as if interest actors work together with educational neuroscientific research communities to produce projects and reports − often with the explicit aim of informing and building collaboration between researchers and policymakers. However, even if the explicit motive is to promote collaboration, one might speculate that some of these interest actors have an underlying motive based on the logic of a neoliberal, globalised and knowledge-driven economy.

Based on these findings, I will draw attention to the different fields' colonisation-appropriation gradation in the recontextualisation process of educational neuroscience's academic level. Firstly, the significant amount of scientifically inconsistent representations, particularly in brain-based educational programs, media texts, and in some texts by policy-makers, is, I argue, more suggestive of *appropriation* strategies rather than colonisation strategies. This is because one can assume that there would be more scientifically justifiable representations in the texts if agents from the academic level had colonised these fields, in contrast to cases where external agents adopt 'new' educational neuroscientific aspects and place these in relation to 'old' elements in public and political discourses. Secondly, considering that educational neuroscience appears to be used to gain authorisation and validation of certain perspectives, one can further argue that these agents have actively incorporated 'new' discursive aspects into strategies pursued within their 'old' field − that is, to 'sell' educational programs (brain-based industries), sensational stories (the media), or political arguments and interventions (policymakers). I therefore suggest that recontextualisation processes found within brain-based industries, media, and also partly within the field of policymakers are dominated by appropriation strategies. The relationship between these agents of these fields and academic agents of educational neuroscience is, arguably, dominated by a one-way conversation, where educational neuroscience is uncritically presented without support from scientists. The field of interest actors is the only field that does not appear to be dominated by appropriation strategies and one-way conversations. Almost all of the interest groups and organizations have, as I have shown, more academically respectable representations of educational neuroscience and many even explicitly promote collaboration between researchers and policymakers. The majority of interest actors have also approached the educational neuroscientific community in order to instigate collaborative projects and reports. More balanced appropriation-colonisation reconciliation strategies are thus found within the field of interest actors, and associations between these actors and academic agents resemble relationships of collaboration rather than 'one-way dialogues'.

It is important to note whether or not recontextualisation processes between academia and social fields are dominated by 'one-way' or two-way dialogues. One-way dialogue is problematic because it can lead to uncritical readings of scientific literature, unscientific re-interpretations, and misinformed re-presentations of educational neuroscience. In my text material, this is seen in how academically inconsistent and unwarranted VAK-learning styles, and recommendations for the use of multiple intelligence theories, are promoted by the UK Governments teacher platform 'TeacherNet'. Not only are such unscientific linkages between neuroscience and education challenging because they reach a large audience; they are also problematic in light of the implicit authority policymakers hold in their position. National governments, represented by policymakers, are 'premise contributors' and have significant influence not only when it comes to forming interventions and policies, but also on public opinion and knowledge. It is therefore noteworthy that representations not in line with educational neuroscientific research are manifested in many political texts and distributed through political channels.

These issues are not only found in the field of policymakers, because brain-based learning industries and the media make statements which are inconsistent with the academic level of educational neuroscience. Even if these fields do not have as significant an influence as policymakers, media and brain-based learning industries have a more prominent proportion of unscientific information in their texts, and both have a considerable audience in the public domain. For example, as Goswami (2006) notes, some teachers receive more than 70 emails a year urging them to buy brain-based educational programs or advising them to sign up to courses in brain-based learning. Media texts and brain-based educational programs are, furthermore, often presented as 'undoubted facts' and scientific explanations behind their media stories or learning techniques are often sparse, general, or simplistically presented in comparison to the academic level. This complicates the matter, since it become difficult for the readers of these texts − whether parents, teachers, students, or others − to identify illogical arguments. These outcomes triggered by uncritical representations in the public and political level of discourse are challenging, since they can contribute in the distribution of neuromyths and edumyths, which, in turn, can reduce the credibility of more academically sound work from the educational neuroscience research community. In this respect it is interesting to ask *why* there appear to be so much difficulty in presenting educational neuroscience in accordance with what researchers say? And why do some agents, whether journalists, brain-based learning agencies, policymakers, or perhaps some interest actors, seem to be so fascinated by educational neuroscience in the first place? In order to illuminate these questions, aspects of causation-correlation translation and the appeal of neuroscientific explanation will now be presented.

Correlation versus causation

Uncritical readings of educational neuroscientific literature and unscientific representations of research can frequently be identified in texts within the public and political field, but it would be too hasty a judgement to claim that the authors of these texts deliberately misrepresent educational neuroscientific statements. There may of course be cases where authors are aware that they are 'twisting the truth' a bit in order to craft a sensational story, to strengthen an argument, or to market educational programs. These deliberate strategies notwithstanding; I argue that there are aspects inherent in discursive structures and in 'the order of things' which may contribute to the (perhaps unintentional) crafting of neuromyths, edumyths, and misrepresentations of educational neuroscience (cf. Fairclough, 2010). In order to demonstrate my point, I will draw attention to the *correlation* versus *causation* problem, which makes it difficult to represent educational neuroscience in accordance to what researchers say. Many texts in the recontextualisation corpora implicitly touch upon the correlation–causation issue[235], as they have a tendency to conflate correlational findings to causal interpretations and representations. Conflation of correlation to causation can occur because researchers who work at the interface of education and neuroscience often present their findings as *correlational data*. When these correlational representations are passed along what I call the 'line of transference', however, they sometimes become translated into *causational data* by actors outside the research community such as journalists, brain-based learning entrepreneurs, or even policymakers and other interest actors.

Line of transference

What research often demonstrates:	*correlational data*
How research is often represented in academia:	*correlational representation*
How research is often understood externally:	*causational interpretation*
How research is often represented in external texts:	*causational representations*

Figure 7.5: Example of translation inconsistency between correlational data and causational interpretations.

The difference between 'correlation' and 'causation' is significant, because whereas the term correlation indicates that X can be significantly *associated* with Y, the term causation has a more substantial denotation since it states that X *causes* Y. Confusion of correlational and causational factors can occur due to various reasoning errors, where the most basic example is when one mixes up the meaning of 'being associated with' and 'being a cause of'. This logical error can be exemplified by an example, where 'pedestrians walking when the signal is red' (X) is correlated with getting 'hit by a car' (Y), but the statement get a completely different meaning if one says that 'walking when the signal is red' (X) *causes* one to be 'hit by a car' (Y). Everyone who has been in a hurry, or crossed a quiet street in the middle of the night, knows for sure that one *can* cross on red light without being knocked down by a car (although, of course, it is still not advisable). Another and more complicated reasoning fallacy, which confuses correlational factors and causational factors, is called the *syllogistic fallacy*. The formal structure of this fallacy, also known as 'affirmation of the consequent', is *if A is true, then B is true; B is true; therefore A must be true* (Hruby, 2012). The issue at stake in this reasoning fallacy is that it cripples attempts to identify causation from correlation

[235] As seen demonstrated in BBC (2013), Carlyle (2014), James (2014), Jha (2012), Whipple (2012), Wighton (2007), Brainboxx (2014), Brain Gym (2014), Scholastic (2014), Kagan (2014), LarningRx (2014), and Allen and Smith (2008).

data, in that one uses a faulty logic of reverse inference: 'A causes B' is distorted to also imply 'B causes A'. An example of such incorrect circular reasoning might be: if your car is out of fuel (A), it will not run (B); and your car does not run (B), therefore it must be out of fuel (A). The problem with this reverse inference is that there can be other valid and possible explanations for a broken-down car (Hruby, 2012), but when making a syllogistic fallacy one conflates the correlation data into causation data and thus makes an incorrect circular reasoning. In my text material, some examples of logical fallacies of correlation-causation conflation include how neuroscientific correlational data between gum chewing and increased blood flow in the brain is transferred to causational data between gum chewing and improved memory (seen in Wighton, 2007), and texts where rats' brain development and deprived laboratory environment is presented as a causational link between enriched home environments and a child's cognitive development (seen in James, 2014; Kagan, 2014). The scientific underpinning is indeed educational neuroscience, but I argue that the transfer of scientific data is faulty. In texts where this is the case, brain-based learning entrepreneurs, journalist, or even policymakers and interest actors have ended up making statements with a core of truth, but their presentations are far removed from the more scientific presentations found at the academic level of the educational neuroscience discourse.

One can easily, and unintentionally, suggest faulty reasoning and neuromyths by confusing correlational data with causational data, and such flawed reasoning seems to occur when educational neuroscientific research are recontextualised into public and political fields[236]. The resulting question is *why* these reasoning fallacies tend to arise along the transference line of educational neuroscience? Why is correlation versus causation a problem when it comes to the recontextualisation of educational neuroscience over structural borders and into other fields? One possible explanation is that most neuroscientific research and neuroimaging data is correlational data. Since most neuroscientific researches do not provide information about causation, this makes them susceptible to transfer error, where correlation is confused with causation (Goswami 2008; Hruby 2012). Additionally, causal data appear to be more 'appealing' than correlational data (Weisberg et al., 2008). The appeal of neuroscientific data will be explained in the next sub-section, but for now it can be noted that the seemingly more 'scientific' and 'definite' trait of causational neuroscientific data often appears more attractive than 'vague' correlational data (Weisberg et al., 2008). Another

[236] As seen in BBC (2013), Carlyle (2014), James (2014), Jha (2012), Whipple (2012), Wighton (2007), Brainboxx (2014), Brain Gym (2014), Scholastic (2014), Kagan (2014), LarningRx (2014), and Allen and Smith (2008).

factor, which can help to illuminate the correlation-causation error, as mentioned in chapter 6, is that neuroscientists often use technical language, which can be difficult for actors outside the neuroscientific discipline to understand. In accordance with critical discourse theories, technical language, jargon, and vocabularies can make a field inaccessible for people outside the discipline, and in previous discussions it was shown how this can appear to be the case within the academic level of the educational neuroscience discourse. The problem is therefore that errors of correlation-causation reasoning are more liable to result in transfer errors, since neuroscience's technical language makes it difficult for non-experts to distinguish causation from correlation (Hruby 2012). Considering that external actors from the media, brain-based learning industries, policymakers and other interest groups are not necessarily experts in either neuroscience or education, there is a potential risk that transfer errors occur when they appropriate educational neuroscience into their fields.

The appeal of neuroscience

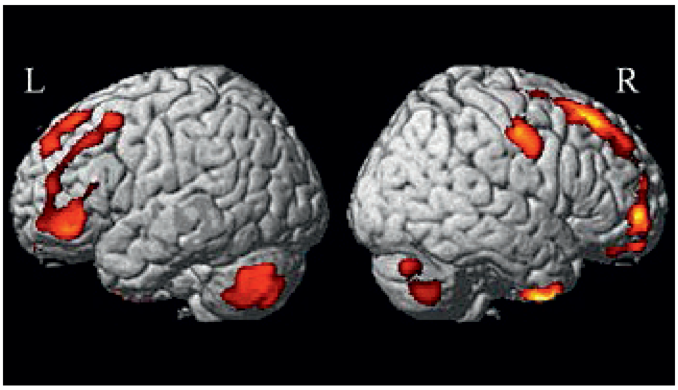
In order to clarify public and political actors' tendency to misrepresent educational neuroscientific research, another aspect identified in my text material can be deployed − namely what has been called *the seductive allure of neuroscientific explanations*. This expression is somewhat of a catchphrase within parts of the educational neuroscience discourse, as it describes the fascinating appearance neuroscientific explanations and brain images seem to have. The phrase was originally suggested by Weisberg and colleagues (2008), when they examined why explanations with neuroscientific information seem to generate more public interest than explanations without neuroscientific information. In order to test whether neuroscientific explanations interfered with people's ability to critically evaluate the logic of an explanation, groups of 'naïve adults', 'students on neuroscience courses', and 'neuroscience experts' were given similar explanation assessment tasks (Weisberg et al., 2008). The findings were remarkable, showing that neuroscience explanations do indeed appear to be appealing, especially to laypersons and students:

> Our most important finding concerns the effect that explanatorily irrelevant neuroscience information has on subject's judgements of the explanations. For novices and students, the addition of such neuroscience information encouraged them to judge the explanations more favourably, particularly bad explanations ... The students in the cognitive neuroscience class showed no benefit from training, demonstrating that only a semester's worth of instruction is not enough to dispel the effect of neuroscience information on judgements of explanations (Weisberg et al., 2008, p. 7).

Weisberg and colleagues' research show how non-experts tend to judge neuroscientific explanation more favourably than experts in cognitive neuroscience. Other authors have expounded on the findings by Weisberg et al. (2008) and related these notions more explicitly to the case of educational neuroscience. There is often talk of a 'neuromania' which affect both sciences and the general public, and how 'the brain-hype' and fascinating brain images seems to enthral part of the educational community, the public society and popular culture (Hardiman et al., 2012; Pasquinelli, 2011).

These views correspond well with my findings concerning recontextualisation of the educational neuroscience's academic level, and thus a clarification of 'neuroscience's persuasive appeal' may help to shed light upon the tendency to misrepresent scientific research within the public and the political levels of discourse. One useful example in this respect is how brain images used in educational neuroscientific research can lead to translation errors when interpreted by non-experts. Brain images are commonly used in neuroscientific studies as a way to present research findings from brain scans technologies such as fMRI and PET scans. By scanning the brains of participants when they execute cognitive tasks, such as working memory assignments or linguistic tasks, one can identify brain areas activated during the performance by measuring changes in metabolism correlated with neural activity (Gazzaniga et al., 2009)[237]. After decoding and comparing different brain scans from a study, some revised brain images are often presented where brain areas associated with the relevant cognitive task are shown (see figure 7.6).

Figure 7.6: This brain image is just an example of how fMRI scans commonly are presented in order to show activity in different brain areas during cognitive tasks.



[237] See the glossary in appendix A for further explanation on fMRI and PET-scan.

What appears to be problematic with brain images, and what complicates the transfer of educational neuroscientific research, is that these images are often misinterpreted and given undue salience. Misinterpretations can, first of all, arise because one can get the impression that a brain image presents the *exact* brain area responsible for ‘naming letters’, ‘reading’, or ‘recalling memories’. That is, however, not the case. Brain images are *correlational* data, not causational data, because they “identify anatomical correlates of cognitive processes” (Gazzaniga et al., 2009, p. 152). This implies that brain areas identified in scans are the regions in the brain most significantly associated with a specific cognitive task function. This does not mean that these brain areas *exclusively* govern a certain cognitive function, because other areas may be responsible for this cognitive function.

A second misconception, which is related to the first, is that brain images can give the impression that only parts of the brain are activated at any given time. Again, this is a misinterpretation, because the brain does not execute only *one* specified task at a time. The brain is multi-functional and can cope with numerous tasks simultaneously, so there will always be neural activity in every part of the brain no matter what cognitive-specific task is being performed (Gazzaniga et al., 2009). For example, if a person is engaged in a difficult object-recognition task, one may detect activation in task-specific brain regions, but neural activation may also be located in other areas related to visual stimuli processing, pattern recognition, naming of colours, and even long-term memory recall of similar objects seen in the past. Additionally, there will be neural activity in the brain regions for somatosensory inputs (e.g. information about touch, temperature, and limb position) and for the autonomic nervous system (which controls activities of the heart), not to mention other brain regions, which may be activated if the participant is uncomfortable in the noisy fMRI machine or if they are hungry and start thinking about what to eat for lunch. All these neural activities are detected in brain scans, but to avoid cluttered and unreadable images all non-related activities are excluded so that only neural activity related to the task-specific performance is shown (Gazzaniga et al., 2009).

A third misinterpretation is that brain images are *photographs* of a *single* brain scan. This is not the case, because brain images undergo processes of subtractions where non-task activations are excluded − it is therefore not a snapshot of a brain per se, but rather a modified image. Moreover, the final brain image presented is usually not a photograph from *one* person’s brain scan, but rather a fusion of *all* the participations’ brains scans in a specific study. This fusion is done in order to correlate overlapping brain areas with neural activity for a cognitive task, and thus exclude areas which may have been involved due to other and 'interfering' non-task activities. The making of a single brain image therefore implies a complex process of normalisation, subtraction, and extraction of neural data. Brain images are therefore far from real life 'photographs' of a single brain and should be understood as *models,* which represent areas of statistical significance for anatomical correlation to cognitive processes (Gazzaniga et al., 2009; Pasquinelli, 2011). Considering that brain images resemble more a basic map of brain activity statistically correlated with a cognitive task, it is further disputed as to whether these technical images can really say something about our complex cognitive processes. In this respect it has been noted that use of brain scans is like trying to comprehend how a complex organisation works just by measuring electricity usage in different offices − such measurements can tell us something about how activity is distributed and varies over time, but would say less about the actual work being done (Wastell & White, 2012).

Brain images therefore have certain implications and limitations, and these are usually acknowledged by educational neuroscientists when they present and interpret such models. However, the problem with brain images, as with neuroscientific explanations, is that non-experts are seldom aware of the complex processes these models represent. Experts in neuroscience are able to pick up on the correlational data and subtle nuances implied by these images, whilst laypersons in public and political fields may readily simplify, overlook, misinterpret, and confuse neuroscientific correlational data with causational neuroscientific explanations. If one also considers the persuasive appeal of neuroscientific explanation, it is understandable that misrepresentation occurs. Overall, and seeing that similar types of transfer error can be identified in 100 per cent of the brain-based educational programs, in 60 per cent of the media texts, and in 50 per cent of texts by policymakers in my study, this is significant. Even if it is difficult to assess the degree of *intentional* misrepresentation in the discourse of public and political actors, ideas regarding the persuasive appeal of complicated educational neuroscientific research can help to clarify how misinterpretations can also appear *unintentionally* when educational neuroscience is recontextualised to other fields.

Non-experts are liable to misrepresent educational neuroscience, and I argue that certain issues arise when such misrepresentations occur in public and political fields. One central aspect, which complicates the matter, is that brain-based learning industries, media, and political agents' interpretations of educational neuroscience are often distributed in political reports, pop-science articles, brain-based educational programs, in news articles and other mass-media texts. If these actors' interpretations of science are not in line with those of the academic community, misconceptions of educational neuroscience are in danger of being distributed to a large audience. Moreover, if certain sets of educational neuroscientific misinterpretations are repeatedly disseminated within societal discourse there is a probability , in accordance with critical discourse theories (cf. Fairclough, 2010), that these narratives become part of common public knowledge and beliefs. Mass-dispersion of popularised neuro-ideas not only spreads inaccurate 'brain facts' within the public discourse, but also complicates the situation for educational practitioners, because popular understanding is liable to influence knowledge and practice at the level of teachers, students, and school administrators. Faulty reasoning and representations inconsistent with the academic level − intentional or otherwise − can therefore have significant consequences, because educational neuroscientific research often ends up at the level of the classroom, where its applications ultimately affect children and teachers. When correlational data in educational neuroscientific research communities becomes distorted into apparently robust causal representations and interpretations at the public and political level, this can give rise to dissonance regarding the assumed implications and effects educational neuroscientific findings can have for educational practice.

In relation to the academic level of educational neuroscience this is important, because numerous researchers emphasise that educational neuroscience encompasses different levels of analysis and, hence, that there is a 'gap' between findings related to microbiological processes in the brain and more social and practical aspects in educational settings. This 'gap' does not mean that cognitive neuroscientific research and educational research cannot be interlinked, but nor does it imply that neuroscientific explanations can be translated directly into causal explanations, implications, and effects on educational practice. Instead, numerous academics argue that one has to be careful when connecting aspects from different levels, so that one does not reduce explanations from one level to explanations in another.

Neoliberal ideologies in text, discursive practice, and social practice

Within critical discourse theories, the relation between text, discursive practice, and social practice is essential, because it captures how discursive and social practices are manifested in linguistic form (Fairclough, 1992). The *critical* aspect of discourse analysis is often linked to this aspect, and here discursive aspects are often related to ideology and power. In doing so, Fairclough draws upon a critical concept of ideology and understands "ideologies to be significations/constructions of reality (the physical world, social relation, social identities), which are built into various dimensions of the forms/meanings of discursive practice, and which contribute to the production, reproduction or transformation of relations of domination" (Fairclough, 1992, 2010). In the following sections the recontextualisation of the academic level of educational neuroscience to the public and political level is examined using this framework. Attention will therefore be given to traces of ideology found in the public and political fields' representations of educational neuroscience (i.e. texts), and how this may reveal certain constructions of social relations and identities pertaining to the discourse of educational neuroscience (i.e. discursive and social practice). The first section will focus on the linkage of educational neuroscience and neoliberalism found in the political field, whereas the last section will elaborate upon how neoliberal rationalities within the public field can be seen to influence understandings of educational practice, identities, and relations between parents and children.

The product of learning versus the process of learning

Findings from my discourse analysis show how aspects related to educational neuroscience are particularly related to a neoliberal rationality amongst policymakers (seen in 100 per cent of the texts) and amongst interest actors (seen in 80 per cent of the texts). A critical question is therefore whether neoliberal rationality contributes to constructing our understanding of educational neuroscience? I begin by examining the ways in which neoliberalism has been combined with educational neuroscience in the political field. I have previously noted how this can be seen manifested in a particular, recurring argument: Firstly, it is argued by policy actors that neuroscience can be seen as a new 'science of learning' which can serve as an evidence-base for education. It is further argued that by providing new insights into *how* people learn − the mechanism of learning − neuroscience can provide answers to 'what works' in education. This new evidence-base for educational practice can further contribute to crafting more effective classroom strategies and improving students' academic outcomes. Improved student outcomes are profitable for the child's success in education and also later in life, it is argued, and this will ultimately benefit society as a whole in the form of a better workforce and growth of the nation's human capital[238]. In this neoliberal agenda at the political level, it appears that attention is focused on evidence-based education, effectiveness, and outcome measurement of the products of learning.

A neoliberal agenda with an economic logic and focus on the outcomes of learning is, however, not new within educational policy and has been associated with governmental policymakers and intergovernmental actors since the early 1990s. When it comes to policy-makers, it has been noted how "education [is made] a function of economic policy in the knowledge economy" (Rizvi & Lingard, 2006, p. 259). Numerous authors concur and argue that education is influenced by neoliberal market mechanisms, as policymakers submit to principles of efficiency, input-output applications, national competitiveness, concepts of the knowledge economy, standards-based accountability systems, privatisation, decentralisation, and calls for evidence-based practice (Bridges, 2008; Feuer, Towne, & Shavelson, 2002; Lauder et al., 2006). It is similarly claimed that interest actors and intergovernmental organizations such as the EU and OECD have neoliberal educational policies (Guile, 2006; Karlsen, 2006; Rutkowski, 2007), and that:

> …the OECD agenda in education has increasingly become tilted towards social efficiency, as it has promoted a particular ideological view of educational aims linked to the requirements of a global knowledge economy and a range of ideas about educational governance derived from the new theories of public management, which increasingly promote corporatized and privatized administration of education, outcome measures, and knowledge as commodity (Rizvi & Lingard, 2006, p. 248).

Fairclough (2003, p. 58) also elaborates upon the neoliberal economic and political discourse seen in educational fields, and notes how this ideology's value system is highly associated with the assumption that "anything which enhances 'efficiency and adaptability' is desirable". Despite its solid position as a political ideology, the neoliberal agenda in education has been met with a mixed welcome and has created profound debate since its arrival in the early 1990s. The dispute can be understood as a tension between those who promote neoliberal and economic agendas in education, and those who support more social democratic values in educational affairs. Lauder and colleagues (2006) encapsulate the debate by noting that:

> …contemporary societies are marked by deep tension and contradictions between the notions of education and democratization and global change ... First, it has become increasingly clear that a number of ideas associated with progressive schooling − such as inclusion − have lapsed as nation-states focus on the role of education in global economic competition and in particular with raising

[238] As seen in Allen and Smith (2008), Federal Register (2001), Government Office for Science (2012), TeacherNet (2007), US Department of Education (2010), and US Department of Education (2012).

> 'standards' ... Secondly, the focus on skill-based education has marginalized the diverse forms of cultural knowledge available to students in schools and higher education (Lauder et al., 2006, p. 19).

Those who advocate neoliberal management methods in education argues that (some) market mechanisms are beneficial, since free market competition and consumer choice in the educational sector will contribute to improving the quality of educational services. Emphasis is often put on rigid and effective research into 'what works' in education since "a focus on rigorous experiments evaluating replicable programs and practices is essential to build confidence in educational research among policymakers and educators" (Slavin, 2002, p. 15). On the other hand, those who are against neoliberal models argue that economic logic has nothing to do with social fields such as education. Schools, teachers, and particularly pupils ought to be shielded from competition, efficiency, standardised testing, accountability, and input-output regulation, such as documentation of investment and results. Focus on efficiency, rigid definitions of evidence, 'what works', and universal classroom designs reduce the complex nature of education to a narrowly defined 'gold standard' for classroom practice. It is further argued that by perceiving education as business − which ought to be evidence-based and governed by economic market principles − education, the child, and the learning process are placed in an instrumental frame (Biesta, 2007; Fairclough, 2003). The problem is that attention is no longer focused on the *process* of learning, but rather on standardised tests of the *outcomes* of learning, which in turn measure whether education is efficient and profitable (Hardiman et al., 2012). But can the quality of education be measured by pupils' test scores? Is the grade of a B or an A on standardised math tests indicative of effective education, and is it reasonable to compare and rank different school areas (and even nations) based on pupils' test scores? What about the learning process itself? Is it not this, rather than final test measurements, that should be indicative of good education? And what about factors which are difficult to measure by standardised tests − such as the ability to cooperate, aspects of creativity, and values such as justice and democracy − will these become less important under the 'teach to the test' regime? Indeed, the overall problem is not so much with measurements of learning outcomes *per se*, but rather with the underlying shift in ideology of which this instrumental input-output measurement forms a part, since essential values and social principles of education are at risk of succumbing to neoliberal influences.

In light of this, I argue that certain issues arise when the academic level of educational neuroscience is recontextualised and associated with neoliberal rationalities within the political level. Firstly, difficulties arise due to political neoliberal rationality and its focus on evidence-based educational practice. Neuroscience is, as indicated by my findings, often perceived as a suitable scientific basis for educational practice. Already we run into problems, because what is perceived as 'evidence' differs between political actors, educationalists and neuroscientists. Political fields with strong neoliberal agendas often hold rather narrow definitions of 'evidence', which is understood to mean findings from robust scientific research, preferably conducted by use of the 'gold standard' of randomised control trials (RCT). It is further posited that evidence from such research will tell us 'what works' in education, so that one can initiate efficient and universally designed education practices for improved teaching and learning (Biesta, 2007; Wastell & White, 2012). Emphasis on such a narrow definition of 'evidence' can be illustrated by the US Federal Register's notice for research grants on their educational neuroscience project where, under 'priority' for project applications, it is noted that "For research questions that cannot be answered using a randomized assignment experimental design, the proposal should spell out the reason why such a design is not applicable and why it would not represent a superior approach" (Federal Register, 2001, p. 66252). Similar emphasis on robust evidence which can provide effective strategies and 'what works' can also be seen in a political text by the US Department of Education (2010, p. 7), where it is noted how neuroscience and cognitive science can help in making "universal designs for learning" that will provide "more effective learning experiences", and in the following text extract from CfBT Educational Trust's report:

> To date, despite the growing literature, there has been little robust research into where to position neuroscience knowledge and how to use it. Even the most ardent enthusiasts have limited themselves to action research-style project designs with groups of enthusiastic teachers. This innovative research project used a randomised control trial in order to assess the value of neuroscience teaching among Year 7 pupils, and present some encouraging findings in terms of the effect such teaching might have on pupil's beliefs about their own intelligence. The report contains important information for teachers, schools and policymakers about where to position neuroscience knowledge for best effect in the system (CfBT, 2014, p. 4).

My argument is that narrow definitions of evidence are partly associated with neuroscientific, rather than educational, research. This is because the nature of neuroscience is more open to 'robust' research methods such as RCTs with laboratory setups, easily controlled factors, and their provision of 'cause-and-effect answers'. Much educational research, however, is unable to satisfy neoliberal standards for what counts as evidence. Not only is much educational research focused on qualitative modes of study, but the nature of education is also closely interrelated to studies of complex social matters which are difficult to condense within randomised control trials. I will therefore suggest that the supposed ‘robustness’ of neuroscience over educational research helps to explain why numerous policy actors give credence to neuroscience as a promising ‘evidence base’ for education.

Overall, what appears to be a problem is that what counts as ‘evidence’ within the political neoliberal field is often in conflict with the perceptions of the educational neuroscientific research community. Indeed, neuroscientific research makes more use of laboratory research, confined factors, and randomised control trials. But within the contemporary academic level of educational neuroscience, it is felt that neuroscience neither provides ‘cause-and-effect answers’ for how we learn (cf. the discussion regarding causation-correlation), nor does it provide universal designs for ‘what works’ in education (cf. Anderson & Della Sala, 2012; Blakemore & Frith, 2005a). Moreover, the academic level of educational neuroscience has a central focus on *education* and its research is therefore also concerned with social factors and variables that naturally occur in social contexts related to the learning process. In consideration of the double-sided nature of the discipline, I argue that what *ought* to be perceived as ‘evidence’ within the educational neuroscience discourse does not necessarily coincide with narrow definitions of evidence found within a neoliberal and political level of discourse. This is because narrow definitions of evidence will favour neuroscientific research and constricted educational research methods (such as RCTs), at the expense of more complex and qualitative educational research. In light of this argument, political and neoliberal calls for neuroscience to be used as an ‘evidence-base’ for education is controversial, particularly if these calls are founded on a narrow definition of ‘evidence’. I argue that educational neuroscience draws strength from its complex nature, combining natural and social aspects of learning, but if the discourse wants to maintain its integrity as a transdisciplinary discipline, its members ought to be wary of underlying political and ideological currents, which can impede the discipline’s complex social and educational perspectives.

This brings us to my second claim, as I argue that certain issues also arise when political neoliberal ideologies in turn influence the *academic* level of the educational neuroscience discourse − particularly if actors therein are unaware of the implicit difficulties created by a neoliberal value system. What I mean by this is that discourses are liable to influence one another, and thus one can suggest that it is not only educational neuroscience that is recontextualised within the political field, but also that aspects of the political and neoliberal discourse will influence the academic level (cf. Fairclough, 2010). This appears to be the case, because if we look back at texts analysed in the hegemony chapter, one sees that numerous texts from the academic level of discourse have traces of neoliberal vocabulary and rationality. This is evident both implicitly and explicitly in texts, for instance in the following academic statement which calls for a rigorous neuroscientific evidence-base for education:

> Knowledge- and evidence-based approaches to education put forward the fact that educational systems are inadequate to provide an answer to the challenges of the 21st century and claim that education should be guided by scientific principles rather than by intuition and professional wisdom only (or, worse, by tradition) ... The time has come for a new science of learning to rise, which is structured around cognitive and neuroscience, investigates topics that stem from educational problems, and rests on rigorous forms of in-laboratory and in-vivo evaluation (Pasquinelli, 2011, p. 186 [sic.]).

Tommerdahl (2010, p. 107) uses similar neoliberal and political rhetoric for the "foundation of the new science of evidence-based education". Ansari and colleagues (2012, p. 107) also talk of evidence-based education, noting that "neuroscience is one of the fields of inquiry that funding agencies and policymakers have turned to for answers to large-scale educational problems". Carew and Magsamen (2011) appeal to political neoliberal ideologies by claiming that 'Neuro-Education' can create more effective teaching methods, better curricula, and ultimately inform and transform educational policy. Finally, Goswami (2008 p. 396) stresses how cognitive neuroscience "enables an evidence base for education in which mechanisms of learning can be precisely understood". Traces of neoliberal ideology are therefore also manifested within the *academic* level of the educational neuroscience discourse.

The central and critical question is whether this neoliberal undertone is intentionally used by these academic actors as a socio-political argument for neoliberal ideologies, or if these authors merely use contemporary 'catchphrases' without being aware of the neoliberal ideology which lies behind the idioms. If the former is the case, and educational neuroscientific actors *deliberately* make use of a neoliberal agenda, then this can be seen as a strategy for manifesting an ideological premise within their text. However, if actors *unintentionally* make use of neoliberal phrasings, then this may indicate that the academic level of the educational neuroscience discourse is under the influence of political and neoliberal ideologies *without* being aware of it or the implications of these ideological rationalities. Unintentional adoption of ideological undercurrents by academics may be understandable, if one considers that policymakers and interest actors often initiate substantial research projects and research grants − often with comprehensive directives for the intended research. Since research directives are liable to echo political ideology and perspectives – for example by emphasising rigorous methods like RCT (seen in CfBT, 2014, and Federal Register, 2001) − academics may also readily adopt such perspectives as a strategy for obtaining research grants. I argue that what is problematic with an uncritical adoption of ideological rationalities is that educational neuroscientists may manifest and reproduce neoliberal rationalities within their discourse but *without* being aware of the implicit premises of this ideology.

I suggest that unintentional ideological adoption frequently happens, considering that numerous authors within the academic level of the educational neuroscience discourse implicitly hold dual ideological perspectives. On the one hand, it is common within the educational neuroscience discourse to emphasise *reciprocal collaboration* between neuroscience and education, and the important perspectives on complex social relations within the learning process which educational researchers and practitioners can contribute [239]. It is therefore a paradox that the same educational neuroscientific community also echoes neoliberal rationalities, with an instrumental focus on 'evidence-base', 'outcome measurements', the 'science of learning', 'rigorous laboratory-research' with 'randomised controlled trials', and research into the 'the mechanism of learning'[240]. Within the educational field, where debates concerning the logic of the knowledge economy have simmered since the 1990s, these 'buzz words' are strongly associated with neoliberalism. Moreover, many educationalists see this neoliberal rationality as constructing an instrumental and simplistic understanding of educational research, the learning child, complex social relations, and a reduction of the learning process to learning outcomes. It is understandable that many educational neuroscientists, particularly those with a neuroscientific or psychological background who may not have encountered this ideological debate, adopt ideological rationalities without being aware of the longstanding controversy around them. Nevertheless, I argue that it is important for members of the educational neuroscientific community to become critically aware of their own ideological positioning, so that they not unintentionally undermine values important for education[241]. Instead of uncritically reproducing neoliberal ideologies, I suggest that actors from educational neuroscience's academic level have a significant opportunity to contribute to a shift in focus. Not only can the discourse's

[239] E.g. as seen in Varma et al. (2008), Goswami (2009), Christodoulou and Gaab (2009), and Stein and Fischer (2011).
[240] E.g. as seen in Pasquinelli (2011), Ansari etal. (2012), Tommerdahl (2010), Goswami (2008), Carew & Magsamen (2011).
[241] This is also of note with regards to the resistance educational neuroscience meets within the educational sphere.

highlighting of the complex and variable social side of *education* act as a counterweight to a strict and narrow neoliberal focus, but educational neuroscience's aim of understanding *how* we learn − i.e. understanding the *process* of learning − can also help to counterbalance the neoliberal focus on the products of learning and test scores (cf. Hardiman et al., 2012). The discourse of educational neuroscience is still in its early stages and as an academic and reciprocal cross-disciplinary endeavour, I suggest it can benefit by discussing its educational and political ideological orientation, instead of uncritically accepting ideologies suggested by intergovernmental organizations and policymakers.

Reduction of the learning process and the individual child

Whereas policymakers and interest actors at the political level tend to couple educational neuroscience with a neoliberal rationality, findings from my analysis indicate other tendencies at the field of media and brain-based learning industries. These two public fields have, as already shown, the greatest number of unscientific representations of educational neuroscience − for example, in simplistic presentations of science used in order to sell sensational stories or brain-based learning programs. Within a critical discourse analytical framework, frequent misrepresentations are significant, because these can contribute to the construction of certain understandings of reality (cf. Fairclough, 2010). The issue I want to highlight in the following section concerns the ways in which media and the brain-based learning industry tend to depict the individual child and the learning process, and how this in turn can construct certain social practices by implicitly defining social relations and identities.

My argument, based on my discourse analytical findings, is that these two fields repeatedly reduce both the learning process and the individual child to mechanical and instrumental conceptions. This instrumental perception can particularly be demonstrated by two examples from the corpora. Firstly, it is evident that the individual child is conflated to properties of his or her brain, for instance by attributing personal skills to aspects of the brain. Conflation of the whole (the learning child) to one of its parts (the brain) is seen in several media texts and brain-based educational programs, revealed in statements like "focus on activities that students' brains enjoy doing" (Kagan, 2014), "feed your brain ... dehydration is bad news for your brain" (Wighton, 2007), "how to teach young brains" (Carey, 2009), and "it is your sequential, time-oriented left hemisphere which tells you how to think" (Scholastic, 2014) (see also table 7.1 and 7.2). Secondly, instrumental perceptions of the child and learning processes are seen in how cognition and learning are presented as something mechanical, objectified and almost external to the learner, evident in statements like “we can actually grow better brains in our children” (Kagan, 2014), and in how cognition and the brain is described as ‘brainpower’ that can be ‘activated’, ‘tuned to perform optimally’, ‘boosted’, ‘generated’ or ‘switched on’ by, for instance, pushing certain ‘brain buttons’ − activities which will ultimately “produce shiny, happy children”[242].

I argue that instrumental and objectified conceptions of the child and the learning process, and the conflation of characteristics of individuals to their brains, are representations which are generally in conflict with the views of the academic community of educational neuroscience (cf. Kraft 2012; Wall, 2004). Most educational neuroscientists are cautious in ascribing characteristics of the individual to her/his brain (Kraft, 2012), since it is scientifically meaningless to say that one should “focus on activities that students’ brains enjoy doing” or “how to teach young brains geometry”. The *brain* does not have feelings and cannot enjoy or dislike anything; nor can it hear what a teacher says or see which geometrical figures a teacher draws on the blackboard. The *child,* on the other hand, has feelings and can hear and see and learn. I further argue that it is scientifically illogical to say that one can ‘turn on’ cognition in a child. The brain, cognition, and also cognitive development are not something that can be switched on or off − it has one state only, which is *on* (one is clinically dead otherwise, since bodily functions like breathing and heartbeat cannot function without brain activity). ‘Boosting’ and ‘tuning’ of ‘brainpower’ by presenting a child with enriched environments or certain stimuli − such as ‘brain-boosting hobbies’ or making them chew gum − also contradict the educational neuroscience research community’s conception of the learner and the learning process. The word ‘brainpower’ is problematic, since the only ‘power’ one can measure in the brain is the increase or decrease of neural activity in certain brain areas (Gazzaniga et al., 2009). Intensification of neural activity in the brain is, however, not an indicator for learning or ‘boosted IQ’, because neural activity in different parts of the brain will be amplified depending on the activity in progress − whether singing a song or catching a ball. Increases in neural activity often happen automatically and the perception that ‘brainpower’ is something the child or even parents can boost, just like turning up the stereo, does not correspond with what is known in academia.

[242] As also demonstrated in BBC (2013), Brain Gym® (2014), Carlyle (2014), James (2014), Kagan (2014), Starskills (2014), The Guardian (2004), Wighton (2007), and Whipple (2012). See table 7.1 and 7.2.

I further suggest that the main problem with brain-based learning industries and the media's *mis*representations of the brain, cognition, the individual child, and the learning process, is that these presentations are liable to construct (unscientific) knowledge of reality. Because these texts reach a rather substantial audience, misrepresentations are also liable to manifest themselves in discursive and social practices within the public field (cf. Fairclough, 2010). The critical question, then, is what effects such a mechanical and instrumental focus on children and learning might have on public understandings of individuals, social relations, and practices? Besides from presenting statements which do not correspond with contemporary science, what is really problematic in articulating the brain, cognition, children, and learning processes within an instrumental and mechanical framework?

In order to answer these questions, I will highlight three recurring and problematic perceptions found within the field of media and brain-based learning industries. Apart from spreading unscientific knowledge regarding educational neuroscientific matters, I argue that the following are examples of unhelpful relations and practices at the public level:

i) Detachment of the child from the learning process
ii) Simplification of the learning process
iii) Children's learning is a parental responsibility

The first issue that reverberates in discursive and social practice is the *detachment of the child from the learning process*. By repeatedly conflating characteristics of the child and the brain, and presenting both the brain and cognition as almost objectified and external from the individual, the learning process is separated from the child. By constantly making statements such as 'it is your left hemisphere which tells you how to think' or 'by pre-school the brain can begin to grasp geometric definitions', the media and brain-based learning industry are constructing a representation of reality where the individual is detached from the learning process. In such an instrumental and objectified view of the learning process, one can easily be persuaded that it is not the *child* who struggles with geometry, but his or her *brain* that simply cannot grasp this mathematical concept. I argue that such detachment of the child from the learning process is problematic, because it takes away the child's responsibility for learning. Moreover, by objectifying the brain into an external mechanism disconnected from the individual, one is at risk reducing children's sense of agency within the learning process. Detachment of the child from the learning process poses significant challenges to important aspects of learning, such as motivation, drive for improvement, feeling of reward for effort, responsibility and sense of ownership of one's learning progress.

Mechanical misrepresentations of educational neuroscientific concepts do not only relieve the child of responsibility for learning. Instrumental representations also trivialise the neurobiological, cognitive, and social processes of learning. This *simplification of the learning process* is connected to the objectification and mechanisation of the brain and cognition, where the process of learning is understood as having an instrumental input-output logic. This is seen in the frequent assumption that just by presenting a child with the right kind of stimuli at the right time − it being 'brain-training' or 'brain-boosting music' − then one will optimise brainpower so that the child becomes smarter. What trivialises the learning process even further is that media and brain-based learning industries tend to suggest rather sensational and easy-to-do strategies for 'boosting brainpower'. Indeed, they present the alluring idea that one just can 'push brain buttons', 'chew gum', 'pop smart pills', 'go for a run', or 'play an instrument' to become smarter. The issue with such misrepresentations is that the media and brain-based learning industry reduce the complex neurobiological, cognitive, and social process of learning into a simplistic and mechanical input-output logic, where it even is suggested that drinking a cup of hot chocolate before bedtime can make you clever (see table 7.1 and 7.2).

The third issue concerning discursive and social practices is that *children's learning is increasingly becoming the parents' responsibility*. If learning implies correct input for beneficial output and if it appears that children's agency in the learning process is reduced, then someone external has to ensure that 'the child's brain becomes optimised'. One can assume that much responsibility is devolved to teachers − given that educating children is their job – but, surprisingly, many media texts and brain-based educational programs also have a strong appeal to *parents*. This can be seen in tips regarding "how to raise smart kids", suggestion that "parents should make their children play musical instruments when in their nappies", recommendation for "creating enriched home environments", and suggestions for "brain-boosting hobbies your child must try". The 'growing' and 'producing' of smart children is also often presented as something parents must do in order to make sure their children succeed in school and also later in life. I further argue that this can be linked to general trends in society, where attention to human capital and competition within the global market has made it increasingly important for individuals to succeed in education as this will determine success later in life. It has accordingly become important to gain educational advantage *outside* standard school settings, since this is seen to improve school outcomes and give students a head start in educational competition. In light of this, I suggest that the importance of individual success in the global knowledge-economy, and a frenzy for early cognitive development and enriched home environments, have fostered a market for brain-based learning programs and media stories on brain-boosting techniques. It therefore appears that parents are increasingly being made accountable for producing 'shiny, happy and smart children'. These views are problematic, since they contribute in the construction of particular practices and social relations. The accountability of parents for optimising their child's brain not only helps to strengthen the marketplace for unwarranted brain-based learning tools and sensational (but unscientifically based) media stories, but also promotes the idea of passive children who are detached from their brains, their cognition, and their learning process.

Previous sections discussed the political field and the neoliberal rationalities manifested within it, but there also appears to be certain echoes of neoliberalism in how education and neuroscience are represented in the public field. Neoliberal ideology suggests an *instrumental* view of education, as can be seen in the jargon of input-output rationalities, efficiency, and measurements of products and results (Fairclough, 2003). I have argued that similar instrumental views are echoed in mechanical and objectified descriptions of the child's brain, cognition, and the learning process, found in numerous media texts and brain-based education programs. Wall has made related connections in her study on 'mothering in the age of new brain research' (Wall, 2004, p. 41), noting that claims about early education and brain stimulation have placed significant accountability on mothers "with whom the majority of responsibility for child outcome is placed". Although Wall studies the child rearing advice literature and discourse, and not the educational neuroscience discourse as discussed in my current study, she has drawn similar links to neoliberalism by noting how "many of the taken-for-granted understandings that underlie the parenting advice based on new brain research also mesh with the tenets of neo-liberalism" and how "[numerous authors have] noted a seeming shift in child rearing ideology toward maximizing and perfecting children" (Wall, 2004, p. 46). It is argued that the ideological undercurrent here is the neoliberal construction of social problems as problems for the individual (Fairclough, 2000; Wall, 2004), which in turn underscores the idea that parents are accountable for the potential − as well as the failure − of the child as a self-reliant entrepreneur of the future. This linkage to neoliberalism also corresponds with findings from my critical discourse analysis, where it is almost taken for granted that parents must ensure the 'brain-boosting' and 'production' of smart children in order to guarantee their success later in life.

Instrumental rationality, specialisation of systems and means-ends agendas found within the modernisation process have also been noted by Habermas (1984), and Fairclough has further drawn links between contemporary society and neoliberal discourse by claiming how “specialization of systems depends upon a development and refinement of an ‘instrumental rationality’ in which action is strategic – people act (and act upon other people) in ways which are oriented to achieving results, greater ‘effectivity’ or ‘efficiency’ and so forth” (Fairclough, 2003, p. 110). Again, this resonates with my findings from the media and brain-based learning industry’s presentations of educational neuroscience − and indeed also with how policymakers rearticulate educational neuroscience within a neoliberal framework with a focus on finding a neuroscientific evidence-base for ‘what works’ and effective classroom strategies. Accordingly, one can draw on Habermas’ (1984) analysis of the modern discourse, with its ‘colonisation of the lifeworld by systems’, and make similar links concerning the recontextualisation of educational neuroscience to the public and political field. By recontextualising topics relevant to educational neuroscience within an instrumental and objectified framework, the focus is drawn away from a complex neuro-biological, cognitive, and social learning process to a simplistic and instrumental input-output mechanism of learning. Moreover, the link between education and neuroscience also appears to be used as a strategic action oriented toward means-end rationalities, where a common goal amongst policymakers, brain-based learning industries, and media is the production of ‘smarter children guaranteed success later in life’. This strategic action is additionally seen in how public and political agents act (and act upon parents, teachers, and children) in order to ‘produce smarter children’, and to achieve higher IQ scores, improve educational results, more effective teaching strategies, rigorous test regimes, individual success, a capable workforce, and overall societal effectiveness[243]. The problem is that colonisation of the lifeworld by systems can end up reducing aspects of education, the child, and the complex learning process to trivialities. Conversely, educational neuroscience is concerned with the complex process of learning where, indeed, it is acknowledged that learning not only encompasses individual neurobiological and cognitive aspects of learning, but also the societal, pedagogical, interactional, and ethical aspects of education. Studying the influence of ideological undercurrents from the political and public fields on these complex processes related to learning is therefore essential for the discourse − particularly if public and political

[243] As seen in Allen and Smith (2008), BBC (2013), Brain Gym® (2014), Carlyle (2014), CfBT (2014), James (2014), Kagan (2014), Starskills (2014), TeacherNet (2007), The Guardian (2004), Wighton (2007), Whipple (2012), Government Office for Science (2012), US Department of Education (2010), and US Department of Education (2012).

understandings contribute to shaping public knowledge, social relations and practice in a way that impedes the important strides made by the more serious academic community of educational neuroscience.

Summary of the discussion

In this chapter I have shown how the academic level of the educational neuroscience discourse is recontextualised in the fields of brain-based learning industry, media, policy-makers, and interest actors. My analytical findings show that the brain-based learning industry has most inaccurate presentations of educational neuroscientific research (in 100 per cent of the texts), followed by brain-based educational programs (viz. 80 per cent), and text by policymakers (viz. 50 per cent). From this, I argue that the fields are suggestive of appropriation strategies rather than colonisation strategies, as relationships between these agents and academic agents are dominated by a one-way dialogue where educational neuroscience is often uncritically presented without support from scientists. One-way dialogue is problematic in that it can lead to uncritical readings of scientific literature, unscientific re-interpretations, and misinformed re-presentations of educational neuroscience.

Findings from my discourse analysis, as well as indicating translation inconsistencies occurring along educational neuroscience's line of transference, also show how aspects of educational neuroscience are particularly related to a neoliberal rationality. This is seen in all the texts by policymakers, and in 80 per cent of the texts by interest actors. In the critical discussion of these findings, I reflect over issues related to ideological under-currents in the discourse, views related to the product of learning versus the process of learning, and difficulties arising when ideological rationalities are uncritically and unconsciously adopted by actors within the educational neuroscience discourse. In the final discussion, problems are raised, related to representations in media and the brain-based learning industry. Here, my argument is that these two fields repeatedly reduce the learning process and the individual child into mechanical, objective, and instrumental conceptions. These representations are in conflict with perceptions held at the academic level, since the educational neuroscientific research community emphasises the importance of both individual neurobiological and cognitive aspects of learning, as well as the societal, pedagogical, interactional, and ethical considerations of education.

Chapter 8

Recontextualisation over scalar borders

In previous chapters, it was noted how educational neuroscience is prominent as an academic discipline internationally, and also how topics pertaining to educational neuroscience have been recontextualised to other public and political fields. In this chapter, the focus of attention will be on how the discourse is recontextualised from an international to a *national* scale by analysing the ways in which educational neuroscience has been recontextualised to Norway. In order to investigate recontextualisation processes over scalar borders, traces of educational neuroscience are studied within academic, public and political fields in Norway. The reason Norway was chosen for this study is partly due to my Norwegian nationality and the resulting, inherent understandings of national academic, public and political discourses. I also argue that Norway is a valuable case study, because it appears that this country only recently developed an interest in the linkage of education and neuroscience. Seeing that Norway gives the impression of being at a rather early phase in the introduction of educational neuroscience, it can thus act as an abundant source of evidence when investigating recontextualisation processes. In light of this, the overarching aim is to investigate the ways in which educational neuroscience is represented in a Norwegian context: how is educational neuroscience viewed by academics in Norway, how do media present this topic, and which views are taken into considerations in Norwegian educational policy documents? Are any of these three fields more prominent in representing educational neuroscience than the others, and how do their representations correspond with the international academic discipline of educational neuroscience? In order to address these questions, the chapter commences by presenting findings from my critical discourse analysis of how educational neuroscience is recontextualised in the academic, public, and political field in Norway. Following this, comparisons will be drawn to the international educational neuroscience discourse, before a more critical discussion of the recontextualisation processes found in Norway is presented.

Educational neuroscience recontextualised to Norway

My general literature searches show that traces of the linkage between education and neuroscience are rare in Norway, in comparison to previous literature searches. To a certain extent this is to be expected, considering that search criteria were restricted to Norwegian national borders, whereas previous international searches do not have such constraints. Even so, it is obvious that there are fewer relevant Norwegian texts than might have been expected in a nation where the discourse of educational neuroscience is already established as a distinct discipline (such as in England or the USA). The lack of textual references does not, however, indicate that linkages of education and neuroscience are non-existent within Norwegian fields. Literature searches for relevant Norwegian texts generated 452 849 hits, indicating that topics pertaining to educational neuroscience have caught the interest of some actors in Norway. In order to elaborate upon these findings the following sections discuss educational neuroscience's recontextualisation in the academic-, public-, and political field in Norway − including relevant comparisons with the international level of discourse. Even if comparison between a single country and an international context is not really a fair comparison, due to quantitative differences, analogies between Norwegian and international discourses of educational neuroscience are nevertheless presented − albeit as a comparison for the purpose of context resemblances and not as an attempt to suggest significant correlations between the two.

The Norwegian *academic* field

Considering that the central nexus in this PhD-project is the international and academic level of the educational neuroscience discourse, I begin by discussing how educational neuroscience is recontextualised to the *academic* field in Norway. Firstly, it must be stressed that educational neuroscience has not, so far, become firmly established as an academic discipline or even as a significant cross-disciplinary project in Norway − at least, not in comparison to the level at which it is found amongst universities and research groups internationally. The literature searches and discourse analysis conducted for Norwegian academic texts pertaining to educational neuroscience therefore have slightly different criteria than my analysis related to the international academic field of educational neuroscience[244]. Literature searches for the Norwegian academic analysis include, for instance, a broader range of pertinent disciplines, and the chosen texts feature educational neuroscience less explicitly than most texts within the international and academic field. Nevertheless, a total of eight texts were selected for the final analysis of educational neuroscience's recontextualisation to the Norwegian academic field − to be precise: Kennair (2008), Nielsen (2011), Lindholm (2012), Solli (2010), Lunde (2011), Egge (2012), Sund (2014), and Dehaene (2014). These texts are published in academic journals ranging from psychological- and educational journals to scholarly magazines such as '*Lektorbladet', 'Skolelederen',* and *'Rus & Samfunn'*[245]. This collection demonstrates the diversity of disciplines, and their respective journals, wherein one can find topics pertaining to education and neuroscience in Norway.

If we start by looking at how these Norwegian academic texts represent, incorporate, and recontextualise the educational neuroscience discourse, some findings should be highlighted. Firstly, many of the texts found in the literature search − and also 37,5 per cent of the academic texts selected for the final corpora[246] − do *not* write about linkages between education and neuroscience *per se,* but focus on an overarching debate concerning the linkage between natural sciences (viz. nature and biology) and social sciences. One example is the text by the evolutionary psychologist Kennair (2008), who claims that one can find a futile "either-or-thinking", a "biophobia" and "bio-naivety" amongst Norwegian social scientists. Another example is provided by the sociologist Nielsen (2011), who reflects upon the relevance of biological explanations (e.g. neuroscience) in humanistic and social sciences (e.g. gender research). Nielsen neither discounts biological explanations, nor does she uncritically advocate biological perspectives in social sciences − emphasis is instead put on different levels of analysis and the challenges this brings forth:

> Natural sciences do not represent any final or objective truth, rather, they constantly try to approach it, just like the social sciences. It is, at the same time, important to be aware that questions both can and should be asked at different levels and that these cannot be reduced to one another (Nielsen, 2011, p. 293 [my translation]).

The crucial point in this respect is, in accordance to Nielsen (2011), that one has to acknowledge which research questions can be answered by biology and which questions can

[244] For a comprehensive clarification on the criteria used for my literature search and critical discourse analysis see page 113-118 in chapter 4 in addition to appendix B.

[245] Correspondingly these can be translated '*Teachers' Magazine*', '*The School Leader*', and '*Drugs & Society*'.

[246] This can for instance be seen in Kennair (2008), Nielsen (2011), and Lindholm (2012).

be answered by social sciences. These two examples are just a fraction of the material found on this topic, as my literature search reveals that academic articles problematizing “the gap” between natural sciences and social sciences appear to have grown in number during the last few years. One particular catalyst for this increased discussion appears to be the Norwegian television program *‘Hjernevask’* (*‘Brainwash’*), which is a pop-scientific documentary on nature-nurture debates that was aired in 2010 (NRK, 2010)[247]. Despite it being a media program − and despite the criticism the show has received for its interview presentations − *Brainwash* caused a significant academic and public debate. Not only does the show appear to have provoked discussions concerning biological and sociological explanation in social sciences, but it also seem to have drawn attention towards the borderlines between strongly-held academic traditions and disciplines in Norway[248].

Despite this overarching debate concerning biological explanations in social sciences, results from my literature search and discourse analysis also identify academic texts on the specific linkage of *education* and *neuroscience*[249]. The way in which these academic texts present the relation between education and neuroscience differ, as do the authors’ views on the advantages of such linkages. For instance, Egge (2012) and Sund (2014) present interviews with a biological psychologist and with brain scientists respectively, as they elaborate on practical aspects of education and neuroscience. Solli (2010) also presents an interview, but this is with an educationalist, who express surprise over political request for more neuroscientific perspectives in pre-school research, whereas Lunde (2011) has an article on the use of cognitive enhancers to increase academic performance, and how usage of such ‘smart pills’ is growing within academia in Norway. It is interesting that 80 per cent of the Norwegian academic texts on the linkage of education and neuroscience convey a top-down view where neuroscience is hierarchically superior to education[250]. An example of this is the text *‘How the brain learns’* by Egge (2012). The text is published in a journal for schoolteachers and is based on an interview with the biological psychologist Sigmundsson.

[247] *Brainwash* is a documentary series co-produced and presented by the renowned Norwegian comedian and sociologist Harald Eia. In each episode Norwegian and foreign researchers are interviewed on topics related to the nature-nurture debate. After being questioned on sensitive thematic such as “gender”, “gay/straight”, “violence” and “the parental effect” Norwegian social scientists are, more often than not, shown to reject biological explanations in these matters. In stark contrast to clips from international researchers, who are featured as they criticise Norwegian scientists’ for their lack of nuanced views on reciprocal influences between nurture *and* nature. *Brainwash* has received significant amount of critique for its pop-scientific staging, as it is claimed that the program has “the intention of knocking Norwegian scientists off their perches”, making them appear ignorant and ridiculous in the presence of prominent international researchers (Bjørkeng, 2011).

[248] As seen mentioned in Nielsen (2011), Lindholm (2012), and Vassnes (2010).

[249] As seen in Solli (2010), Lunde (2011), Egge (2012), Sund (2014), and Dehaene (2014).

[250] As seen in Solli (2010), Egge (2012), Sund (2014), and Dehaene (2014).

Sigmundsson is introduced with the quote "Through my knowledge of biology and brain science, I have also learned a lot about learning. It is therefore nearly impossible [for me] not to have any opinions about schools and education" (p. 14 [my translation]), before his criticism of the Norwegian educational system is presented. His criticism centres on educationalists' neglect of taking biological and psychological research into consideration and how "contemporary education suffers from fear of biology ... It seems that everything remotely resembling biological explanations is kept at arm's length" (Sigmundsson, in Egge, 2012, p. 14). A proposal for "an ideal timetable" for the first four years in school is then suggested, "founded in biological research conducted to discover how the brain learns best" (p. 16). The proposed recommendations for school practice are neither too controversial, nor do they seem to diverge much from presentations found within the international and academic level of the educational neuroscience discourse[251].

However, the ways in which Egge and Sigmundsson present the linkage of education and neuroscience seem to denote a subtle top-down view where neuroscientific and biological explanations are given predominance at the expense of educational and social theories. I argue that this is due to the overall structure, phrasing, and presentation in the article, which seem to denote an idea of a superior brain-scientific research that can come to the aid of educationalists. This can be seen in how the contemporary Norwegian school system is presented as a failure in that it "produces educational losers" (Egge, 2012, p. 14) and the suggested solution is to start building educational practice on biological and psychological knowledge of "how the brain learns best". Even though a link is drawn between education, psychology, and brain science, no clarification of the precise nature of this linkage is given, nor are any relevant educational or social perspectives offered regarding the topics discussed. This neglect of educational and social perspectives is especially noticeable in the repeated stressing of the phrase "how the *brain* learns best" (instead of "how the *child* learns best"), which contributes to an impression that the complex process of learning is reduced to a focus on individual biological and cognitive neuroscientific perspectives. Conflation of qualities of the whole child (viz. learning) to its parts (viz. the brain) has already been elaborated upon in previous chapters, but it is worth mentioning that such reduction of the child, as a complex

[251] Example from Sigmundsson's timetable proposed for schools: "Start the day with 30 minutes physical activity. This gives better order in class" and "Most important is individual supervision, many repetitions and challenges, everything after the [individual's] level of skills" (Egge, 2012, p.16).

learning individual, does not correspond with the general values of the international and academic level of educational neuroscience.

It is not only in the texts by Egge (2012) where one finds a top-down view where educational and social perspectives are subtly neglected in the linkage of neuroscience and education − the text *'Music lessons improve learning'* by Sund (2014) also appears to have similar top-down perspectives. Sund notes "how playing musical instruments has a positive effect on children's intelligence" (p. 7 [my translation]) by referring to an interview with two scientists − to be precise, two *neuro*scientists. Although this article is about a topic highly relevant for education, educational theories appear to be neglected. Some reference is made to educational practice, however, as the author mentions the head teacher of a Norwegian culture and music school and her views on the 'effect of musical lessons'. "She can confirm that she observes cases where pupils having success at the culture school also have success at school. She [the head teacher] thinks this is caused by their music lessons − lessons where pupils become familiar with using relevant skills and where they acquire the ability to work in a thorough and structured way" (Sund, 2014, p. 9). I argue, however, that this 'confirmation' of the effect of music lessons is dubious, since the author commits the syllogistic fallacy. This reasoning fallacy, as mentioned in chapter 7, blurs the lines between causation and correlation by using a faulty logic of reverse inference and circular reasoning by confusing 'A causes B' to also imply that 'B causes A' (cf. Hruby, 2012). In this case, how can one know if a child who is successful in school gets his or her diligent and structured study skills from music lessons, or if diligent and structured children are the ones most likely to apply for, and succeed in, music education?

Another example of a top-down perception of the linkage between education and neuroscience is the public lecture held by Dehaene (2014) in association with Kavli Public Lecture in Trondheim. Dehaene is a French cognitive psychologist who focuses on brain areas relevant for reading and mathematics, and in the occasion of Kavli Week in Norway in 2014 he held an open lecture titled *'The matter of education'* (Dehaene, 2014). In public announcements of this lecture, both distributed in the local newspaper and amongst faculty and staff of the University of Trondheim (NTNU), educators and teachers were particularly encouraged to attend. In the lecture program posted at NTNU's webpages it was, for instance, stated that:

> Stanislas Dehaene will talk about what happens in our brains when we learn to read and calculate, and how this knowledge can be used by educators ... The lecture will be an eye-opener and will fascinate educators concerned with the contested issues of how we learn to read, calculate, and of pathologies like dyslexia (NTNU, 2014 [my translation]).

Despite invitation for educationalists to attend, the presentation held by Dehaene was of a technical nature, in that he used difficult neuroscientific theories and complex neuro-methodological graphics. Overall, the lecture appeared to be highly specialised in its form and the language used was difficult to understand for anyone without an academic background in cognitive psychology or neuroscience. After about 50 minutes of lecturing on intricate topics such as "How learning to read changes the cortical networks for visual language" and "The VWFA connects preferably to temporal and inferior frontal language areas", approximately 5 minutes were dedicated to "Consequences for education" (Dehaene, 2014). The bullet-points presented under this slide were short and seemed to lack in-depth understanding of educational theories and practices relevant in these matters. In one of Dehaene's bullet-points for educationalists, for instance, he concludes that "many children can struggle to read" − surely an observation one can make just by poking one's head into any regular classroom. As such, Dehaene's lecture on "the matter of education" appears to present a top-down view, where cognitive psychological and neuroscientific theories are put forward as aids for educationalists, but where few, if any, substantial links are drawn with educational theories.

One final and, in my view, important aspect with regards to the Norwegian context is that my analytical findings did *not* identify a single reference to the international discipline of educational neuroscience (or Brain, Mind and Education if one prefers) in any of the eight Norwegian academic articles[252]. This is significant, particularly as many of these texts explicitly mention linkages between education and neuroscience. The question, though, is whether these authors are familiar with the established international discipline of educational neuroscience (but chose not to mention it in their texts), or if these authors are unaware that such an international discipline on the linkage of education, psychology and neuroscience even exists. This aspect, in addition to the findings already mentioned above, will be further discussed, and critically reflected upon, later in this chapter.

[252] That is, neither in Kennair (2008), Nielsen (2011), Lindholm (2012), Solli (2010), Lunde (2011), Egge (2012), Sund (2014), nor Dehaene (2014).

If we shift focus to a comparison between a Norwegian context and the international level of the educational neuroscience discourse, certain aspects ought to be highlighted. What first can be noted is that the most significant difference between educational neuroscience's dispersion internationally and in Norway is, as I argue, found within *academia*. Whereas educational neuroscience has become established as a distinct academic discipline internationally during the last decades − indeed, this is the central nexus of my dissertation − the linkage between education, psychology, and cognitive neuroscience has not so far managed to gain the same foothold within the Norwegian academic field. This is, first of all, evident in the few hits resulting from literature searches for Norwegian academic articles pertaining to education and neuroscience. The minimal impact of educational neuroscience within the Norwegian academic field can, secondly, be demonstrated by the lack of academic debates, conferences, and collaborative research projects on the topic. Thirdly, whereas the majority of international academic texts on educational neuroscience are published in high ranking peer-reviewed journals (such as *'Educational Researcher'* and *'Journal of Philosophy of Education'*), Norwegian articles on the specific linkage between education and neuroscience are not featured in renowned Norwegian educational journals − rather, they are often found in less distinguished scholarly magazines such as *'Lektorbladet'* and *'Skolelederen'*. This reinforces the impression that prominent academic debates on educational neuroscience are relatively absent within the Norwegian academic field. A fourth and even more striking aspect, which speaks to the lack of recontextualisation within the Norwegian academic field is that *not one* of the academic texts mention the international discipline of educational neuroscience (or Mind, Brain, and Education) − this despite the fact that they all write about topics connected to such linkages.

Even if debates concerning educational neuroscience appear to be relatively absent in more distinguished Norwegian academic journals, these journals do publish discussions regarding disciplinary intersections between natural and social sciences. The debates are centred on a range of themes, from nature-nurture debates to discussions on biology versus sociology, but a common trait is whether or not one should take natural scientific explanations into consideration in social sciences[253]. I suggest that this can be seen as an *overarching* scientific debate that implicitly touches upon numerous aspects that are also highly relevant for the specific linkage between education, psychology, and cognitive neuroscience (viz. the educational neuroscience discourse). This more general scientific debate is of note, since it is

[253] This can for instance be seen in Kennair (2008), Lindholm (2012), and Nielsen (2011).

suggestive of a growing problematization of borderlines between natural sciences and social sciences within the academic field in Norway. My earlier emergence analysis suggests that similar problematization of discursive borderlines between natural and social sciences are found in the earliest stages of educational neurosciences' development internationally (viz. chapter 6). Time will show if a more prominent academic debate concerning linkages of education and neuroscience may also grow out of this increasing problematization of traditional scientific borderlines in Norway.

Another aspect of overarching nature-nurture debates within the Norwegian academic field is how many of the authors appear to hold relatively similar views, regardless of whether or not they argue for using more natural scientific explanations in social research. I suggest, moreover, that the different 'stands' taken in this matter are more like strategies used by authors in order to *protect* their disciplinary traditions, rather than any denial of possible connections between natural and social explanations in human behaviour and social matters. This can be seen in all three articles concerning the overarching scientific debate, where it is acknowledged that the nature-nurture question ought to be perceived as a complex relationship, wherein one can find reciprocal influences between the two. The texts accordingly express an awareness of different levels of analysis between social and natural scientific disciplines, where problems of reductionist approaches are addressed[254]. These views are in accordance with the position 'cautious optimism' in the international academic debate on educational neuroscience, as reciprocal collaboration, caution regarding reductionism, and different levels of analysis are also emphasised here, although with reference to the specific linkage between education, psychology and cognitive neuroscience and not to the general linkage between social scientific and natural scientific explanations.

The Norwegian academic texts that actually mention an explicit linkage between education and neuroscience however, differ from other international academic texts regarding educational neuroscience. It has previously been stressed that a common view amongst educational neuroscientists in the international discourse is a cautious optimism, which stresses reciprocal collaboration between the disciplines of education, psychology, and neuroscience. In Norway, though, four out of the five academic articles on the specific linkage of education and neuroscience seem to convey a top-down view, in which neuroscience is

[254] As seen in Kennair (2008), Lindholm (2012), and Nielsen (2011).

almost represented as a superior "advisor" which can help to answer educational questions[255]. Whereas one of these texts expresses aversion to such disciplinary relations, the remaining three authors seem to express an optimistic tone regarding neuroscientific guidance in educational matters. This optimistic top-down view of a neuroscientific-education relation is particularly notable, considering that two of these texts are written by educationalists (cf. Egge, 2012; Sund, 2014). In parallel to findings from the emergence analysis (viz. chapter 6), it can be mentioned that a similar top-down view is found in discursive texts from educational neuroscience's earlier stages in the 1960s and 1970s.

The Norwegian *public* field

When it comes to recontextualisation of educational neuroscience to the public field in Norway, my analysis also indicates traces of the linkage of education and neuroscience. In comparison to the literature search for academic texts, searching for public texts related to education and neuroscience is less challenging, as it produces numerous media texts and brain-based learning programs. Of the relevant literature, 16 texts were chosen for the final corpora − 14 of these being media articles from well-known Norwegian news agencies, whereas the remaining two texts are brain-based educational programs[256].

These public texts can be loosely grouped into four recurring topics: i) the pop-scientific debate on natural sciences vs. social sciences, ii) smart-drugs, iii) sensational stories on aspects pertaining to neuroscience and education/learning, and iv) brain-based educational programs[257]. Five media articles from the corpora can be categorised in the first group as they are on topics related to disciplinary debates on 'the gap' between natural sciences and social sciences (i.e. Time, 2011; Vassnes, 2010) − hence also linkages between nature and nurture as well as between neuroscience and social sciences/education (i.e. Ebdrup, 2014; Monsen, 2010; Time, 2012). As with some of the texts from the academic field, many of these media articles appeared as a result of the pop-scientific show *'Brainwash'* and the academic and public debate which emerged in its wake. Intertextual references associated with *Brainwash's* nature-nurture discussion are therefore also found within the public field, revealing both

[255] As seen in Dehaene (2014), Egge (2012), Solli (2010), and Sund (2014).
[256] See the method chapter and appendix B-D with regards to selection criteria and detailed reference list of the corpora.
[257] These four topics frequently reoccur in texts from my literature search for the Norwegian public level. Since texts chosen to the final corpora should be representative for the respective level under analysis, it is, accordingly, essential that texts chosen for my discourse analysis represent these four topics.

criticism and counter-arguments related to claims that Norwegian social scientists do not take biological explanations into considerations in their research. An example of a critical stance towards so-called 'biological aversion' amongst researchers is the text *'The problem of social sciences'* (Vassnes, 2010). Through references to the philosopher Daniel Dennett, it is argued that Norwegian social scientists "haven't paid attention in class" when it comes to biological explanations in social and human behavioral research:

> In USA and other countries one has moved away from post-modernism, and there is a new spirit within social and human sciences. A reason for this is that one is now taking seriously the wave of new insights from disciplines such as neuroscience, behavioural genetics, psychology, and biology. These [insights] have shown that the premises which traditional social sciences have been built on, like the idea that we are born as "blank slates", are not correct ... Norwegian social scientists have, however, shown little interest ... Today we have to acknowledge that they [social scientists] have failed in many areas: the school is just one example, gender equality policy is another (Vassnes, 2010 [my translation]).

Similar criticism of sociologists' aversion to biological explanations is also found in the text *'Educators' fear of biology produces losers in school'* (Monsen, 2010) − again based on an interview with the biological psychologist Sigmundsson. As with the interview presented in the academic text, this media article also elaborates upon Sigmundsson's critique of the Norwegian educational system, arguing instead that scientifically based knowledge from biological psychology and neuroscience should be translated into educational practice and applied in schools. Nevertheless, criticism of social scientists and their alleged aversion for biological explanation does not go unchallenged, and findings from my analysis can also indicate a stance that speaks up for the humanities and social sciences. One such text is an interview with the international philosopher Raymond Tallis in the text *'Neuro this and neuro that'* (Time, 2011):

> It is time for humanists to answer back to over-enthusiastic psychologists and brain scientists, says the British critic Raymon Tallis [sic.] ... Attempts to bring cognitive psychology and brain science into humanities and social sciences end up in an eradication of the specifically human factors in research, he claims. This is one of the reasons he considers that the results often become trivialised, such as how artwork can be a source of delight (because it triggers biological reward systems) (Time, 2011 [my translation]).

Tallis' critique of the array of research areas that are emerging in the wake of brain sciences (such as neuro-law, neuro-economy, neuro-technology, and neuro-literature) is further elaborated. His biggest concern is what happens when the belief that "we are our brain" is supplemented with what Tallis claims is "an exaggerated confidence that evolutionary explanatory models can explain our behaviour, our society, our culture, and our values" (Time, 2011 [my translation]). The central point is, as noted in the text, that certain aspects within humanities and social sciences cannot be explained by brain sciences − "it is doubtful as to how much one can understand of an artwork by perceiving it as a form of stimuli for an brain developed in an evolutionary way".

What is interesting to note from my discourse analytical findings is that Norwegian neuroscientists themselves agree with Tallis. For instance, Kenneth Hugdahl, professor in biological psychology at Bergen University, stresses, in an interview, that "…it is the brain sciences that are frequently asked to answer life's big and small questions. −It would be fantastic if brain scientists could achieve just half of what people expect from us" (Hugdahl cited in Time, 2012, p. 20 [my translation]). Similar notions are expressed in the article *'Educationalists should stay away from brain sciences'* (Ebdrup, 2014) where several Danish neuroscientists are interviewed on the linkage of education and neuroscience: "The brain sciences cannot tell us how teachers can best arrange their teaching in school ... One has to remember that they "only" offers biological explanations" (Ebdrup, 2014 [my translation]). These examples from the discourse analysis therefore suggest that there is a popular-scientific debate within the public field, wherein one can find different positions concerning the linkage of neuroscience/ biological explanations and education/social sciences. The resulting question, which will be critically reflected upon later in this chapter, is how this polarisation in the Norwegian debate corresponds with views held internationally.

The second set of media texts consists of articles on the topic of *smart drugs* − a topic which has caused a noticeable public debate in Norwegian media and which is represented in the corpora by Byrkjedal and Misje (2013) and Visjø (2014). Both texts stress the novel issue of cognitive enhancers in academia and how the international trend of using illegal smart drugs such as Ritalin has increased in popularity amongst Norwegian university students. 'Smart drugs' is a term for pharmaceutical stimulants that enhance a person's cognitive ability − for instance by enabling a person to concentrate better on a task or by increasing level of dopamine in the brain (qualities to be found e.g. in medicines prescribed for ADHD, narcolepsy, and Alzheimers). These cognitive enhancers are used by students to help them study more effectively, and to get better scores in tests and exams. There are no accurate statistics on use of cognitive enhancers in Norway, but results from a study on students' health and well-being show that use of cognitive enhancers in higher education in Norway has increased from 1,4 per cent in 2010 to 4,2 per cent in 2014 (Nedregård & Olsen, 2014; Visjø, 2014). Even if Byrkjedal and Misje (2013) and Visjø (2014) appear to be concerned about the use of smart drugs, other and more enthusiastic views are also presented − for instance by Sterri from the Student Union in Oslo, who argues that "We are born with different skills and different capacities. Some people have a head start and a better ability to concentrate, and I don't see the problem in taking pills if one hasn't been born with the same possibilities" (Sterri cited in Byrkjedal & Misje, 2013 [my translation]). Without elaborating further on cognitive enhancers and the related ethical considerations, these texts represent a growing public concern and debate regarding the increased use of illegal smart drugs by Norwegian students.

The third and largest group of public texts in the corpora consists of media articles where brain science is used to create rather sensational stories regarding social and/or educational topics[258]. Findings from my discourse analysis show *how* these public texts represent, incorporate, and recontextualise educational neuroscience. First, this group consists of media texts published by well-known Norwegian media agencies such as VG, NRK, and Dagbladet (often published online as well as in print), where stories are usually short with a scope-limit between one and two pages. These texts often make use of neuroscientific perspectives in order to illuminate social or behavioural issues − for instance learning difficulties and ADHD (Henriksen, 2005), exams and study tips for students (Nydal & Asland, 2007), early learning and toddlers' language skills (Andreassen, 2014), social behaviour in teenagers (Holst & Hansen, 2011), gender and school structure (Holterman, 2010) and the effect of stress in early childhood (Yttervik, 2012) (see table 8.1). Many of these texts also seem to show fascination for, and perhaps uncritical confidence in, neuroscientific explanations. Brain science is often used to explain or elucidate social phenomenon, paying little or no attention to social explanations or critical reflections[259]. A general tendency amongst texts in this group seems to be for journalists to use sensational and attention-grabbing headlines − often with the result that statements are simplistically and incorrectly presented in comparison to representations found in contemporary science articles. However, introductory and sensational statements tend to become more nuanced later in the media stories, when insights from specialists are used to elaborate the topic. Use of attention-

[258] As seen in Henriksen (2005), Nydal and Asland (2007), Knudsen (2010), Holst and Hansen (2011), Yttervik (2012), Andreassen (2014), and Holterman (2010).

[259] As seen in Henriksen (2005), Knudsen (2010), Yttervik (2012), Andreassen (2014), and Holterman (2010).

grabbing headlines which later become more moderate can, for instance, be seen in the texts *'Jogging makes the brain bigger'* (Knudsen, 2010), *'Teenagers have unfinished brains'* (Holst & Hansen, 2011), and in the following text extract by Yttervik (2012):

> *New report concerning children: High levels of stress leads to smaller brains.* Prolonged stress and lack of care will lead to children having smaller brains and make them losers in school, research shows ... "New neuroscientific research show that prolonged stress influences the hippocampus in the brain. This can damage cognitive functions such as memory and impede the ability to learn", says professor in children and youth mental health Willy-Tore Mørch at University of Tromsø (Yttervik, 2012 [my translation]).

In this excerpt, there is a significant difference between the journalist's introductory statement and the statement given by the specialist in children's mental health. Firstly, the journalist does not use any modalised markers, whereas the professor is more careful in his expressions. This can be illustrated by how the professor use expressions like "stress *influences* the hippocampus" in comparison to "stress *leads to* smaller brains" or "this *can* damage cognitive functions such as memory and *impede* the ability to learn" in contrast to the journalist's phrase "[this] *makes* them *losers in school*". Comparison also shows how the journalist appears to 'twist' the scientist's statements, in addition to drawing overly hasty conclusions from what has been said. For example has the statement '…impede the ability to learn' become '…losers in school' − a leap in the argumentation which, as an educationalist, I feel is suspect, because impeded learning abilities do not necessarily make a child a *loser* in school. A similar hasty conclusion is drawn concerning neuroscience, when the journalist suggests that "stress leads to *smaller brains*". This sentence, I argue, changes a neuroscientific representation concerning *structural differences in hippocampus* between children who have been brought up in affectionate environments and children who have not, to implying a reduction in *the entire size of the brain*[260]. Yttervik (2012) thus commits a gross over-simplification in his representation of educational neuroscience, as contemporary neuroscientific research emphasises that structural changes in one brain area do not imply either a reduction or increase in the size of the *entire* brain (cf. Hood, 2014).

There appears, therefore, to be a tendency amongst some journalists to jump too quickly from (educational) neuroscientific statements to sensational and simplistic representations. However, it is difficult to say if this leap from cautious and correlational explanation to sensational and causational explanations is made intentionally in order to sell

[260] A similar representation is found in Knudsen (2010), as also this journalist claims how "jogging makes the brain bigger".

these stories, or whether it is a lack of critical readings. Nevertheless, it is challenging when the media present simplistic accounts regarding neuroscience and/or education − particularly when such accounts do *not* correspond with representations from contemporary science. The media's uncritical reading and misrepresentation of educational neuroscientific statements are problematic since they can lead to the spread of neuromyths within the public arena.

The last group of text from the public field consists of Norwegian 'brain-based' educational programs. As in my analysis of the international brain-based learning industry, my Norwegian literature searches and discourse analysis focus on learning products for purchase, which make claims for connections between these educational material and brain science (cf. Sylvan & Christodoulou, 2010). Based on this definition, two Norwegian brain-based learning industries and their respective educational programs were chosen for the analysis − namely Memolife (2014) and the Bravo games (Intempo, 2014). What should first be noted, when identifying how these brain-based learning industries represent and recontextualise the educational neuroscience discourse, is that both texts offer learning products and training-games that will supposedly improve cognitive functions − as seen in learning material such as *'Memo language'* and *'Memo gym'* (Memolife, 2014) and *'Bravo games and courses'* (Intempo, 2014). The clients for these 'brain-based' educational programs differ, though, as Memloife seems to target a wide public audience, ranging from parents and students to people who want to "become a leader at work", whereas Intempo's Bravo games more specifically target parents and pre-school teachers of children aged 0-3 years. Both texts emphasise that their programs and learning techniques are based on brain science, often using phrases like "brain science shows that ...", "research shows ...", and "new brain science confirms that ..." (Intempo, 2014; Memolife, 2014). Other findings from the discourse analysis indicate that both Memolife (2014) and Intempo (2014) represent neuroscientific and educational research rather generally, simplistically and, at times, detached from a larger scientific context. As an illustration, Memolife bases its products on accelerated learning, multiple intelligence, VAK-learning styles, and left/right dominant hemispheres. The following extract is from Memolife's webpage where 'left/right dominant hemispheres' is used as an argument for different learning styles:

> The brain's two sides, the left and the right hemisphere, have completely different qualities and completely different methods for learning. If you master how to combine these qualities you will also become a master in learning! ... Numerous people have a dominant right or left hemisphere ... The left hemisphere attends to our language with words and sentences. It undertakes different types of analysis

with, for instance, number, sequences, and mathematics, and it is the part that builds on logic and rationality. The right hemisphere uses bodily sensation inputs in form of pictures and visualisation, sounds, smells, taste, and other bodily perceptions in its work. This part also takes care of music, rhythm, rhyme and is constantly seeking overview and unity (Memolife, 2014 [my translation]).

In this excerpt, topics related to the brain are represented in order to demonstrate differences in people with left- and right hemispheric dominance and, furthermore, how these people should make the best use of learning techniques appropriate to their leading hemispheric qualities. However, no references to cognitive neuroscientific research or educational neuroscientific research are provided, and no explanation is provided for *why* people with an assumed right or left hemispheric domination ought to use different learning techniques. In addition, the most significant problem with Memolife's text is that notions regarding right- and left hemispheric domination do not correspond with contemporary educational neuroscientific research. Numerous theorists and researchers within educational neuro-scientific communities have, as previously mentioned, established concepts of right- and left hemispheric learning styles as *neuromyths* (Alfernik & Farmer-Dougan, 2010; Howard-Jones, 2010; Ritchie et al., 2012). Even if our brain can be anatomically categorised into left and right hemispheres, and even if one can find a cerebral asymmetry of functions (for instance, Broca's and Wernicke's language areas are usually found in the left hemisphere) (Gazzaniga, Ivry, & Mangun, 2009), it is commonly agreed within the research community that one cannot talk of hemispheric dominance in people. Our brain has a complex set of neural networks between different brain areas and a process of parallel interconnected functioning is occurring between these areas whenever we execute cognitive tasks. In other words: when we perform cognitive tasks, we make use of numerous parts of the brain simultaneously. Some cognitive tasks may activate one hemisphere more than the other, but there is no reason to suppose that individuals differ markedly in which side of the brain is activated during any given learning activity (Corballis, 2012; Geake, 2008). Thus, to categorise people according to statements of left- or right-brained learning styles is too simplistic, and is a misinterpretation of educational neuroscientific research. Another narrative which differs from academic representations is the repeated objectification and mechanisation of the brain found throughout Memolife's texts. This is for instance seen in the statement "become *friends* with both hemispheres", "the *brain uses* our senses actively" and "*activate* both hemispheres" (Memolife, 2014 [my italics]). As previously argued, this is a way of representing the relationship between the individual and his/her brain that few educational neuroscientists would support, because such depictions presents the brain as something objectified and almost detached from individuals.

Similar 'brain based' explanations are also seen in materials produced by Intempo (2014). Results from my analysis indicate that this commercial education program encompasses fewer and less recognizable misrepresentations and neuromyths than Memolife (as the latter builds on the criticised VAK-model, accelerated learning, and neuromyths of right/left hemispheric domination). Intempo also makes use of representations that are allegedly science-based, but which on closer examination differ from representations found in academic disciplines of cognitive neuroscience and educational neuroscience. The following extract provides an illustration:

> The child is ready to explore and investigate sooner than parents and most personnel in pre-schools are prepared for. Few know that the most important time for the child has passed − before one has realised it. Development in this period has lifelong effects. One can, by the use of Bravo games, give children daily sensory inputs to ensure that the brain builds enough networks ... We encourage everyone who is working together with children between 0 and 3 years to actively use language and the senses. Sensory experience creates a connection in the brain and the more connections and networks of connections a child gets early in life, the easier the child learns later on (Intempo, 2014 [my translation]).

Later in the text it is even stressed that "older kids can also play [with Bravo games], but the brain is most responsive to stimulation during the first three to four years, so start as early as possible!" and "such extra early and comprehensive efforts promotes learning and can prevent reading and writing difficulties" (Intempo, 2014). Based on statements like these, it appears that educational products, courses, and learning techniques marketed by Intempo are built upon the assumption that various sensory experiences and stimuli between the ages of 0 to 3 years will create important neural connections and networks crucial for successful learning later in life. A further issue is that Intempo (2014) provides no explicit literature references for the claims made regarding the brain, cognitive stimulation and early learning[261]. This is problematic, because lack of references to original research makes it difficult to validate the scientific basis for the Bravo games. Despite Intempo's lack of scientific references, one can find numerous neuroscientists and educational neuroscientists who write on similar topics −

[261] The only reference offered is to a report by Vista Analysis, which is commissioned by Intempo's investors Ferd Social Entrepreneurs. Sections of this analysis are presented in Intempo's webpage where one for instance can read about how extra early intervention (i.e. in the ages of 0-3 years) is profitable when it comes to cost-effective investments in human capital. However, this assessment is built upon Heckman's theory and model for early interventions − a theory which previously in this dissertation was shown to have significant flaws in its argumentation (see page 261-262). Hence, the only reference offered in the Bravo game is a report commissioned by Intempo's investors and which, additionally, is partly built upon the much criticised work by Heckman.

albeit that these academics tend to argue *against* the idea of effective early learning and cognitive stimulation, and this notion is even known as 'the myth of three' (Anderson & Della Sala, 2012; Blakemore & Frith, 2005a; Bruer, 1999; Howard-Jones, 2010). Educational neuroscientists' critique of the 'early learning hysteria' has already been discussed in previous chapters[262], but in brief it can be noted that theories regarding synaptogenesis and synaptic pruning early in a child's cognitive development are often misinterpreted. Not only do '*sensitive* periods' in a person's life tend to be mistaken for '*critical* periods' in the earliest year, but the notion that pruning (i.e. the cutting back) of neural connections is a normal and crucial aspect in cognitive development also seems to be misapprehended. Some, such as Intempo (2014), have misunderstood the gradation of stimulation necessary for normal cognitive development, since it is exceptionally *deprived* environments lacking social and cognitive stimulations (not *enriched* environments) that are shown to significantly affect cognitive development (cf. Anderson & Della Sala, 2012; Blakemore & Frith, 2005a; Howard-Jones, 2010). Intempo's argumentation for early sensory stimulation to improve children's academic skills does not correspond, therefore, with contemporary educational neuroscientific representations at the international and academic level.

As well as misrepresenting contemporary educational neuroscientific theories, both Intempo and Memolife appear to use general and simplistic explanations. Another recurring tendency is argumentative leaps, in the explanations offered by Memolife (2014) and Intempo (2014), when the authors 'jump' directly from a statement regarding educational neuroscientific theory to conclusions at a more practical level. This is shown in the following extract from Memolife (2014) where VAK-learning styles are promoted:

> Generally one can say that there exist three basic kinds of memory and learning: **visual, auditory, and kinesthetic** ... Research show that 37 % of the population is dominantly kinesthetic, 34 % dominantly auditory and 29 % dominantly visual. It is also shown that children with kinesthetic preferences can often experience problems in schools and that adult kinesthetics are more likely to end up on a downward path in society (Memolife, 2014 [my translation]).

References to research that divides the population into these visual-, auditory- and kinesthetic per centages are not offered, nor is it clear whether the statement that people who are kinesthetic- dominant have academically and socially disadvantages, is Memolife's own conclusion or if it is based on research. Nevertheless, the leap from accounts of VAK-learners to the assertion of kinesthetic disadvantage in society is presented without any further

[262] See for instance page 247 and page 261.

explanation. A similar argumentative leap can be found in Intempo (2014) where it is stated in bold-face that "Good vocabulary gives great reading understanding and reduces drop-out from high school". The statement provides neither references to research, nor any explanations of why good vocabulary can reduce drop-out. What further makes these general and simplistic accounts problematic is that both Memolife (2014) and Intempo (2014) tend to present their statement without any modalised markers (e.g. markers such as 'can', 'may', 'possibly' etc.). Use of non-modalised phrasings leave statements closed for dialogue and thus the brain-based learning texts convey their messages with the appearance that 'this is just how it is' (cf. Fairclough, 2003).

Another strategy used by these two Norwegian brain-based learning industries is frequent reference to favourable evaluations of the program being marketed. Memolife's website offers links to television interviews and media articles on the positive effect of Memolife's brain-training products (Memolife, 2014), whereas Intempo presents recommendations, experiences and video-interviews with some of the 200+ Norwegian pre-schools that have bought Bravo games (Intempo, 2014). The problem is that the positive recommendations presented are either from customers, or from the main entrepreneurs of these brain-based learning industries themselves. Even if such recommendation can easily be taken at face value, they hardly offer unbiased and scientific assessment of these brain-based learning programs. This adds to the overall impression that the interest and motive for these brain-based learning industries to recontextualise educational neuroscience into their field is the construction of a seemingly 'valid' evidence base which, in turn, may help to sell learning products to teachers, parents, students, and others, who are interested in increasing their cognitive abilities.

To sum up, educational neuroscience is thus represented and incorporated into the Norwegian public field in different ways, ranging from pop-scientific debates, to more sensational news stories and 'brain-based' educational products (see table 8.1). A general feature of these public texts is their uncritical reading of educational neuroscientific topics which, in turn, is manifested in general and simplistic accounts and overly enthusiastic expectations of what brain science can achieve in education and other social settings. It is also worth mentioning that one cannot find a single reference to the international and academic discipline of educational neuroscience in any of the public texts analysed.

Regarding educational neuroscience's recontextualisation at the public level in Norway, certain aspects can be mentioned. Firstly, literature searches for relevant *public* texts are more productive in comparison to literature searches conducted for the Norwegian *academic* field, because the public search produced numerous relevant media articles and brain-based learning programs, in comparison to the sparse material from academic literature searches. This finding is interesting by itself, because it indicates that representations of educational neuroscience are more prominent within the public sphere than within academia in Norway. In comparison to the international situation, it can be noted that one finds a more even distribution at the international level, where educational neuroscientific representations are frequently presented in both academic and public fields (cf. chapters 6 and 7).

Despite this difference, my data suggests that there are numerous similarities between the way in which educational neuroscience is recontextualised and presented within the public field in Norway as compared to international public fields. For instance, Norwegian and international public texts are both fascinated with the brain and explanations given by brain scientists. In my corpora, brain science is given a key role in explaining social aspects, human qualities and/or behaviour. Many Norwegian and international public texts, moreover, tend to use attention-grabbing headlines, present their stories in non-modalised wordings, and giving simplistic presentations of complex (educational) neuroscientific topics. There is also a tendency in international media to present the relation between the individual and his/her brain as something objectified, conflated, or mechanical[263]. Similar presentations can also be seen in Norwegian media − for example in sentences like "the right hemisphere prefers figures, drawings and illustrations" (Nydal & Asland, 2007) and "the frontal lobe keeps tabs on you" (Holst & Hansen, 2011) − but mechanical and objectified phrasings nevertheless appear to be less frequent than in the international texts. I will further argue that many Norwegian media texts make use of appropriation strategies, as they recontextualise aspects of the educational neuroscience discourse into their own media discourse. This is frequently done by using educational neuroscience to create fascinating stories, which are then 'sold' to a public audience[264]. Similarities like these can be seen across media discourses in general, and thus this trait can be seen generic to both Norwegian and international media agencies, rather than specific traits found across scalar boarders.

[263] As seen demonstrated in BBC (2013), Carlyle (2014), Hammond (2013), James (2014), The Guardian (2004), Whipple (2012), and Wighton (2007).

[264] This can for instance be seen in the Norwegian media texts Henriksen (2005), Knudsen (2010), and Yttervik (2012), and in the international media texts Carlyle (2014), James (2014), and Wighton (2007).

Recontextualisation of the educational neuroscience discourse to the public field is not only manifested in general and simplistic accounts of contemporary science, as more nuanced and critical media texts pertaining to education and neuroscience can also be found − both internationally and in the Norwegian public field. This is demonstrated by the range of more pop-scientific debates featured in media articles, such as discussions regarding smart drugs, warning about neuromyths, and debates concerning the use of natural scientific explanations in the social sciences[265]. The so-called 'brain-based' learning industry has also caught on in Norway (see table 8.1). As with international corporations, one can also find representations closely linked to neuromyths and edumyths in Norwegian businesses, in their so-called 'brain-basis' for learning products and also in learning material targeted and sold to a public audience[266]. Even if the international brain-based learning industry is significantly larger than the one identified in Norway, the establishment of brain-based educational businesses is noteworthy − particularly seen in relation to the lack of focus on educational neuroscience in Norwegian academia.

The Norwegian *political* field

Findings from my analysis also show a recontextualisation of the educational neuroscience discourse to the political field in Norway. Literature searches were conducted in relevant research databases, such as the Norwegian government and Ministry of Education and Research, and various search criteria were used in internet searches in order to find texts relevant to recontextualisation within the political field. Of the relevant literature found a total of 7 texts were chosen for the final corpora − namely the Official Norwegian Report about systematic education to all preschool children (NOU 2010: 8), Bjørnestad and Samuelsson (2012), Departementene (2013), three analysis by the Norwegian Ministry of Education and Research (2013a, 2013b, 2013c), and Backe-Hansen, Walhovd, and Huang (2014) (see appendix C for full reference list). It should be noted that some texts are literature reviews, reports or conference reports commissioned by the Norwegian government[267], and some of their authors are therefore researchers and not (educational) politicians per se. I will

[265] This can for instance be seen in the Norwegian media texts Byrkjedal and Misje (2013), Time (2012), and Ebdrup (2014), and in the international media text by Rose (2013).
[266] This can be seen in the Norwegian brain-based learning programs Memolife (2014) and Intempo (2014), and similarly in the international Brain Gym (2014), Kagan (2014), and Learning Rx (2014).
[267] Such as Bjørnestad and Samuelsson (2012), Departementene (2013), and Backe-Hansen et al. (2014).

Table 8.1: Examples how different public texts represent educational neuroscience [my translation].

Norwegian pop-scientific articles	**Norwegian media articles**	**Norwegian brain-based learning industry**
"Brainwash: Norway has trusted in social scientists. We have believed that titles meant knowledge. Then a comedian comes along and shows us a different story: ... Norwegian scientists haven't paid attention in class and are so unaccustomed with critique that some react with anger and threatens with lawyers" (Vassnes, 2010). "Neuro this and neuro that. It is time for humanists to retort the over-enthusiastic psychologist and brain scientists, says the British critic Raymon Tallis (sic.)" (Time, 2011). "We are in the middle of a revolution of knowledge and this fascinates many − for good reason. But it also leads to the emergence of some myths and that the presentation can become dubious, says Moser" (Time, 2012). "Neuroscience is increasingly revealing more of the brain's secrets. Education and educational policy have not taken this new knowledge into account, says professor Hermundur Sigmundsson" (Monsen, 2010). "−Everything I say is scientifically based. I look at what actually works; I do not have any other guiding principles. I ask that scientifically based knowledge is incorporated in schools, into classrooms, and is translated to educational practice" (Sigmundsson cited in Monsen, 2010). "−Educationists should stay away from brain science. Brain science can only in a diminutive way tell us how we should arrange schools and pre-schools" (Ebdrup, 2014).	"Use the whole brain ... Many can benefit of making illustration of their curriculum texts, so called mind-mapping. We will then make use of the right hemisphere which prefers figures, drawings and illustrations. In this way, the whole load will not be on the left hemisphere, which is a specialist in words, sentences and numbers" (Nydal & Asland, 2007). "Jogging makes the brain bigger. An area in the brain involved in memory and the ability to learn new stuff can become bigger if you tie on your running shoes" (Knudsen, 2010). "Teenagers have unfinished brains. They love speed, don't manage to tidy their rooms, and they don't see the consequences of their actions. They cannot help it. Their brains is in fact not finished" (Holst & Hansen, 2011). "This area of the brain [frontal lobe] keeps tabs on you" (Holst & Hansen, 2011). "New report concerning children: Considerable stress gives smaller brain. Prolonged stress and lack of care will simply give a child smaller brain and makes them losers in school, research show" (Yttervik, 2012). "Brain scientists have found substantial differences between girls and boys and genders should therefore be divided in first grade, experts say" (Holterman, 2010). "A Norwegian fish oil can help children with substantial learning difficulties and ADHD, numerous studies show" (Henriksen, 2005).	"Memolife − The Brain Club" (Memolife, 2014). "The brain can be trained, just like the body, but with faster results" (Memolife, 2014). "Double your memory, get better focus, become a master in mental calculation, or learn a new language at a fraction of standard phase" (Memolife, 2014). Regardless if your aim is to learn a new language, become a leader at work, become a good speaker, or simply develop to become more content with yourself and others, then it is important to become friends with both hemispheres (Memolife, 2014). "The left hemisphere is of the academic and structured type, whereas the right hemisphere is more creative and artistic" (Memolife, 2014). Generally one can say that there exist three basic kinds for memory and learning: **visually, auditory, and kinesthetic** ... Research show that 37 % of the population is dominant kinesthetic, 34 % dominant auditory and 29 % dominant visual. It is also shown that children with kinesthetic preferences often can experience problems in schools and that adults kinesthetics is more likely to end up on a downward path in society (Memolife, 2014). "Investment in Bravo the three first years of a child's life could give the child lifelong profit" (Intempo, 2014).

nevertheless consider the texts as political documents since they refer to guidelines and research questions generated by national politicians[268].

The first question to be answered is to *what degree* educational neuroscience is recontextualised to the Norwegian political field. Findings from my literature search show some traces of a linkage between education and neuroscience here, although to a lesser degree than in the political field internationally. Two examples of a Norwegian political text found during the literature search are the Official Norwegian Report *'Pupil's learning in the school of the future'* (NOU 2014: 7) and the Norwegian Government's white paper on early intervention for lifelong learning *'... no one left behind'* (St.meld. nr. 16, 2006-2007). The former text is based on international research reviews concerning "knowledge of how students learn and what characterises good education", such as OECD's report *'The Nature of Learning'* (2010) and *'National Research Councils: How People Learn. Brain, Mind, Experience, and School'* (2006) − both of which are reports that assemble "a wide range of theoretical and empirical work, such as developmental psychology, cognitive psychology, neuroscience, and educational psychology" (NOU 2014: 7, p. 19 [my translation]). Similar traces of a linkage between education and neuroscience are also seen in the white paper from the Norwegian Ministry of Education where, with references to UNESCO's report *'Strong Foundations. Education for all'*, it is stressed that:

> Learning is closely connected with development of connections (synapses) between brain cells. Formation of these connections occurs rapidly until the age of three. The amount of synapses levels out after this. The first three years is therefore the most important for brain development. Young children's development is very sensitive with regards to undernourishment and malnutrition, neglect, and lack of stimulation. If basic needs are not met, it usually leads to consequences in adulthood. The environment a child is raised in − both the physical and the emotional − influences brain development (St.meld. nr. 16, 2006-2007, p. 57 [my translation]).

When it comes to the texts in the final corpora, these political texts also show linkages to education and neuroscience. In discussing how such linkages are represented, it can first be noted that themes range from pre-school and kindergartens (NOU: 8 2010; Bjørnestad & Samuelsson, 2012), gender differences in educational achievements (Backe-Hansen et al., 2014), child welfare (Departementene, 2013), and short reviews concerning linkages between education and neuroscience (Ministry of Education and Research, 2013a, 2013b, 2013c). All

[268] Again, see the methods chapter and appendix B-D for a comprehensive account on the literature search, selection criteria, and the critical discourse analysis.

these texts draw on neuroscience as a *new perspective* which can contribute to clarifying topics central to children, education, learning, and/or children's cognitive development[269]. Two of the research overviews commissioned by the Norwegian Ministry of Education and Research note how "new research within development psychology and neuroscience ... can be said to have revolutionised the perception of the youngest children in kindergartens" (Bjørnestad & Samuelsson, 2012, p. 63 [my translation]), and how perhaps the most significant change in the knowledge base and perception of gender differences in school achievements "is an increased interest in possible contributions from a cognitive neuroscientific perspective" (Backe-Hansen et al., 2014, p. 3 [my translation])[270]. Five out of the seven political texts, moreover, emphasise that brain sciences can help to enrich educational research, as well as how insights from cognitive neuroscience appear to support numerous educational theories, rather than devalue them[271]. In the text *'New connections'* by the Ministry of Education and Research (2013c) it is stressed how neuroscience can contribute to the improvement of schools, but also that what brain scientists have said about learning in school settings should already be familiar to teachers. What is new, it is argued, is that brain scientists offer a micro-perspective on aspects such as memory and learning. Accordingly, the following excerpt on memory is presented as an example of congruent perspectives between education and neuroscience:

> A central point regarding memory [in neuroscience] is that you remember best if you have numerous ways in to the relevant memory, numerous ways in to the specific cell connection. In practice, this means that knowledge that has been incorporated over time and which is connected to numerous events will be more easily recalled than knowledge that is quickly incorporated. This is why cramming[272] the day before a test does not work that well (Ministry of Education and Research, 2013c [my translation and footnote]).

The text continues by explaining why it can be beneficial for educationalists to take such neuroscientific perspectives into account, arguing that knowledge about the brain, learning, and memory can aid educationalists in their preparation and understanding of learning practices (Ministry of Education and Research, 2013c). The focus is, however, not only on

[269] As seen in NOU 2010:8 (2010), Bjørnestad and Samuelsson (2012), Departementene (2013), Ministry of Education and Research (2013a, 2013b, 2013c), and Backe-Hansen et al. (2014).
[270] Both of these research overviews are largely based on international research relevant for educational topics.
[271] This is explicitly seen in Departementene (2013), Backe-Hansen et al. (2014), Bjørnestad and Samuelsson (2012), Ministry of Education and Research (2013b), and Ministry of Education and Research (2013c).
[272] 'Cramming' is in this respect meant in the educational sense of 'memorizing a large amount of information in short time' and is used as a translation for the Norwegian word 'pugge'.

how educationalists can benefit by new perspectives from neuroscience, since emphasis also is put on reciprocal collaboration, wherein neuroscientists can learn from educationalists.

> Collaboration between different scholarly disciplines requires meeting places, but the distance between the disciplines is still great ... Educationalists and practical psychologists know little about how the brain functions, there are likewise numerous aspects of children's learning we [neuroscientists] cannot say anything certain about ... But it is very useful for us to be challenged on new themes and on different ways of perceiving these things (Moser & Moser quoted in Ministry of Education and Research, 2013c [my translation]).

Although five out of the seven political texts explicitly state that neuroscience can help to enrich educational research, some texts also exhibit an optimistic yet cautious − sometimes even an uncertain − stand with regards to what neuroscience can contribute to education[273]. This is seen in Backe-Hansen and colleagues' (2014) literature review on gender differences in school achievements:

> There is, however, a long stride to deduce from knowledge of normal variation in brains to interventions in schools. In my opinion, there is currently no well-founded cognitive neuroscientific basis for the claim that surrounding girls and boys with different gender-specific educational resources will benefit them, their brains, or their school achievements. That being said, it can be beneficial for educational personnel to have basic knowledge about neural and cognitive development in order to understand and detect normal and deviant development in children (Walhovd, in Backe-Hansen et al., 2014, p.77 [my translation]).

The text excerpt seems to exhibit caution with regards to translating neurobiological theories into practices and interventions in schools. The text does nevertheless stress that basic knowledge of the brain and cognitive development can be expedient for educationalists, since the brain sciences offer new perspectives, which can help to "expand educationalists' knowledge and understanding". This view appears to be common within the Norwegian political texts analysed, as several texts emphasise how neuroscience can provide new perspectives on memory, learning, teaching, childcare, and/or children's cognitive development[274]. Neuroscientific perspectives are, furthermore, often presented as something which can help to *enrich,* rather than establish rules, for educational research − a notion which is often followed by references to reciprocal collaboration and/or caution with regards to differences in educational and neuroscientific explanations[275]. Despite this approach, which

[273] As seen in NOU 2010: 8 (2010), Backe-Hansen et al. (2014), and Ministry of Education and Research (2013c).
[274] As seen in NOU 2010:8 (2010), Bjørnestad and Samuelsson (2012), Departementene (2013), Ministry of Education and Research (2013a, 2013b, 2013c), and Backe-Hansen et al. (2014).
[275] As seen in NOU 2010: 8 (2010), Backe-Hansen et al. (2014), and Ministry of Education and Research (2013c).

seems to resemble a cautious optimism toward the linkage of education and neuroscience, three out of the seven political articles make references to Heckman and his suggestions that early intervention for children's cognitive development (particularly before the age of three) will lead to economic profit[276] − a model which has already been evaluated and deemed problematic, because it conveys certain representations that are not in accordance with contemporary educational neuroscience. More significantly, although all the political texts refer to themes closely related to the international discipline of educational neuroscience, *not a single text* mentions this international academic discipline by name. This aspect, in addition to other findings concerning educational neuroscience's recontextualisation to the political field, will be further discussed and critically reflected upon in the following sections.

If one compares educational neuroscience's recontextualisation to the Norwegian political field with similar processes internationally, educational neuroscience is more established and manifested within an international political field than within Norway − as shown by the small number of Norwegian political texts in comparison to those from similar international searches. In addition, texts emerging from Norwegian literature searches are often literature reviews or reports authored by scientists but *commissioned* by Norwegian politicians, whereas international political texts often are written by policymakers themselves and/or by their political staff. Since educational neuroscience has, up until now, had a relatively small impact within Norway, this may explain why references to linkages between neuroscience and education/social sciences are more frequently found in analysis and commissioned literature reviews than in explicit policy-statements. Nevertheless, the fact that many of the Norwegian political texts are commissioned work written by scientists is significant, since this can clarify some of the differences found between the recontextualisation of educational neuroscience in the Norwegian and international political fields.

A second aspect when comparing Norwegian and international political texts is that neuroscience in Norwegian political texts is often represented as a *new* perspective which can help to illuminate aspects relevant to social and/or educational aspects − such as a child's development in kindergartens (Bjørnestad & Samuelsson, 2012; NOU 2010: 8, 2010), aspects of children's mental health and childcare (Departementene, 2013), gender differences and school performance (Backe-Hansen et al., 2014), and linkages of neuroscience and

[276] As seen in NOU 2010: 8 (2010), Bjørnestad and Samuelsson (2012), and Departementene (2013).

education/learning (Ministry of Education and Research, 2013a, 2013b, 2013c). When referring to linkages between neuroscience and education/social aspects, authors of these political texts tend to refer to international research. However, despite frequent references to international academic fields, the academic *discipline* of educational neuroscience is never mentioned. Again, one can speculate whether lack of references to the international academic discipline of educational neuroscience is a deliberate choice, or whether it is attributable to lack of knowledge that such an international discipline exists.

Thirdly, it can be noted that apart from international academic articles, many of the Norwegian policy documents refer to international documents from intergovernmental interest actors − particularly the OECD[277]. This is perhaps not surprising, considering that international organizations such as the OECD, EU, and WTO are significant influences on the shaping of Norwegian educational policy (Karlsen, 2006). The OECD (for instance, in its comprehensive report *'Understanding the Brain: The Birth of a Learning Science'* (2007) and *'The Nature of Learning'* (2010)) and EU (e.g. in *'Neuroscience explains the impact of poverty on early brain development'* (2012)) positively link educational and cognitive neuroscientific perspectives in their policy directives.

Many of the international documents also seem to link educational neuroscience with neoliberal argumentation[278]. Similar neoliberal connections are not found to the same extent in Norwegian political texts − but again, this may be ascribed to the authorship of these reports, since a majority of the Norwegian political text are commissioned research reports. Another aspect worth mentioning is that almost all of the Norwegian political texts appear to present representations which are more in line with the ones found in the academic discipline of educational neuroscience − that is, representations of nuanced and more 'cautious' accounts where reciprocal collaboration between neuroscience and education/social sciences is emphasised[279]. This is of note, since my findings indicate that three out of six international political texts have representations that do not correspond with representations from the academic level of educational neuroscience[280], such as the UK Governmental teacher webpage, which argued for VAK learning styles (TeacherNet, 2007). Again, this variance may be due to the extent of political commissioned reports and research overviews found

[277] As seen in Backe-Hansen et al. (2014), Bjørnestad and Samuelsson (2012), and NOU 2010: 8 (2010).
[278] As seen in the international policy text Allen and Smith (2008), UK Government Office for Science (2012), TeacherNet (2007), and US Department of Education (2012).
[279] In the corpora this can be seen in Backe-Hansen et al. (2014), Bjørnestad and Samuelsson (2012), Departementene (2013), Ministry of Education and Research (2013b, 2013c), and NOU 2010: 8 (2010).
[280] As seen in Allen and Smith (2008), TeacherNet (2007) and US Department of Education (2012).

Table 8.2: Examples how different political texts represent educational neuroscience [my translation].

Text excerpt from the Norwegian political field
"*Experiences change the brain.* The committee has been imparted basic knowledge about brain science, particularly concerning developments of children's brains in their pre-school year. The brain's structure and function are influenced by experiences, and experiences related to children's activity in kindergartens do therefore play an important role in every learning process" (NOU 2010:8, p.23).
"The question is thus if kindergartens in the future should in greater extent make use of neuroscientific knowledge in order to aid better motoric, social, emotional, and cognitive development for disadvantaged children" (NOU 2010: 8, pp. 23-24).
"Heckman, the Nobel prize winner in economy, has in his research investigated relations between interventions in early childhood and later profit for the individual and for the society. Heckman says that early learning begets more learning − learning is a self-reinforcing process and gives a so-called "multiplication effect" ... This means that the later we implement learning interventions, the less effective and more expensive will such intervention be" (NOU 2010: 8, p. 131).
"Heckman, Moon, Pinto, Savelyev and Yaditz (2010) and Heckman, Pinto, Shaikh and Yavitz (2011) show that it is a statistic significant effect for both girls and boys when it comes to their participation in kindergarten activities, which means that the society can measure effect in form of economic profit when children get the opportunity to attend kindergartens" (Bjørnestad & Samuelsson, 2012, p. 30).
"There is in Dalli's research overview much work that is relevant for contemporary kindergarten debate, but usually these are not directly linked to kindergarten's activities. One example can be new research within development psychology and neuroscientific research which can be said to have revolutionised the perception of the youngest children in kindergartens ... When it comes to research from developmental psychology the borderlines between childcare and learning has been removed and newer research argue that there are no divisions between these two perspectives. Emotional development appear today as a total necessity for cognitive development, nobody can learn without safe and stabile conditions" (Bjørnestad & Samuelsson, 2012, p. 63).
"New brain science support the knowledge that the brain's development depends upon experience, and caregiver's emotional involvement in the infant is crucial. Traumas in the first three years of a child's life have therefore been shown to have particular damaging effect. The child adapts to neglect" (The Departments, 2013, p. 11).
"The conclusion was therefore that children in good shape have better ability to activate frontal and parietal brain regions which is important for abilities to control, maintain, and plan complex tasks related to cognitive control. These are essential skills for learning and academic performance in the classroom (Ministry of Education and Research, 2013a).
"During the last decades has the appetite for brain science significantly increased, also within the educational field. The authors mean that one should differentiate between two approaches to brain science. At the one hand are studies of the brain perceived as a source of knowledge which can enrich educational research. Knowledge from this research can be integrated with other research for what works within learning and education. On the other hand are brain science perceives as a source where one can extract guidelines and methods which further can be used directly in teaching. One example of this latter approach is methods for "brain gym" or "learning styles" which are sold as commercial products to schools" (Ministry of Education and Research, 2013b).
"Brain science can contribute to an improvement of schools. But what researchers insofar know about learning should be obvious for educationists, says Norway's two leading brain scientists Edvard and May-Britt Moser ... Our view is that there is absolutely no harm using what one know about memory to optimise learning in school" (Ministry of Education and Research, 2013c).
"This knowledge summary is an updating of a similar overview which was conducted by NOVA in 2008. Both times the Ministry of Education and Research was the commissioner. It has been interesting to investigate if there has happened alterations in the knowledge base and perception of gender differences in school achievements during the time that has ensued since the last review was written. Perhaps the most significant change that has occurred is an increased interest in which contributions a cognitive neuroscientific perspective can give. We have therefor also invited professor Kristine B. Walhovd, Institute of Psychology, University of Oslo, to write a distinct chapter with regards to this" (Backe-Hansen, Walhovd & Huang, 2013, p.3).
"There is, however, a long stride to deduce from such studies to implementation of knowledge of the brains normal variation to interventions in schools. In my opinion there is currently not a cognitive neuroscientific well-founded basis to claim that to surround girls and boys with different gender-specific educational facilitations will benefit them, their brain, or their school achievements. That being said, it can be favourable that educational personnel have basic knowledge about neural and cognitive development in order to understand and detect normal and deviant development in children (Walhovd in Backe-Hansen et al., 2013, p.77).

within the Norwegian field, since scientists authoring political reports may be more predisposed to critical readings and cautious representations of themes concerning education and neuroscience than policymakers.

Even if Norwegian political texts are more careful in their statements regarding topics pertaining to educational neuroscience, one can nevertheless find references – albeit in passing − to the much criticised theories of Heckman and Perry in almost half of them[281]. References to Heckman and Perry appear, as argued in chapter 7, to be a recurring intertextual feature when it comes to children's cognitive development and early intervention within the international political and public field, despite critiques from the educational neuroscientific community (Gillies, 2013; Howard-Jones, 2014b). It is nevertheless of note that similar references also occur within Norwegian political texts.

Discussion − the recontextualisation of educational neuroscience in Norway

What overall can be said as regards educational neuroscience's recontextualisation over scalar borders is that the discipline has, insofar, had a lesser impact in Norway compared to an international context − an aspect underscored by the fact that *none* of the Norwegian academic, public, or political texts mention the international discipline of educational neuroscience, although topics concerning such cross-disciplinary work are nevertheless manifested in the Norwegian context. References are most frequently found within media, in Norwegian 'brain-based' learning industries, and within educational and social policy texts. The same cannot, however, be said of the Norwegian academic field. Not only does the academic field have significantly *fewer* references to educational neuroscience than the Norwegian public and political fields, but the paucity of academic texts pertaining to educational neuroscience also stands in stark contrast to the substantial number of texts and debates in international academic fields. In the following sections I draw attention to some critical discourse theoretical aspects of the way in which educational neuroscience is recontextualised to Norway.

[281] As seen in the Norwegian texts Bjørnestad and Samuelsson (2012), Departementene (2013), and NOU 2010: 8 (2010).

Where is the academic debate and educationalists' engagement in the matter?

The first issue I want to address is the lack of debate concerning educational neuroscience within academia in Norway. Whilst there are debates about a general and overarching linkage of natural sciences (viz. biological explanations) and social sciences amongst Norwegian academics, the specific linkage of education and neuroscience has so far received little attention. The few texts about educational neuroscience found in the academic field are articles published in minor scholarly magazines and not in renowned Norwegian peer-reviewed journals. The inevitable question is therefore *why* there is so little focus on educational neuroscience within academia in Norway − particularly considering that the topic has already surfaced in Norwegian media, within policy documents, and also in the emergence of Norwegian brain-based learning industries.

The relative lack of academic focus on educational neuroscience can be explained by the noticeable 'gap' between natural sciences and social sciences in Norway. Indeed, several of the text in the corpora − from the Norwegian academic field, but also from the public field[282] − draw attention to this, using terms such as "two cultures" which can be found on different sides of "the big watershed" (respectively in Time, 2012, p. 23; Nielsen, 2011, p. 293). Discussions, as previously noted, often centre on the nature-nurture debate, where social scientists in particular are criticised for not taking biological explanations into consideration in their research. Arguments frequently proffered in light of this are how one in Norway can find "a fear of biology", "a futile either-or thinking", "bio-naivety" and "biophobia" amongst educationalists, psychologists, and other social scientists[283]. The following excerpt from the text *'Biophobia and biologism'* exemplifies such argumentation:

> Even if one acknowledges that development is caused by *both* nature *and* nurture, one chooses to focus on nurture only ... Within the academic world it is likely that biophobia is a relevant explanation for why so many academics and intellectuals are in opposition to, and know too little about, biological explanations ... What is often the case is that biophobia generates bio-naivety [i.e. lack of understanding of biology] (Kennair, 2008, p.19 [my translation]).

In the literature review by Bjørnestad and Samuelsson (2012), a report commissioned by Norwegian policymakers, one also finds references to similar tendencies within the academic field in Norway. The Ministry of Education and Research specified that this report should be

[282] As seen in Ebdrup (2014), Egge (2012), Kennair (2008), Lindholm (2012), Ministry of Education and Research (2013c), Monsen (2010), Nielsen (2011), Time (2011), Time (2012), and Vasnes (2014).
[283] As seen in Egge (2012), Kennair (2008), Monsen (2010), and Vassnes (2010).

a review of the type of pre-school research found internationally, in comparison to Norway. Based on findings from their extensive literature review, Bjørnestad and Samuelsson (2012) conclude that such educational studies are chiefly conducted by educationalists in Norway, whereas internationally one finds a predominance of psychological research approaches together with contributions and new perspectives from developmental psychology and neuroscience. This emphasises that the Norwegian educational research community, in contrast to similar international research communities, tends to pay more attention to social and environmental aspects, as opposed to biological explanations, in their studies. This aspect is noteworthy, since it can help to clarify the lack of any prominent debate on educational neuroscience within the academic field in Norway.

Educationalists' engagement − or rather *lack* of engagement – is significant in the few Norwegian texts and debates which actually focus on educational neuroscientific linkages. Findings from my discourse analysis of Norwegian texts pertaining to educational neuroscience show how a majority of these articles are published by, or are based on interviews from, neuroscientists or (biological) psychologists. In fact, of the 16 texts about education and neuroscience in the Norwegian corpus, 11 texts are written by, or based on interviews from, neuroscientists and/or (biological) psychologists whereas only three are written by educationalists[284]. Moreover, a majority of the educationalists seem to be educational practitioners such as teachers and school leaders. Voices from educational theorists and researchers therefore seem to be lacking from the discussion, since the central topic in many of these texts is the linkage of education and neuroscience. As *education* in one way or another is an essential aspect of this, it is surprising how few educational theorists voice their perspectives on the matter. Again this finding is noteworthy, since it can clarify the significant lack of debate within the academic and educational field in Norway.

Critical discourse theories of dominant representations, normalisation, and slow discursive change are relevant here. These theories draw attention to how certain representations within a discourse can become dominant − that is, when discursive representations exist within a discourse as relatively unquestioned conceptions. If such representations are continuously repeated and reinforced by discursive regularities, and where

[284] Of the 16 texts in corpora which explicitly talk of a linkage between education and neuroscience, only Bjørnestad and Samuelsson (2012), NOU 2010: 8 (2010), and Solli (2010) have perspectives from educational theorists. In 11 texts perspectives from neuroscientists or (biological) psychologists are presented, as seen in Backe-Hansen et al. (2013), Dehaene (2014), Departementene (2013), Ebdrup (2014), Egge (2012), Holterman (2010), Ministry of Education and Research (2013a; 2013c), Monsen (2010), Sund (2014), and Time (2012). The remaining two is a political text (Ministry of Education and Research, 2013b) and an interview of a brain-based education entrepreneur (Andreassen, 2014).

there is resonance between discursive 'realities', values, and institutions, dominant representations can become normalised. Representations, which remain normalised and relatively undisputed, contribute to sustaining the status quo in the discourse which, in turn, undergoes slow discursive changes. Dominant and relatively normalised representations can therefore be seen as significant influences, which shape and preserve how people perceive, think, and act within the world (Fairclough, 2010; Neumann, 2010). Parallels can, to a certain extent, be drawn from this and from the reluctance of Norwegian social scientists to take biological explanations into consideration in their research. This point is even noted in one of the academic articles from the corpora:

> Some significant ideological arguments against biological perspectives have been established as unyielding truths within modern social sciences. These ideas do, as such, continually direct the academic and intellectual debate − both through the debate's focus and in what the debate is blind to (Kennair, 2008, p. 11 [my translation]).

Kennair further argues that many social scientists should work to overcome their implicit objections against biological perspectives, claiming that such attitudes impede important scientific developments:

> Because of this unsubstantiated critique [against biological perspectives], many scientists and theorists have been hindered in thinking certain thoughts and in researching certain themes (...) − both due to direct censorship and because these ideas have been repeated uncritically over such a long period that many now assume them to be truths. This may have prevented academic developments within numerous disciplines (Kennair, 2008, p. 21 [my translation]).

I will claim that the tendency amongst Norwegian social scientists to neglect biological perspectives in social and educational matters is an intricate discursive process, which appears to have been sustained over a long period. One aspect of this process is the attitude of social scientists themselves, as research communities give the impression of being somewhat unenthusiastic in incorporating and exploring biological perspectives. I will, however, argue that it is unjust to ascribe the manifestation of 'biophobia' exclusively to social scientists, because discourses also have power, in virtue of their own self-sustaining structures and regularities. This power *of* discourse influences actors; often without these actors being aware of the intricate net of discursive structures with which they comply (cf. Fairclough, 2010; Neumann, 2010). Based on these critical discourse theoretical concepts, I suggest that certain knowledge and truths − wherein social scientific aspects are favoured over biological ones − may have become institutionalised over time within Norwegian social research discourses.

Institutionalisation of certain representations may also have become normalised, thus helping to restrict certain ways of being, thinking and acting within social scientific discourses − perhaps without social scientists being aware of the subtle influence of these discursive structures. One example might be how predominance of a nurture-view in social aspects becomes established within a psychological or educational research community at a university. Discussions, research programs, studies, articles written and, indeed, university courses for new students are therefore likely to emphasise perspectives where nurture is preferred to nature. In point of fact, this is even emphasised by some texts in the corpus, where university professors claim that students in education and psychology in Norway are not sufficiently exposed to courses or literature where biological perspectives are presented (cf. Kennair, 2008; Monsen 2010). Discursive processes of resonance can continue as these students become the new researchers, professors, and practitioners who, by virtue of being actors in the discourse, may also express preferences to nurture over nature in the way they think, speak, and act. Thus, if dominant nurture representations remain relatively uncriticised in this discursive feedback-loop, one may assume that biological explanations will gradually become marginalised within social scientific discourses. I do not imply that this is exactly what has happened within Norwegian social scientific discourses, although I suggest that the example clarifies how discursive powers operate. Opaque and self-reinforcing discursive structures can occur, in accordance with critical discourse theories, and claims of 'biophobia' amongst Norwegian social scientists ought to be seen in a larger discursive matrix where the power *of* discourse is also ascribed a significant role.

Despite the power of discursive structures, it is important to remember that critical discourse theories also emphasise subjects' actions and possibilities for discursive change. By resisting discursive conformities, by questioning the unquestioned, and by problematizing and crossing discursive boundaries, one can build foundation for new understandings and new ways of being and acting in the world (Fairclough, 1992, 2010)[285]. This discourse theoretical aspect supplements the process of discursive and social change and can also elucidate aspects of educational neuroscience's recontextualisation process in Norway. Should Norwegian actors not be seen as *active* rather than passive subjects who surrender to discursive recontextualisation processes? Cannot the augmented academic and pop-scientific debate concerning natural scientific explanation in social sciences witness of an active and dynamic problematization of discursive boundaries within and between the disciplines of biology,

[285] For further elaboration see critical discourse theories presented in the emergence chapter, page 67-69.

education, neuroscience, and psychology in Norway?[286] Moreover, do not the few emerging references to a linkage of education and neuroscience in Norwegian texts signal such a transgression, as old discursive aspects are re-articulated and re-understood through cross-discursive endeavours? If one further considers this discursive process in Norway in light of the emergence and development of educational neuroscience internationally (cf. chapter 5), one can see certain similarities. From my emergence analysis, it seems that the international development of educational neuroscience was instigated by a problematization of disciplinary borders between social sciences (viz. education and nurture) and natural sciences (viz. neuroscience, biology and nature) in the late 1800s − a problematization and disciplinary reconfiguration which recurred in the 1950s and 60s, before peaking in the late 1990s with the establishment of the educational neuroscientific discipline. Even if one cannot find evidence for the establishment of educational neuroscience as a distinct academic discipline in Norway, one can find several similar developmental traits with the international developmental process[287]. For instance, Norway had a prominent milieu of educational psychology and children's cognitive development in the 1950s and 1960s, and one could also find a strong belief in 'objective knowledge' inspired by natural scientific modes of studies. In the 1970s, criticism emerged of the 'positivistic stance', though, as social scientific perspectives gained ground in education. In the 21st century, one can also see in Norway the establishment of a political 'evidence-movement' within the educational field, whereas one in the more academic sphere one finds a problematizing and transgressing of disciplinary boundaries between biology, psychology, neuroscience, and education, although the definitive emergence of an academic discipline of educational neuroscience has not yet occurred. Some national variation notwithstanding, it is apparent that the Norwegian development and recontextualisation of the educational neuroscience discourse bears significant resemblances to the discourse's emergence internationally.

However, when considering the impact and development of educational neuroscience in Norway it is important to bear in mind that the Norwegian context cannot be seen in isolation and that this, to a certain extent, must be seen as a *re*-contextualisation process. By this, I mean that international discursive structures and actors are likely to influence Norwegian

[286] Within an international context it is noted by Aldrich (2014) that debates about the importance of nature and nurture have entered a new era with the introduction of neuroscience and education. This underscores my argument that nature and nurture debates in Norway can be seen highly interlinked, and almost as an inevitable prelude to the education and neuroscience debate

[287] My discourse analysis does not include an emergence analysis of historical texts in Norway, but certain parallels can nevertheless be drawn with references to Norwegian educational history (cf. Telhaug & Mediås, 2003).

discourses, in accordance with concepts of intertextuality and interdiscursivity (cf. Fairclough, 1992, 2010). Educational neuroscience's impact, emergence and development in Norway are therefore likely to have been, and continue to be, influenced by elements from international discourses of educational neuroscience. Indeed, this can already be seen in how certain international aspects of the linkage of education and neuroscience are manifested within the Norwegian context − such as smart drugs, brain-based learning industries, and how some literature reviews commissioned by policymakers look towards international research linking neuroscience and education.

Reversed premises in the Norwegian debate

Even if there is a lack of prominent academic debates about educational neuroscience within academia in Norway, this does not mean that discussions regarding such linkages are entirely absent − as previously stressed, discussions can be found in both pop-scientific media articles and in certain text published in scholarly magazines[288]. However, a significant proportion of this debate does *not* correspond with contemporary educational neuroscientific debates found internationally. I even suggest that the arguments for or against educational neuroscientific linkages in Norwegian debates appear to have become somewhat *reversed* in relation to the international discourse. This argument is based upon my analytical findings, which indicate that many of the texts which explicitly discuss linkages of education and neuroscience seem to i) either imply a *top-down relation* of neuroscience-over-education wherein neuroscientific explanations are often given predominance over educational theories[289] and/or ii) perceive linkages between education and neuroscience to signify *direct translations* of neuroscientific theories into educational practices, as often seen in 'brain-based' educational products[290]. Examples of the former are the texts by Egge (2012) and Monsen (2010). Both authors interview the biological psychologist Sigmundsson, who claims that biological research on "how the brain best learns" might provide a viable basis for practical interventions in schools. It further appears that both texts give biological and cognitive neuroscientific explanations predominance in aspects relevant to education, and the overall message is how such brain

[288] Discussions about linking neuroscience and education can for instance be found in the media texts Ebdrup (2014), Time (2012), and Monsen (2010), and in the scholarly magazine texts Egge (2012), Solli (2010) and Sund (2014).
[289] As seen in the scholarly magazine texts by Dehaene (2014), Egge (2012), and Sund (2014), and in the media articles by Anreassen (2014), Holterman (2010), and Monsen (2010).
[290] As seen in the pop-scientific media article by Time (2012) and Ebdrup (2014).

scientific knowledge can help to change Norway's "inadequate school system" (cf. Egge, 2012; Monsen, 2010). By the same token, it is stated that:

> Everything I say is scientifically based. I look at what actually works; I do not have any other guiding principles. I ask that scientifically based knowledge is incorporated in schools, into classrooms, and is translated to educational practice (Sigmundsson cited in Monsen, 2010 [my translation]).

Even if Sigmundsson, in this example, argues for linking education with cognitive neuroscience, I suggest that representations such as this do *not* correspond with common ideas held in the contemporary international discipline of educational neuroscience. A central aim within the international and academic level is, as mentioned in previous chapters, to build reciprocal collaboration between the discourses of education, cognitive psychology, and neuroscience. This relates to awareness of disciplinary differences in levels of analysis, where emphasis is put on cautious approaches to linking neuroscientific and educational research in matters related to learning[291]. Many within the educational neuroscientific community therefore resist top-down approaches, in which educational perspectives are made subsidiary to neuroscientific and biological explanations, because this is seen to undermine important steps in building balanced and equal collaboration. Norwegian actors who advocate for a linkage adherent to a top-down relation between neuroscience and education can therefore be seen to deviate from representations, views, and aims held by the international and academic level of the educational neuroscience discourse.

It is not only certain Norwegian authors who argue *for* a linkage between neuroscience and education who appear to be in conflict with representations held by actors from the international discipline − inconsistencies are also found in representations from Norwegian authors arguing *against* education and neuroscience. Two examples are the texts titled '*Educationalists should stay away from brain science'* (Ebdrup, 2014) and Time's (2012) text on linkages between neuroscience and social sciences, where the final section is entitled *'Educationalists misunderstand'*. Both texts emphasise different levels of analysis between the neuroscientific discipline and social science disciplines such as education, and that scientifically invalid conclusions can readily be drawn if one translates neuroscientific theories uncritically into educational practices − perspectives, that is, which also are

[291] As noted by for instance Ansari et al. (2012), Greenwood (2009), Mason (2009), Christodoulou and Gaab (2009), Ferrari (2011), and Varma et al. (2011) in previous corpora.

accentuated at the academic level of the international educational neuroscience discourse[292]. However, even if both Ebdrup (2014) and Time (2012) seem to hold ideas similar to those of the international discipline, they still seem to reject linkages between education and neuroscience on the premise that such an endeavour implies over-hasty and misjudged translations. There is, therefore, an inconsistency between the Norwegian debate and international debates on educational neuroscience. To be precise, both international and Norwegian authors take similar, cautious approaches as regards the linkage between education and neuroscience, and they both criticise approaches where neuroscience is too swiftly translated into practical instructions for (allegedly) improving education. The Norwegian authors nevertheless warn educationalists against neuroscience by saying "it is best if educationalists stay away from brain science altogether" (cf. Ebdrup, 2014). It is difficult to say whether these Norwegian authors use such remarks deliberately as an *exaggeration* in order to warn off educationalists until further developments in cognitive neuroscience can contribute to stronger linkages between education and neuroscience, or whether they are simply apprehensive and pessimistic about reductionistic approaches and neuromyths. Nevertheless, their approach appears to deviate from similar approaches and representations at the international discipline of educational neuroscience. Most significantly this is seen in how these Norwegian authors show wariness of linkages between neuroscience and education which also renders more cautious and reciprocal approaches to futile attempts.

Overall, one can get the impression that much debate regarding linkages of education and neuroscience in Norway is based on premises which do not correspond with the principles held within the international academic discipline of educational neuroscience. Paradoxically, it appears, then, that some Norwegian authors who argue *for* linkages between neuroscience and education will not find support in the international discipline, whereas some Norwegian authors taking a more apprehensive stand *against* educational neuroscience have more in common with the views of the international and academic level of the discourse. Considering that none of the Norwegian texts in my corpus refer to the established international discipline, one can wonder if this difference in positions between Norwegian and international debates may be due to Norwegian actors' lack of contact with the international and academic level of the educational neuroscience discourse.

[292] As seen demonstrated in the text by Ansari and Coch (2006), Goswami (2008), Anderson and Reid (2009), and Christodoulou and Gaab (2009).

Implications – and a summary of the chapter

As a summary of the chapter, and in consideration of the ways in which educational neuroscience has been recontextualised to Norway, there are four particular aspects and implications which I deem important to address. The first aspect is issues related to *reductionistic approaches to learning, the individual, and certain social matters.* This issue is twofold, since on the one hand there is a tendency to hold a reductionistic perspective in some Norwegian social scientific fields, where natural scientific aspects, such as biology and neuroscience, are not taken into consideration in learning, individual emotion, motivation, social interaction, and other aspects central for education. On the other hand, one can find a reductionistic perspective when top-down approaches result in translations from cognitive neuroscientific theories directly down to recommendations for educational practice. It has already been noted how the majority of educational neuroscientific linkages found in the Norwegian corpora tend to be suggested as top-down perspectives where neuroscientists are posited as 'superior mentors' over educationalists[293]. This unbalanced relation is problematic in itself, because it can lead to a reduction or neglect of educational and social perspectives in aspects pertaining to education and learning. Further difficulties arise when actors with a top-down approach suggest recommendations directly from neuroscientific or biological psychology theories to educational *practice* without taking educational perspectives into considerations.

Examples of this are seen in Norwegian brain-based learning programs and in certain media texts and scholarly articles where brain science is used as argumentation for particular educational practices or learning techniques[294]. Not only are such recommendations at risk of neglecting essential insights and ethical considerations which educationalists can offer, but these recommendations are usually intended for learning settings in kindergartens, in families, and in schools where practices ultimately will influence *children*. The international discourse of educational neuroscience appears to emphasise the importance of cautious approaches and reciprocal collaboration precisely because of this, and both social and ethical aspects are highlighted when considering complex processes of learning. In fact, the international research community appears to be so cautious in its approach, that only a few practical

[293] Traces of this can be seen in Andreassen (2014), Dehaene (2014), Ebdrup (2014), Egge (2012), Holterman (2010), Intempo (2014), Monsen (2010), Memolife (2014), Solli (2010), Sund (2014), and Time (2012).

[294] As seen in Andreassen (2014), Egge (2012), Holterman (2010), Intempo (2014), Monsen (2010), Memolife (2014), and Sund (2014).

implications have been suggested, as they find that “neuroscientific understanding is only just approaching the point where some limited educational implications and applications can be made that are of general significance to mainstream education” (Howard-Jones, 2010, p. 7). In comparison to this, Norwegian actors, in suggesting top-down views where neuroscience is directly translated to educational practices, are out of line with the views and values held by many within the international and academic educational neuroscience community.

The second aspect addressed with reference to educational neuroscience’s recontextualisation in Norway is *uncritical fascination with neuroscientific explanations.* In previous chapters it was noted that international research indicates that neuroscientific explanations and brain images have an appealing appearance and, moreover, how particularly non-experts tend to judge explanations with neuroscientific information more favourably than explanations without such information. This ‘alluring appearance’ of neuroscience is further shown to enthral part of the international educational community, the public, and international popular culture (Hardiman et al., 2012; Pasquinelli, 2011; Weisberg et al., 2008). This is the case in Norway as well, and findings from my discourse analysis reveal numerous incidences in academic texts, in media stories, and brain-based learning products where authors or people interviewed appear to be fascinated by brain sciences, to mis-evaluate neuroscientific explanations, and/or to have unrealistic confidence in neuroscience and the social and behavioural aspects it can “explain”[295].

For example do the texts *‘This is how the brain learn’* by Egge (2012) and *‘Music lessons improves learning’* by Sund (2014) − both published in scholarly magazines for educational practitioners and school leaders − present accounts where a top-down approach is taken to the linkage of neuroscientific theories to educational practice. Considering that both articles are written by *educationalists* and that the topic at hand also is *educational* matters, it is surprising that neither of them offers any educational perspectives or digressions on the matter. This is understandable if these authors do not have any expertise in cognitive sciences and thus do not feel able to evaluate neuroscientific perspectives. Nevertheless, the topics discussed in both texts are elementary educational matters, which any educational practitioner, theorist, or school leader without difficulty could expound upon. The relevant educational, ethical, and critical perspectives seem to have evaporated in the sunny glory of

[295] Traces of this can be seen in Andreassen (2014), Byrkjedal and Misje (2013), Egge (2012), Henriksen (2005), Holst and Hansen (2011), Holterman (2010), intempo (2014), Knudsen (2010), Lunde (2011), Memolife (2014), Monsen (2010), Nydal and Asland (2007), Sund (2014), Yttervik (2012).

neuroscientific explanations given by the brain scientists interviewed. This fascination with neuroscientific explanations and lack of critical readings is noteworthy, but it must be stressed that similar tendencies are also found amongst non-experts in the international field. Nevertheless, when considering aspects pertaining to educational neuroscience in Norway one ought to bear in mind that there is a tendency (even if unintentionally) amongst non-experts to misevaluate information with neuroscientific explanation.

Related to uncritical fascination of neuroscientific explanations is the third implication to be addressed − namely *neuromyths and misinterpreted representations of educational neuroscience.* The problem of misinterpretation of educational neuroscientific research has been discussed in previous chapters, where it was noted how simplification, generalisation, misunderstanding and misrepresentation of educational neuroscientific research can be manifested in academic, public, and political texts. The impact of such misinterpreted educational neuroscientific representations can differ, based on where and how a text is published and the number of its potential readers. If an educational neuroscientific misrepresentation is frequently repeated, it becomes a *neuromyth*, or an *edumyth*, thought to be true by many actors within the discourse (cf. chapter 7). When it comes to Norway, there are misinterpreted representations from the international and academic level of educational neuroscience, and even some neuromyths and edumyths, in many of the Norwegian texts[296]. Examples of this are seen in how 'the myth of three' is manifested in some Norwegian texts (cf. Andreassen, 2014, Intempo 2014), the effect of Omega-3 on cognition (Henriksen, 2005), VAK learning styles (Memolife, 2014), and left- and right- hemispheric dominance (Memolife, 2014; Nydal & Asland, 2007). This is noteworthy, because not only can mis-representations of educational neuroscientific research contribute to misunderstandings regarding the values and aims of the international discipline of educational neuroscience, but also, frequent appearances of misrepresentations can also be manifested in the ways in which people understand concepts such as learning, the brain, and education.

The last and, in my view, most important aspect of educational neuroscience's recontextualisation in Norway is the implications of *lack of academic debate and educationalists' engagement in matters related to educational neuroscience.* Throughout the discussion concerning Norwegian recontextualisation processes, I have repeatedly stressed how topics pertaining to educational neuroscience are more visible within public and political

[296] For example in Andreassen (2014), Egge (2012), Henriksen (2005), Holst and Hansen (2011), Holterman (2010), Intempo (2014), Knudsen (2010), Memolife (2014), Monsen (2010), Nydal and Asland (2007), Sund (2014), and Yttervik (2012).

fields than within academia in Norway. Moreover, the few academic debates that do occur tend to be led by neuroscientists and (biological) psychologists, whereas educational theorists seem to be relatively absent from the debate. Based on critical discourse theories, and also by understandings resulting from my previous discourse analysis of educational neuroscience, I argue that this tendency in Norway has some significant implications. First of all, the lack of prominent educational neuroscientific debates within academia in Norway is important, because it is within academic fields that one might expect to find more critical discussions and considerations − as opposed to media texts and brain-based learning products. When academic debates on educational neuroscience are missing, it is therefore also likely that critical consideration of educational neuroscience's issues and possibilities will become marginalised within the Norwegian context. This is particularly problematic, considering the number of neuromyths, brain-based learning programs, and other misrepresented educational neuroscientific accounts, which have appeared in Norway over the past decade. Insights and perspectives from academic communities can act as an important counterweight in the Norwegian educational neuroscience discourse, so that discussions do not become dominated by uncritical readings and misrepresentations of educational neuroscientific research. By the same token I will also suggest that it is important for Norwegian educational theorists and researchers to get involved in the debate. Just as the voices of academics can provide a counterweight to more uncritical readings of educational neuroscience, so can educational theorists provide a counterweight to top-down approaches where neuroscientific and psychological perspectives are given precedence over educational considerations. In turn this will contribute to an anti-reductionistic understanding of aspects relevant to learning and the individual child. Overall, and with reference to aspects of the educational neuroscientific debate internationally, it would give rise to more critical considerations and debate about educational neuroscience in Norway, if voices from neuroscientists, psychologists, educational theorists and practitioners were to be heard in the discourse.

Apart from more academic debates and more engagement by educationalists, I also deem it important for Norwegian actors to look at the work of actors from the international academic discourse of educational neuroscience. This is because manifestations of education and neuroscience in Norway can, to some extent, be seen as a *re*-contextualization process. This implies that elements from the international discourse have had, and still have, an impact on how educational neuroscience is manifested within a Norwegian context. By the same token it must be emphasised that Norway is *not* a passive bystander in the recontextualisation of educational neuroscience. Even if certain recontextualisation processes occur by means of discursive structures (viz. the power *of* discourse), Norwegian actors are active subjects who translate and appropriate aspects of educational neuroscience into their own national context (viz. the power *over* discourse). Numerous examples of this have been provided throughout this chapter, covering both similarities and *differences* in the ways in which educational neuroscience is constituted over scalar borders. I will reason that in the process of *re*-contextualisation, there are elements of discursive progression, in that actors can acquire knowledge and expertise from one discourse in order to influence or change discursive events in their own discourse. For instance, one can find numerous similarities in Norway and internationally in the ways in which educational neuroscience is represented, incorporated, and manifested in fields such as academia, media, brain-based learning industries, and amongst policy makers. However, the international discourse is in many ways more established than in Norway, which is seen in internationally outstanding research collaborations, and discussions regarding aspects which only recently have become themes of interest in Norway. Significant negotiations, considerations, and experiences have therefore ensued from the international discourse, such as ethical issues regarding educational neuroscience, difficulties with established neuromyths, criticism of Heckman's model, issues related to reductionistic top-down approaches, issues and possibilities related to different levels of analysis, and other aspects regarding educational neuroscience. This is valuable knowledge for actors within the Norwegian context, although by arguing for the importance of looking towards the international educational neuroscience discourse, I do not imply that Norwegian actors should uncritically accept and adopt parts of the international discourse. Norway has different traditions, policies, values, and other unique discursive structures, which should not be reduced to international discursive conformities. What I therefore regard as essential is *critical interaction* in the recontextualisation process of educational neuroscience to Norway, wherein Norwegian actors enter into a dialogue with international educational neuroscientists. In this way, Norwegians can make use of knowledge and expertise from the international discourse, while at the same time making deliberate decisions for adopting and translating knowledge in order to adapt it for the unique context of the Norwegian discourse.

Chapter 9

Final reflections

A central focus of my doctoral study has been to analyse and discuss the development and impact of the educational neuroscience discourse at different academic, public, and political levels. I have emphasised that educational neuroscience is a field in continual flux, changing both in response to discursive structures and actors' strategic actions. But although I have, so far, examined the past and present development and impact of educational neuroscience, I have tried to avoid subjective and over-normative assessments concerning the road ahead − is the project of linking education and neuroscience an important task worth pursuing, or is the endeavour a bridge too far? Indeed, I touched upon similar themes in previous chapters, but therein I have chiefly described and discussed findings from my critical discourse analysis. This is because discourse analysis is performed in order to descriptively map out and critically reflect upon aspects of discourse, but a central canon of discourse analysis is that the analyst should be careful in presenting value-laden evaluations of 'good' or 'bad' and 'correct' or 'incorrect' discursive aspects − particularly if such assessments can be misunderstood as descriptive analytical findings. It is, by the same token, unrealistic to think that anyone can dedicate years to studying a discourse without having any personal opinions on the matter. This final chapter is therefore presented in order to separate my critical discourse analytical accounts from my more normative evaluations, which have been acquired and shaped throughout these years of studying educational neuroscience[297]. Moreover, considering that the discourse is likely to continue changing in the years to come, I find it essential to write down some thoughts with regards to the future development of the educational neuroscience discourse.

[297] It should be noted that some of the following views are also suggested by others (e.g. Varma et al. 2008; Samuels 2009; Beauchamp & Beauchamp, 2013), and other ideas can be seen to lie at a nexus of the educational neuroscientific endeavour. Such resemblance notwithstanding; the following commentaries are personal evaluations formed during my critical discourse analytical work of the educational neuroscience discourse.

The importance of anti-reductionistic approaches

The first point I will stress for further developments of the discourse is the importance of *collaboration* between all the disciplines working at the interface of the educational neuroscience endeavour. This implies that there should not only be cooperation between the discipline of cognitive neuroscience and that of education. Aspects from cognitive psychology are also important; so are insights from sub-disciplines such as social cognitive neuroscience, critical neuroscience, cognitive psychology, psychology, educational psychology, educational theory, and pedagogy. These sub-disciplines can be located at the interface between neuroscience, psychology, and education, and I argue that allowance for such sub-disciplines in an educational neuroscientific model can help to moderate the idea of rigid disciplinary boundaries between the three respective levels of the brain, the mind, and the level of behaviour and the social. Moreover, and in line with critical discourse theories, these sub-disciplines should also be seen to influence, and be influenced by, one another. For example, when new understandings of neurobiological functions in the brain are suggested in the field of cognitive neuroscience, this is also likely to influence understandings in the sub-field of social cognitive neuroscience. This new knowledge of how the brain works can further influence aspects at the level of the mind, and even at the level of behaviour. The model of educational neuroscience's ordering may therefore be one of complex interdiscursive relations where none of the levels of analysis can be understood in isolation from the others. Such cross-disciplinary work may seem exceedingly far-reaching and excruciatingly demanding. But no one has suggested that work at the interface of educational neuroscience is *simple*. The work set out by the educational neuroscience discourse is highly complex, since it crosses so many levels of analysis − from micro-biological aspects in the brain, to complex sociological aspects in the classroom. To succeed in this multifaceted project, one has to acknowledge that the task at hand needs to be approached from different angles, and that it is essential with collaboration between disciplines related to neuroscience, psychology, and education.

This collaboration must also be *reciprocal*, because top-down approaches where some disciplines take a hierarchical, superior position are liable to obscure valuable insights from other disciplines. This means that neuroscientists should not see it as their goal to 'inform' educationalists; nor should educationalists shy away from biological explanations of learning and memory. Equal collaboration is of importance for further developments in educational neuroscience, I will argue, because findings from my discourse analysis show that numerous academics fail in building reciprocal relationships, despite the fact that balanced cooperation is seen as an essential aim within the academic level of educational neuroscience. One can, for instance, find cases where educationalists ignore insights from the brain in matters related to learning, or some who even perceive neuroscience as a potential threat to the educational tradition[298]. The ways in which these apprehensive views are expressed vary from explicit disputes to neglect of cognitive and neuroscientific factors in educational matters − the latter appears to be the case in Norway[299]. Explicit or implicit aversion notwithstanding, such subject positions towards new insights from cognitive and neuroscientific sciences are, in my view, exceedingly unhelpful, comparable to an ostrich with its head in the sand, rather than constructing collaborative forums in order to cultivate educational and social theories in phase with scientific progress. Concepts essential to education, whether learning, motivation, emotion, social interaction, or reading, can surely be addressed from social scientific approaches, but they *also* have a natural scientific underpinning and can accordingly be addressed by natural scientific approaches. To say otherwise is to disavow the role of biology in human nature, and hence to suggest a reduction of nature into aspects solely related to nurture.

However, there are not only actors who weaken reciprocal collaboration by 'leaving out the brain' in educational and social matters, because one can also find numerous instances where *education* is ignored in the work of educational neuroscience, whether by neuroscientists, psychologists, and even educationalists[300]. This not only occurs when theorists and researchers in the educational neuroscientific community neglect educational *practice* in their work, but it also occurs when psychologist and educationalists (whether practitioners or theorists) become mesmerised by the 'seductive appeal of neuroscientific explanations' and consequently overlook significant insights from their own field. Top-down approaches, where educational perspectives are devalued in relation to more neuroscientific and cognitive scientific insights, are particularly seen at the academic level in Norway, when educational texts offer interviews with neuroscientists and cognitive psychologists on "how the brain best learns" − but *without* giving any reference to educational theories. Not only is this approach highly reductionistic, but this time it is educational and social explanations that

[298] As seen in for instance Schumaker (2007) and Davis (2004).
[299] References to *negligence* of 'the brain' in educational text are inevitably more difficult to pinpoint to specific texts, but it is shown in findings (or rather *lack* of findings) from the literature search and critical discourse analysis in Norway.
[300] As seen in Dehaene (2014), Wilson et al. (2006), Carew and Magsamen (2010), Solli (2010), Egge (2012), and Sund (2014).

are reduced in importance in relation to the natural sciences. It is important for actors working at the interface of the educational neuroscience discourse to remember that education has a long history and a significant accumulated knowledge base on motivation, social interaction and communication, learning disorders, social inequality, teaching strategies, curricula designs, school organizations, educational leadership and, not least, social and individual ethical considerations. Researchers within the fields of cognitive neuroscience and cognitive psychology can gain much from listening to educationalists – both theorists and practitioners – because their knowledge can point out other perspectives and possible solutions which may not be obvious to neuroscientists and cognitive psychologists. Including educational knowledge also brings valuable perspectives concerning ethical, evaluative, practical, and individually or socially beneficial aspects. Whereas neuroscientists and cognitive psychologists often bring new insights into how we *can* organise and structure educational practice, it is educators who can give indispensable insights regarding how we *should* organise and structure educational practice. This vital difference between 'what can be done' and 'what should be done' does not solely depend on what science says is possible, but also on what in the long run is individually and socially beneficial. Even if the educational field does not move forward under a golden banner reading '*science'*, the educational profession should not be underestimated. Neglect of the educational side in work pertaining to educational neuroscience is therefore, in my opinion, highly problematic since it suggests a reductionistic view where concepts of nurture are subsumed to concepts of nature.

In order to overcome obstacles in the discourse of educational neuroscience, it is important to continue encouraging anti-reductionistic approaches in work related to learning, individual cognition, social interaction, cognitive development, emotions, and other concepts of educational neuroscience. It must, however, be accepted that neuroscientists and cognitive psychologists often discuss aspects of educational relevance, such as what happens in the brain when we learn and why children with dyscalculia comprehend numbers differently. At the same time it must be acknowledged that the aim of cognitive science is not to *replace* social and educational perspectives, but instead that cognitive and neuroscientific knowledge are most valuable when they offer new and complementary perspectives of education. The same applies in reverse, because educational theorists, researchers, and practitioners in my view also hold essential social perspectives relevant to cognitive and neuroscientific concepts. There are, in other words, different levels of analysis, ranging from neurobiological analysis of learning to socio-interactional analysis of learning, and these different levels will address and answer different question. No level excludes the other levels, nor is any level more vital than the others, but they can complement each other and together contribute to more comprehensive and holistic perspectives on topics such as learning. Engagement in *reciprocal collaboration* between the disciplines of education, psychology, and neuroscience is, indeed, one way of improving anti-reductionistic approaches. I concede that the task of shaping mutual and bi-directional bonds between the disciplines cannot be done overnight, because reciprocal collaboration implies acknowledging the importance of other disciplines in work pertaining to educational neuroscience. Moreover, reciprocal collaboration also necessitates awareness of *differences* between disciplines, such as differences in vocabulary, values, theories, methods, methodologies, practices, and philosophies. If one overlooks these dissimilarities, one may easily underestimate the traditions of individual disciplines. I therefore agree with many others within the educational neuroscience discourse, and argue for a cautious approach, in which one does not conflate the different levels of analysis.

Educational neuroscience as a transdisciplinary field of study

In accordance with arguments for anti-reductionist approaches and reciprocal collaborations between the disciplines, I will argue that much can be gained by perceiving educational neuroscience as a *transdisciplinary* endeavour. A transdisciplinary endeavour is different from both an interdisciplinary and a multidisciplinary understanding of a discourse, as it does not hold the view that educational neuroscientific work solely includes operating and combining knowledge at the crossing points between different disciplines[301]. Instead, transdisciplinarity encompasses a perception that new disciplinary knowledge is created in the merging and negotiation of discursive boundaries, as new knowledge and 'new articulations' arise from interactions within a new discursive group (cf. Fairclough, 2010; Samuels 2009). In other words: the novel discipline of educational neuroscience ought to be recognised as precisely that − a *novel discipline* in its own right, neither governed by cognitive neuroscience, psychology, nor by education, but instead developing through joint collaboration between these prior discourses (see figure 9.1 and my model in 9.2). Samuels (2009), della Chiesa et al. (2009), and Beauchamp and Beauchamp (2013) also argue for recognising educational neuroscience as a transdisciplinary phenomenon:

[301] Even if authors within the educational neuroscience discourse talk of multidisiplinarity or interdisciplinarity, many appear to do so without necessarily grounding these notes on theories regarding different disciplinary connections.

> What this means is that the type of knowledge being pursued here is not the sum of individual knowledges shared by experts or specialized groups (multidisciplinarity) nor the knowledge that is created at the intersection of established disciplines (interdisciplinarity), but a new kind of knowledge that arises from the interaction of diverse people within an entirely new group (transdisciplinarity) ... What connects transdisciplinary participants is not a common theoretical perspective or methodology or epistemology, but a common issue to which all apply their own particular expertise with the goal of reaching a holistic understanding of the issue (Samuels 2009, p. 49).

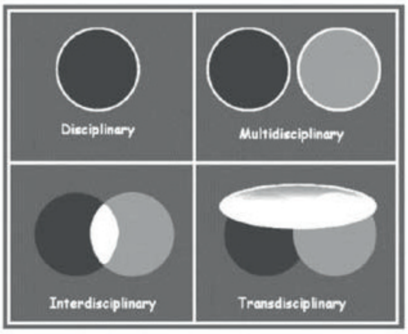


***Figure 9.1** –Differences between multi-, inter-, and transdisciplinary approaches (model from Samuels, 2009).*

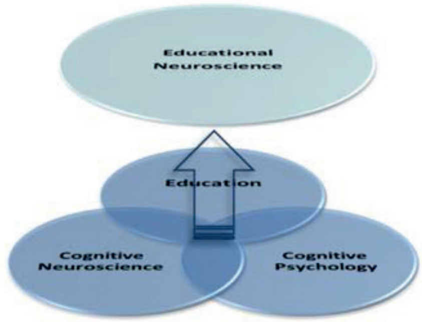


***Figure 9.2** –My model of educational neuroscience as a transdisciplinary endeavour emerging from the field of prior discourses.*

I will argue that reductionist approaches can be avoided if one identifies educational neuroscience as a transdisciplinary field emerging from the prior field comprising discourses of cognitive neuroscience, cognitive psychology, and education. The concept of transdisciplinarity implies that the discipline of educational neuroscience lies neither within the territory of cognitive neuroscience nor within the educational domain. With a transdisciplinary view, one also acknowledges the ongoing process where these prior disciplines together contribute to the development of a new field. This implies, as do critical discourse theories, (cf. chapter 5), that actors from different fields must negotiate and *re*-articulate old discursive narrations so that they are compatible with the new transdisciplinary framework of educational neuroscience. This indicates negotiation and re-articulation of disciplinary knowledge, as well as negotiation with regards to new transdisciplinary positions, practices, values, goals, ethics, and ideologies.

Bear in mind that my transdisciplinary model in figure 9.2 only covers disciplinary aspects of educational neuroscience's academic level. Other and more overarching aspects of the larger academic and scientific discourse can also affect any of these disciplinary levels. This has been shown in previous chapters, in how hegemonic struggles pertaining to educational neuroscience are related to similar struggles, which have been fought out in academia for decades. Some hegemonic struggles in the educational neuroscience discourse can therefore be seen as negotiations with more durable and institutionalised conflicts within academia (cf. Fairclough, 2010). Indeed, these interdiscursive relations are explicitly manifested by intertextual references, and in how the educational neuroscience debate frequently refers to representations of nature vs. nurture, biology vs. environment, and natural sciences vs. social sciences[302]. Intertextual and interdiscursive relations to a *larger academic discourse* are perhaps rather obvious, but these relations are important when it comes to an understanding of how the educational neuroscience discourse changes in phase with the general scientific community. What is more, national and international political programs, economic considerations, influences from parents and families, public attention, media coverage, attention from so-called 'brain-based' learning industries, and other societal aspects are also relevant levels of analysis. All these discursive aspects can be seen to be included within a *larger societal discourse* and have, as shown in my recontextualisation analysis, significant interactive relations with the educational neuroscience discipline − not only do societal factors influence the educational neuroscience discipline, but the academic level of educational neuroscience in turn affects the larger societal discourse.

I therefore argue that a comprehensive model of the levels of analysis pertaining to educational neuroscience should encompass a multifaceted, dynamic, and interactive set of levels − including levels within the transdisciplinary endeavour of educational neuroscience (viz. education, psychology, and neuroscience), and levels between this transdiscipline and other overarching discourses (viz. the larger academic discourse and the larger societal discourse). Accordingly, I suggest the following model (figure 9.3). The model emphasises that educational neuroscience as a transdiscipline cannot be understood in isolation and, hence, how one ought to strive for reciprocal and anti-reductionistic approaches both within disciplinary boundaries and between the academic, the public, and the political level of discourse.

[302] Representations of the former are seen in Logan and Johnston (2007), and Gelman and Taylor (2010); biology vs. environment in Ansari et al. (2012), and Goswami (2008); and the latter in Cerulo (2010), Kraft (2012), Perkins (2009), and Willingham (2009).

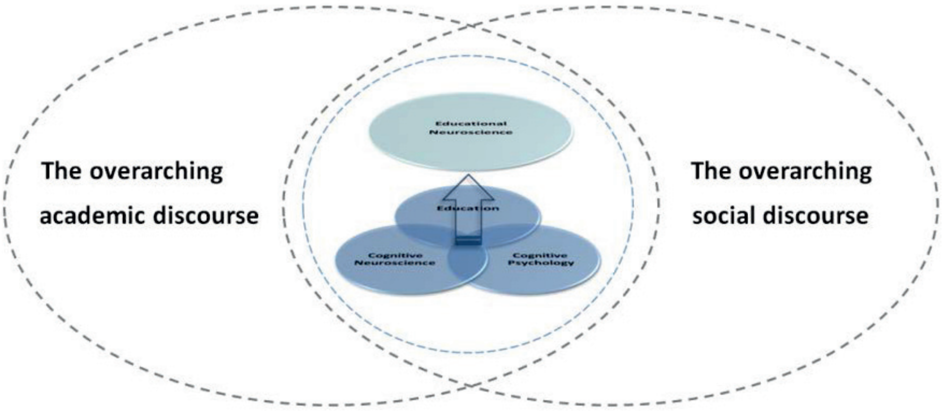


Figure 9.3: My model of reciprocal relationships between different levels of analysis relevant for educational neuroscientific research.

I will furthermore argue that understandings of educational neuroscience as a trans-disciplinary field of study also have practical implications for further development − particularly when it comes to the continuing establishment of academic courses and degrees in educational neuroscience. Numerous bachelor, master, and doctoral courses in educational neuroscience have been established internationally[303], and I will argue that these university programs play an important role in shaping the present and the future of the educational neuroscience discourse. In line with my previous arguments I suggest that it will be most beneficial for the prospect of educational neuroscience if such university programs build upon a trans-disciplinary understanding of educational neuroscience. This implies that university degrees in educational neuroscience should endeavour to introduce new scholars to the field *emerging from* disciplines of cognitive neuroscience, cognitive psychology, and education, wherein knowledge from all three academics fields is mutually considered. Such transdisciplinary approach can prevent reductionistic understandings, since emphasis is on a *novel* field rather than a field with a preliminary basis in neuroscience, psychology, or education[304].

In addition to distinct programs and degrees in educational neuroscience, I also think it is highly important to offer courses pertaining to the linkage of the brain, mind, and education

[303] Such as at Harvard University, Cambridge University, University of London, and University of Bristol.
[304] Also authors such as Berninger and Coring (1998), Ansari and Coch (2006), and Samuels (2009) argue for the importance of training researchers with competence in the field pertaining to education, cognitive psychology, and neuroscience.

to students in the disciplines of cognitive neuroscience, cognitive psychology, and education. Educational studies ought to encompass themes in cognitive neuroscience and psychology, because this will contribute to a more comprehensive understanding of aspects such as learning. Similarly, it is just as important to introduce new students in cognitive science to education, because cognitive scientists have much to learn from social and practical approaches to learning, memory, motivation, emotion, and social collaboration. In addition, the introduction of transdisciplinary perspectives in education, psychology, and cognitive neuroscience can help to foster a common acceptance that the 'human brain' cannot be understood in isolation from our social environment, nor can human behaviour and cognition be separated from our brains.

It must be stressed that I am not saying that every neuroscientist, psychologist, and educationalist should have a *degree* in educational neuroscience; what I am saying is that every university department has a responsibility to equip students with the required knowledge pertaining to their respective field of study. This is because the discursive structures and practices of an academic discourse are built around the enterprise of educating students, disseminating ideas, and demonstrating learning. Additionally, and even more importantly, the enterprise of academic discourses is *knowledge creation* (Hyland, 2009). With reference to critical discourse theories on self-sustaining discursive regularities, an academic department is powerful in that it simultaneously regulates meaning-making, represents particular ways of perceiving the world, shapes social roles for students and academics, and, in addition, is an enterprise for creating knowledge itself. Actors within academic discourses are therefore essential to the future development of educational neuroscience, because these actors hold the power to shape disciplinary structures and the creation and maintenance of knowledge. An educational department, which *completely* neglects to mention the brain in the course materials and knowledge presented to students, is liable to reproduce an unbalanced picture of education and learning. This is because an exclusive focus on the social aspects of, for instance, learning, fails to show how social aspects and behaviour also have crucial interactional links to the brain and to the mind. In turn, this neglect may be manifested in students' perceptions of the world, as they do not recognise the complex nature of learning, emotions, education, and individual and social behaviour. As a critical discourse analyst, I cannot help but take a critical stand towards the retention of knowledge, whether this is a conscious or unconscious act, since how the world is represented to students is likely to affect how students themselves represents, perceives, and acts in the world.

At the moment, there are only a few universities around the world with specific courses on the linkage of education and neuroscience. I believe that establishment of new courses and degrees will be an important step in building more awareness within the discourse of educational neuroscience and between discourses in the related fields of education, cognitive psychology, and cognitive neuroscience. Such efforts do more than contribute to an understanding of discursive differences and how to mutually collaborate in building transdisciplinary knowledge about educational neuroscience. More awareness amongst neuroscientists and teachers can also help to prevent neuromyths and misguided 'brain-based' programs, since understanding of the complex brain-mind-education link can create critical readers in topics pertaining to educational neuroscience.

The importance of a philosophical grounding

At the beginning of my dissertation, I claimed that the academic discourse of educational neuroscience has a significant deficiency − the discourse lacks an explicit *philosophy of science* for grounding its educational neuroscientific research[305]. One can get the impression that educational neuroscientific research is adrift either from philosophies of social sciences (viz. education) or from philosophies of natural sciences (viz. cognitive neuroscience). In short, the issue comes down to basic epistemology and ontology, as a linkage between education, psychology, and cognitive neuroscience challenges certain prominent philosophical understandings. In a relativist standpoint such as social constructivism, certain natural scientific premises like biological aspects of the living brain are inadequately considered, because social constructivism tends to focus on epistemological doctrines of social constructed understanding. If, on the other hand, one adopts a philosophical position of realism, social aspects such as meaning-making and underlying discursive structures are liable to be given less consideration than more existential aspects, such as neural biochemical processes in the brain. Educational neuroscientific research therefore often has divergent

[305] A philosophical theme has already been noted in chapter 2, where I describe philosophical difficulties the discourse of educational neuroscience is facing. It is, however, a difference between attempting to tackle *philosophical issues*, such as the mind-brain dilemma and the philosophical issue of consciousness, and attempts to craft a basic *philosophy of science* apposite to educational neuroscientific research.

philosophical underpinnings, because the traditions of education, psychology, and cognitive neuroscience have different understandings of epistemological and ontological aspects of the world. This is problematic not only because philosophical issues are manifested within the discourse, but issues also arise because philosophical differences often imply differences in methods, theories and scientific values and aims.

I argue that the chief problem is that actors working at the interface of educational neuroscience tend to address educational neuroscience from a background in one of the prior disciplines, rather than addressing philosophical issues from a *transdisciplinary* framework. In other words, the philosophical 'divide' between the disciplines of education, psychology and neuroscience should not be bridged by reducing one or more of these disciplines to another. The solution is not, therefore, to alter educational philosophies, theories, and methods in order to make them compatible with naturalistic doctrines. I am, for example, sceptical regarding extensive use of the so-called 'gold standard' method of randomised control trial (RCT) in education. This method originates from (natural) scientific methodologies pertaining to a specific type of clinical experiment, which seeks to measure and compare the outcomes of two or more clinical interventions (Jadad & Enkin, 2007), and is thus a method supposed to yield valid and rigorously scientific data (Slavin, 2002). In itself, the randomized control trial can be a valid method for evaluating certain aspects of education, such as 'effectiveness' in using different reading methods. A problem, however, arises when it is claimed that randomized experiments are the best way of evaluating educational interventions and policies (cf. Slavin, 2002; Biesta 2007). By emphasizing only one kind of method in educational research, one risks limiting one's view of the educational domain. Do complex aspects of educational, such as children's reading skills, only encompass what can be measured by randomized control trials? Do reading abilities not also encompass aspects of motivation, family influences, the classroom setting, the teacher's strategy, aspects pertaining to dyslexia, and more clinical problems such as restricted eyesight? And what about other educational research, such as philosophical, historical or, indeed, critical discourse analytical studies; can one utilize a randomized control experiment in these studies? By restricting what counts as a 'valid method' to methods such as rigorously scientific randomized control experiments, one excludes significant aspects of the educational domain. Relating the example to educational neuroscience, I thus think that there is little to be gained by making the educational discipline conform to natural scientific expectations. Rather, I believe that the quality of education and what it can contribute to educational neuroscience lies in the fact that it does, indeed, have different perspectives and different values than those of neuroscience.

My general argument is therefore simply that neuroscience will call for naturalistic approaches, just as society must be described in terms of social categories. But since educational neuroscience is, arguably, a new discipline emerging from a field of prior discourses − and *not* a discipline rooted in either of the traditions − I argue that its philosophical underpinnings will also emerge through boundary transgression and negotiation between its prior discourses. A philosophy of science compatible with educational neuroscience must, as a consequence, go *beyond* the disciplines of education, psychology, and neuroscience and their respective philosophies of science, because transdisciplinary educational neuroscientific research attempts to combine both naturalistic and social scientific aspects of study. It is, therefore, necessary that the scientific philosophy transpiring from the field of prior discourses makes allowance for, but does not give pre-dominance to i) neuroscientific ideas where existence of real objects is essential and ii) central educational and social scientific premises wherein, for instance, the idea of underlying social and discursive structures is essential.

In chapter 2, I argued that *critical realism* might provide a possible scientific-philosophical grounding for the transdiscipline of educational neuroscience. A comprehensive account of possible links between critical realism and educational neuroscience is given in chapter 2, but to recapitulate, it can briefly be noted how critical realism acknowledges the importance of both the social and natural world, but without falling into disciplinary reductionism. Its essential tenet is that the world can be seen as 'stratified', since different mechanisms are ordered in different 'layers of nature' − implying that lower generative mechanism, such as biology and cognitive neuroscience, can explain phenomena without replacing higher levels, such as the level of the educational and societal. This non-reductive approach is further manifested in the critical-realist view on methods for studying different aspects of reality, as it is stressed that different research objects will demand different modes of study. A critical-realist perspective on educational neuroscience will accordingly stress the importance of *not* using naturalistic methods to study the social − nor using social methods to study the natural − but rather of using transdisciplinary methods relating to different perspectives on the natural and social worlds. I therefore suggest that critical realism offers a common scientific philosophical ground between education, cognitive psychology, and cognitive neuroscience, without reducing any of the three disciplines to one another. A critical realist philosophy for the transdiscipline of educational neuroscience can furthermore be advantageous since it emphasises a critical, anti-reductionist, and elementary philosophical understanding of learning, cognition, emotions, behaviour, individual development, social behaviour, and other topics relevant for educational neuroscience.

Again, it must be stressed that critical realism is just my preliminary *suggestion* for a philosophy of science appropriate for educational neuroscientific research. More evaluation is required of the potential of, and issues related to, the connection of critical realism and educational neuroscience. Nevertheless, critical realism is an interesting philosophy of science in this context, since it poses some fundamental and critical questions as regards the issue of finding a philosophical foundation for educational neuroscience, which can be constructed by means of a reciprocal transdisciplinary endeavour from the field of prior discourses.

Ideological undercurrents

I also address the importance of being aware of political and ideological undercurrents. This issue is discussed in the hegemony chapter and the recontextualisation chapters, where it is noted that one can find certain traces of a neoliberal rationality within the political level of the educational neuroscience discourse. The neoliberal argument stresses that neuroscience can be seen as a new 'science of learning' which can serve as an evidence-base for education. It is further argued that by providing new insights into *how* people learn − the mechanism of learning − neuroscience can provide answers to 'what works', effective classroom strategies, and how to improve students' academic outcomes[306]. However, neoliberal rationalities from the political level also seem to influence the academic level of the educational neuroscientific discourse. Political and neoliberal influences can, for instance, be seen in the ways in which several academics, implicitly and explicitly, represent educational neuroscience in terms of how cognitive neuroscience "enables an evidence base for education" and "foundations of the new science of evidence-based education" which should "rest on rigorous forms of in-laboratory and in-vivo evaluation"[307].

[306] As seen in Allen and Smith (2008), Federal Register (2001), Government Office for Science (2012), TeacherNet (2007), US Department of Education (2010), and US Department of Education (2012).
[307] Respectively in Goswami (2008, p. 396), Tommerdahl (2010, p. 107), and in Pasquinelli (2011, p. 186). Also seen in texts by Ansari et al. (2012) and Carew and Magsamen (2011).

In light of this I argue that certain issues arise when the academic level of educational neuroscience is set in relation to neoliberal rationalities suggested by intergovernmental organizations and policymakers − particularly if academic actors are *unaware* of the implicit difficulties inherent in a neoliberal value system. I suggest that unconscious ideological adoption often appears to be the case, considering that numerous authors within educational neuroscience's academic level exhibit traces of dual ideological perspectives. On the one hand, reciprocal collaboration is emphasised, as an argument for the importance of neuroscientific, cognitive, *and* educational perspectives when approaching complex process such as learning at the interface of education and neuroscience[308]. It is therefore a paradox that, on the other hand, the same educational neuroscientific community (perhaps unintentionally) echoes neoliberal rationalities. By adopting an instrumental and neoliberal focus on a rigorous 'evidence-base', 'outcome measurements', the 'science of learning', 'rigorous laboratory-research' with 'randomised controlled trials', and research of 'the mechanism of learning', certain long-held traditions and values within education are contested. I will not repeat my argument in full here, as I have discussed it in previous chapters, but, in brief, the essential problem is not the use of some neoliberal representations *per se* − rather, the problem is that neoliberal rationalities and 'buzzwords' appear to be used by educational neuroscientists *without* them being aware of the underlying shift towards instrumental input-output measurement of education that this ideology represents. My suggestion for further development of the educational neuroscience discourse is therefore that academics should be wary of which ideological orientation they, perhaps unintentionally, adopt. By uncritically representing, adopting, and/or accepting neoliberal rationalities, one is at risk of undermining central aspects of the educational, social, and ethical side of the educational neuroscientific endeavour. I nevertheless think that the educational neuroscientific research community, by being a novel *transdiscipline*, has a significant opportunity to critically negotiate ideological perspectives that would benefit the educational neuroscientific research endeavour.

[308] E.g. in Varma, McCanliss, and Schwartz (2008), Goswami (2009), Christodoulou and Gaab (2009), and Stein and Fischer (2011).

Media and the 'brain-based' learning industry's reduction of the complex

The final aspect I want to address is public presentations, in which complex research on learning, cognition, the brain, the social, and the individual is misrepresented. Such (mis)representations are often found when educational neuroscientific research becomes appropriated by media and by the 'brain-based' learning industry, often resulting in neuromyths, edumyths, over-simplifications, and reduction to other simple narratives. In my analysis, I argue that misrepresentations of research can occur at several levels along educational neuroscience's line of transference, because actors from different fields are liable to interpret and *re*-present educational neuroscientific narrations in different ways. Factors such as technical research language, complicated methods of study (e.g. in brain images), problems separating correlation and causation, and 'the seductive appeal of neuroscientific explanations' do not help in this matter, as they further complicate transference of educational neuroscientific representations.

Nevertheless, even if misrepresentation of research such as neuromyths and edumyths are challenging in that they distribute *un*scientific narrations, I also suggest that they pose a risk when it comes to their manifestations in public knowledge and social practice. The argument, which is based on findings from my recontextualisation analysis, is that these two fields repeatedly reduce both the learning process and the individual child to mechanical and instrumental conceptions. For example, the individual child is often conflated to properties of his or her brain, revealed in statements like "focus on activities that students' brains enjoy doing" (Kagan, 2014) and "it is your sequential, time-oriented left hemisphere which tells you how to think" (Scholastic, 2014). Reduction of complex concepts is also seen in how cognition and learning are presented as something almost external from the learner, increasingly leaving parents accountable for children's learning − revealed in statements where cognition and the brain are described as 'brainpower' that can be 'activated', 'tuned to perform optimally', 'boosted', 'generated' or 'switched on' in order to "produce shiny, happy children"[309]. The problem with brain-based learning industries and the media's *mis*representations of research concerning the brain, cognition, the individual child, and the learning process, is that these representations are liable to construct (unscientific) knowledge

[309] As seen demonstrated in BBC (2013), Brain Gym® (2014), Carlyle (2014), James (2014), Kagan (2014), Starskills (2014), The Guardian (2004), Wighton (2007), and Whipple (2012). See table 7.1 and 7.2.

of reality. Considering that these texts have a rather substantial audience, misrepresentations are also liable to become manifested in discursive and social practices within the public field.

Genuinely, I do not think we will ever escape misrepresentations of research in the public sphere, because the ways in which academia and the public media operate stem from two different cultures. However, I do believe that we can reduce the *impact* of such misrepresentations − both with respect to media and to brain-based learning industries. For instance, public actors should be more critical when reading, representing, and believing in narrations concerning education and neuroscience, acknowledging, as such, that one can easily can be persuaded by 'glossy brain images' and persuasive neuroscientific explanations. At the same time researchers must be better prepared to engage in public debates, in order to provide balanced counter-arguments to the more unscientific representations of educational neuroscientific research. Again, I think much benefit will come from awareness and focus on the complex discursive web of educational neuroscience and, hence, the complex line of transference which can be found therein.

Suggestions for further research

The discourse of educational neuroscience is still a novel field of study, and it thus makes a range of different research topics worth pursuing. Researchers and research groups studying topics connected to education and neuroscience have insofar often taken a *practical* path, for instance by investigating reading and letter processing through an educational neuroscientific approach. These studies are important in that they investigate concepts like reading, letter processing, ADHD, dyslexia, dyscalculia, emotion, cognitive development, memory, and learning by a holistic and cross-disciplinary approach, contributing new perspectives to the transdiscipline of educational neuroscience. I will, however, argue that investigation of the educational neuroscientific *field* in itself is also highly important. The discipline, and discourse, of educational neuroscience is a rather novel field, and my critical discourse analysis has shown that there still are uncertainties, discussions, and confusions related to educational neuroscience's narratives, relations, ideologies, values, approaches, practices, and other discursive structures. It would therefore be constructive if more knowledge concerning the consolidation and organization of the field *itself* could be suggested, so that a transdisciplinary framework for educational neuroscience might be more clearly manifested in its own right. In view of this, I will suggest that further discursive, theoretical, philosophical, political, and macro-social studies of the educational neuroscientific field might be important. This must include anti-reductionistic and transdisciplinary approaches to studies, whether by working in reciprocal and cross-disciplinary research groups, or by following transdisciplinary tenets of study. In the following, I will briefly pinpoint some suggestions for further research, which might be beneficial for the further development of the educational neuroscience discourse.

Further in-depth explanations of the educational neuroscience discourse

In my doctoral study it has been necessary to be descriptive, since my aim is to elucidate the manifestation and impact of the educational neuroscience discourse at the academic, public, and political level of discourse − both internationally and in Norway. By covering the discourse at such an extensive level, what is analytically gained in breadth is lost in depth. I suggest that a comprehensive and broad-reaching analysis is valuable, precisely because it can provide a basis for further in-depth analysis. What might be advantageous in this respect is that further in-depth research sets out to explain aspects of the educational neuroscience discourse − such as aspects of discursive development, practice, or relations between different fields and actors − in light of larger contextual structures (e.g. political, academic, social, ideological, or historical structures). Such research might take different forms and use different modes of study, but a general tenet ought to be construction of knowledge relevant for the transdiscipline of educational neuroscience.

Research concerning scientific philosophical groundings for educational neuroscience

Throughout my dissertation, I have argued that the academic discipline of educational neuroscience is in need of a scientific philosophy adherent to a transdisciplinary framework. Even if some academics address philosophical issues such as the brain-mind dilemma or epistemological differences between education and neuroscience, few, if any, explicitly submit suggestions for a common philosophy of science for educational neuroscientific research. In fact, it appears that many working at the interface of education and neuroscience avoid addressing the philosophical underpinning of their research altogether − leaving a central scientific premise unaccounted for. I think this is a significant disadvantage, because unless a common philosophy of science is established, educational neuroscientific research will continue to be cut off from either social scientific philosophies or natural scientific philosophies. In my research, I have addressed these questions and additionally proposed critical realism as a *possible* philosophy of science for the transdiscipline of educational neuroscience. The question needs further exploration, though, in order to investigate the abundant links between the transdiscipline of educational neuroscience and potential philosophies of science such as critical realism.

Research on relations between educational neuroscience, policymakers, and interest actors

When analysing educational neuroscience's recontextualisation process, many interesting results are found with respect to the political level of discourse. Aspects have been mentioned such as translation issues between policymakers and researchers, strategic actions for shaping educational policies, implications for curriculum design, ideological influences, and relations between national and international policymakers and intergovernmental interest actors. Again, I will emphasise that it would be valuable to research these aspects in more detail and to link discursive aspects with more contextual and macro-social theories − such as theories of ideology, intergovernmental influences, political organization, curriculum studies, and so on. An advantageous study in this respect might be to examine and explain the international influence of political ideologies with respect to the educational neuroscience discourse, or to analyse in more detail the ways in which educational neuroscientific research influence, or are manifested in, political initiatives. Details of these studies notwithstanding; research concerning relations between the academic level and the political level − whether within or across national borders − can help to illuminate a part of the educational neuroscience discourse which so far has received little critical commentary.

Further research concerning the Norwegian context

Last, but not least, I regard it as crucial to conduct more research on the Norwegian context. Much research related to different aspects of the educational neuroscience discourse has been suggested at an international scale, but findings from my analysis show that similar research in Norway is negligible in comparison. This is, firstly, important due to the amount of neuromyths, edumyths, brain-based educational programs, and other misrepresentations of educational neuroscientific research, which flourish at the Norwegian public level. Secondly, a majority of the Norwegian academic texts that actually address the linkage between education and neuroscience, appear to do so by use of top-down and reductionistic approaches. I therefore argue that Norwegian studies on educational neuroscience − it being literature reviews, critical commentaries, philosophical papers, practical research, or organizational studies − are beneficial in that they can contribute to increasing awareness, attention, and critical consideration in Norway.

One particular study that I suggest is essential with regards to Norway, and which can be seen as a continuance of this critical discourse analysis, is attention to the *operationalisation* of educational neuroscience at the Norwegian level. Such a study would, more thoroughly, address how educational neuroscience is operationalised and manifested in social practice and investigate the knowledge and views held by actors within the discourse. In this respect it would also be interesting to investigate how Norwegian teachers, students, school administrators and/or other educational practitioners perceive and understand concepts related to educational neuroscience. What are their perceptions, opinions, and expectations with regards to the linkage between education and neuroscience? Research shows that educators in other countries are often targeted by 'brain-based' learning industries, and that, unfortunately, many misconceptions and neuromyths are manifested at the practical level of educational neuroscience (cf. Dekker et al., 2012; Hook & Farah, 2013). Is this also the case in Norway? By including in-depth interviews and/or quantitative surveys one could take this doctoral research to another level, by including the voices of educational practitioners in a critical discourse analytical study. This can contribute to a more complete picture of educational neuroscience's recontextualisation to the Norwegian level, since here one would also examine how educational neuroscience is manifested and operationalised at a practical level in schools and classrooms.

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The discourse of educational neuroscience is a complex field of study, encompassing an intricate and interrelated network of discursive structures, relations, and practices within and between different discursive levels. At the academic level, one can find cross-disciplinary work where researchers at the interface of education, psychology, and cognitive neuroscience come together in order to address topics such as learning, reading, cognitive development, dyslexia, dyscalculia, ADHD, emotion, and social interaction. Findings from my discourse analysis, however, show that the academic level of educational neuroscience has a rather unclear and ambiguous framework − a notion which is evidenced by how different academic actors convey different understandings of, and take different approaches to, the educational neuroscience endeavour. Topics of educational neuroscience are additionally recontextualised to other levels, such as the public and political level of discourse, and here one can also find varying understandings, approaches, and practices related to the linkage of educational and neuroscience.

It is important to note, however, that educational neuroscience is still developing as a discourse, and its structures, relations, and practices are therefore liable to change in the years to come. I therefore suggest that actors working at the interface of education, psychology, and neuroscience − but also at the interface of the academic, public, and political level of the discourse − have a substantial opportunity to negotiate, re-articulate, and shape the discourse of educational neuroscience. This not only implies construction of educational neuroscientific knowledge per se, but also constructions of aims, values, research approaches, subject positions, practices, research assemblies, university programs, public forums, and arenas for dialogue with policymakers and other interest actors. As a final remark, I will conclude that in this discursive construction, much is to be gained by perceiving educational neuroscience as an anti-reductionist and transdisciplinary endeavour, where different actors strive towards better communication and critical readings in order to reduce translation inconsistencies within and between the academic, public, and political level.

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Appendix A

GLOSSARY

Academic discourse − a discourse which can be seen to encompass discursive structures, ways of thinking and using language, subject positions, relations, practices, and other discursive facets which exist in the academy. Hyland (2009, p. 18) further notes on the significance of the academic discourse, since it "is used to construct knowledge, disciplines and the professional careers of academics themselves … [T]hey are situated activities which regulate meaning-making in complex ways and represent particular social relations and ways of seeing the world".

Action potential − an electric signal that is required for synaptic communication in the brain. Action potential moves from the cell body of a neuron, along the axon and to the synapse where neuro-transmitters are released to other neurons. This is how information is transmitted from one neuron to other neurons.

Axon − the long stem extending from the body of a neuron and down which action potential travels. The terminals of axons contact other neurons at synapses.

'Brain-based' education − an alternative and commercialised field where research regarding the brain, cognition, education, and learning are simplified/misinterpreted/misused in order to sell a learning product (viz. 'brain-based' learning industry).

Critical discourse analysis (CDA) − a tradition within discourse analytical studies associated with Norman Fairclough.

Critical period − see 'sensitive period'**.**

Critical realism (CR) − a philosophical approach associated with Roy Bhaskar, which describes the interface between the natural and social 'worlds'. Critical realism is seen to combine 'transcendental realism' (a general philosophy of science) and 'critical naturalism' (a specific philosophy of human sciences).

Declarative memory − our capacity to recall memories that can be discussed, including facts from textbooks, and *episodic* memories of what we have experienced. It does not include procedural memories such as how to ride a bicycle.

Discourse − a complex concept used to describe underlying structural dimensions, ways of thinking, language and text, relations, social roles, practices, processes, events, and other facets in a field. A discourse has relations to other discourses, it can be in constant change, and in discourse studies 'discourse' must be seen as a variable analytical dimension rather than a fixed social concept.

Dyscalculia − a 'developmental disorder' involving difficulty in acquiring mathematical skills.

Dyslexia − a 'developmental disorder' involving difficulty in learning to read.

Educational neuroscience as an academic discipline − a relative novel academic project/field/ discipline. (It is disagreed whether or not educational neuroscience can be defined as a solitary discipline. Considering the increased extent of educational neuroscientific establishment during the last couple of years, I do throughout my dissertation call educational neuroscience an academic *discipline*). Educational neuroscience can be seen as a mediating field at the interface of education, psychology, and neuroscience. This academic project is known under different names, such as *Mind, Brain, and Education* and *Neuroeducational Research*.

Educational neuroscience as a discourse − educational neuroscience can, in line of a discourse analytical framework, be seen as a *discourse.* An overarching educational neuroscience discourse encompasses different levels of discourse, such as an academic level (see 'educational neuroscience as an academic discipline'), a political level (e.g. encompassing the fields related to policy-makers and other intergovernmental interest actors), and a public level (e.g. encompassing the fields related to the media and the so-called 'brain-based' learning industry).

EEG − electroencephalography, a brain-imaging technique used to measure the electrical activity of the brain.

Episodic memory − the ability to recall autobiographical events (time, places, etc.).

Epistemology − a term used in philosophies of science designating knowledge and understanding; "How we can *know* what exists".

Evidence − implying something which is presented in support of an assertion. The word can further be interpreted by use of a narrow definition or a broad definition. The narrow definition has a stronger notion in that evidence is that which provides direct *proof* of the truth. The broader definition, however, has a weaker notion of evidence in that it implies support for an assertion but does not rule out other possibilities. How the word 'evidence' is used and interpreted do also vary among different actors and different fields, as 'evidence' in a political setting can imply something different than 'evidence' used in neuroscientific research or in an educational setting.

Evidence movement in education − during the last decades, and particularly with the increase of the political and neoliberal ideology in education, there has been uttered request for 'evidence', 'evidence based practice', and 'evidence based education' within the educational sphere.

fMRI − functional magnetic resonance imaging (fMRI) is a brain imaging technique used for measuring metabolic variations (blood oxygen levels) in the living brain. The method takes advantage of the fact that neurons, like all other cells in the body, require energy in form of glucose and oxygen in order to perform their specialised functions. This energy supply is distributed via the blood circulatory system, and the more active a brain region is, the more oxygen and glucose are made available by increase in blood flow to this particular area (Gazzaniga et al., 2009). By identifying these changes in metabolism and blood flow with fMRI (and also by PET scans), researchers can identify brain regions that correlate with neural activity when subjects are engaged in cognitive tasks.

Ideology − a set of conscious or unconscious ideas. Fairclough (2010) understands ideologies to involve the representation of 'the world' from the perspective of a particular interest (which may be operationalised in ways of acting and interacting, in identities, 'ways of being' and in practices). Ideology is accordingly connected to 'meaning in the service of power'. In discursive and textual analysis one should be cautious when saying that something, or someone, is ideological, because this would need to be based upon a complex social scientific analysis of the relationship between beliefs, identity, action, power relations and so on (Fairclough, 2003). What one can identify with more ease in textual analysis, though, is if certain *representations* bear resemblance to ideological rationalities (since this does not make claims of a person's underlying conscious or unconscious actions).

Impact − in this study 'impact' is used in the sense of 'an influence' or 'an imprint' of something, and not in a more strong sense of 'a marked and causational effect' of something.

Long-term potentiation (LTP) − the brain area *hippocampus* appears to play a key role in memory and a central aspect here is long-term potentiation (LTP). LTP indicates the process of long-term strengthening of a synapse, which is of interest because changes in synaptic strength between neurons are the most likely mechanism for learning and memory. When it comes to the process of LTP, it is shown that N-methyl-D-asparate (NMDA) receptors are located on the dendritic spines of postsynaptic neurons that show LTP. It is further known that glutamate, the major excitatory transmitter in the hippocampus, can bind with NMDA receptors and this makes glutamate relevant with regards to LTP (Gazzaniga et al., 2009).

MBE − the abbreviation for the research association Mind, Brain and Education.

Neoliberalism − neoliberalism as an ideology has a long history in economics and its ideas are inspired by renowned economics such as Adam Smith, Friedrich Hayek, and Milton Friedman. During the last decades neoliberal ideology has had a renaissance amongst politicians and policy-makers in many countries, and also private and public service sectors have become affected by the neoliberal market agenda. In this respect it has been noted that "neo-liberalism is a political project for the reconstruction of society in accord with the demands of an unrestrained global capitalism" (Fairclough, 2000, p. 147). The field of education is no exception, as it has experienced transformation in structures and practices under titles of 'new public management'. These changes are related to the increased attention given to education as we entered the 'age of human capital' in the 80s, where knowledge and innovation became important forms of capital in modern economics.

Neuromyths − translation of (neuro)scientific findings into misinformation regarding the brain, education, learning, etc. One can also use the term 'edumyths' when educational research is translated into misinformation.

Neuron − a cell type in the nervous system which is responsible for processing neural information.

Ontology − a term used in philosophies of science designating existence and reality; "*what* exists".

PET-scan − position emission tomography (PET) is a brain imaging technique. PET-scan, as well as functional magnetic resonance imaging (fMRI), is set out to measure metabolic variations in the brain. See also fMRI.

Sensitive period − a period of time during which we display a heightened sensitivity to certain environmental stimuli and develop in particular ways due to this experience.

Synaptogenesis − the formation of synaptic connections between neurons.

Synaptic plasticity − changes in the patterns of connectivity between neurons and, hence, the ability of synapses to modify the efficiency by which they communicate information.

Transdisciplinarity − a merging of discourses where *new* disciplinary facets (i.e. knowledge, practices, etc.) emerge from the field of 'prior discourses'. Transdisciplinarity is therefore something more than a combination of disciplines in form of multi- or interdisciplinarity, in that it encompasses the construction of *new knowledge* rather than the sum of old knowledge from different disciplines.

Working memory − the ability to recall and temporarily maintain information in consciousness.

Appendix B

EMERGENCE: Four-step evaluation list for inclusion or exclusion of texts in the corpus

<u>1st stage: General literature search in e-library, per-reviewed databases, and grey literature</u>

Relevance based on keyword searches and screening of titles and abstract:

- Texts relevant to educational neuroscience
- Texts relevant to the emergence concept
- Texts relevant to the academic level of the discourse
- Written texts mainly
- Texts in English
- Searches with different keywords:
    - (education* neuroscience*)
    - (education* brain*)
    - (learning* brain*)
    - (learning* neuroscience*)
- Searches with different criteria (timespan, most cited, certain journals, different Boolean operators, etc.)
- Searching additional and relevant texts by cues given in citations and reference lists.
- Searching additional 'grey literature' by cues given in citations and reference lists.
- Focus on monument text and cruces in the discourse

A total of 123 553 hits showed up in this stage, and 7 303 of these were screened.
131 texts went through to the next stage

Data report table from the general literature search:

Web of Knowledge serach (peer-reviewed journal articles)

Keywords	Timespan searches	Timespan showed	Refine by:	Date of serach	Number of hits	Number screened	Included	Excluded
(education* neuroscience*)	All years	1967 - 2013	Publication date - oldest to newest	04.10.2013	2490	808	26	782
(education* brain*)	All years	1918 - 2013	Publication date - oldest to newest	08.10.2013	19776	4462	12	4450
(learning* neuroscience*)	All years	1970 - 2013	Publication date - oldest to newest	18.10.2013	4840	781	8	773
(learning* brain*)	All years	1928 - 2013	Publication date - oldest to newest	18.10.2013	92852	100	3	97
(brain* mind* education*)	All years	1970 - 2013	Publication date - oldest to newest	18.10.2013	408	77	1	76
(education* neuroscience* learning* brain*)	All years	1986 - 2013	Publication date - oldest to newest	18.10.2013	296	148	9	139
(education* neuroscience*)	All years	1992 - 2013	Refined by: specific Journal searches	21.10.2013	105	17	0	17
(education* neuroscience* learning* brain*)	All years	1986 - 2013	Time cited - highest to lowest	21.10.2013	296	50	20	30
					121063	6443	79	6364

Follow-up references

Search based on:	Timespan searches	Timespan showed	Where was the text found	Date of serach	Number of hits	Number screened	Included	Excluded
Citations/reference follow-up	All years	1963-1960	Google Scholar, internet search	8-23 okt. 2013	52	52	52	0
					52	52	52	0

	Number of hits	Number screened	Included	Excluded
IN SUM	121115	6495	131	6364

2nd stage screening:

Relevance based on topic, title, and potential in scope:

- Title of the article
- Year published
- Author
- Where was the text published
- Document type *(political report/book etc.)*
- Topic keywords
- Language
- How was the text found *(web search / reference follow-up)*
- Search words
- Date search conducted
- Traces of educational neuroscience's emergence?
- Is the text relevant as regards discursive concept of emergence?
- Reason for inclusion/exclusion

A total of 131 texts were evaluated in this stage, and 79 texts went through to the next stage

3rd stage screening:

Relevance based on topic after reading abstract/full text:

- Does the text have explicit traces of the emergence of educational neuroscience?
- Does the text link education and neuroscience/brain science?
- Does the text bring anything new to the discourse?
- Reason for inclusion/exclusion
- Additional notes

A total of 79 texts were evaluated in this stage, and 24 texts went through to the next stage

4th screening:

The third stage screening was the actual critical discourse analysis of the 24 texts in the corpus for analysing the emergence of educational neuroscience. All the 24 texts where read thoroughly in this stage, and a separate and more detailed data extraction sheet for the analysis was used. To see the complete data extraction sheet used in the final critical discourse analysis of the 24 texts in the corpus, see appendix D.

HEGEMONY: Four-step evaluation list for inclusion or exclusion of texts in corpus

<u>1st stage: General literature search in e-library, per-reviewed databases, and grey literature:</u>

Relevance based on keyword searches and titles:

- Texts relevant to educational neuroscience
- Texts relevant to the hegemony concept
- Texts relevant to the academic level of the discourse
- Written texts mainly
- Texts in English
- Searches with different keywords, e.g.:
    - (education* neuroscience* nature* nurture*)
    - (education* neuroscience* biology* sociology*)
    - (learning* brain* nature* nurture*)
    - (education* neuroscience* bridge* gap*)
- Searches with different criteria (timespan, most cited, different Boolean operators, etc.)
- Searching additional and relevant texts by cues given in citations and reference lists.
- Searching additional 'grey literature' by cues given in citations and reference lists.
- Focus on monument text and cruces in the discourse

A total of 2 082 hits showed up in this stage, and 1 146 of these were screened.
107 texts went through to the next stage

Data report table from the general literature search:

Web of Knowledge serach (peer-reviewed journal articles)

Keywords	Timespan	Search language	Refine by:	Date of serach	Number of hits	Number screened	Included	Excluded
(education* neuroscience* nature* nurture*)	1980-2014	English	Most cited	07.02.2014	5	5	0	5
(education* neuroscience* biology* sociology*)	1980-2014	English	Most cited	07.02.2014	38	38	2	36
(learning* brain* nature* nurture*)	1980-2014	English	Most cited	07.02.2014	33	33	8	25
(learning* brain* biology* sociology*)	1980-2014	English	Most cited	07.02.2014	1236	300	1	299
(education* brain* biology* sociology*)	1980-2014	English	Most cited	07.02.2014	271	271	1	270
(education* nature* nurture*)	1980-2014	English	Most cited	07.02.2014	133	133	13	120
(education* neuroscience* bridge* gap*)	1980-2014	English	Most cited	07.02.2014	9	9	3	6
(education* neuroscience* hegemony*)	1980-2014	English	Most cited	07.02.2014	0	0	0	0
(nature* nurture* hegemony*)	1980-2014	English	Most cited	07.02.2014	3	3	1	2
(education* neuroscience* dominance*)	1980-2014	English	Most cited	07.02.2014	14	14	0	14
(education* neuroscience* learning* brain*)	1980-2014	English	Most cited	12.02.2014	305	305	57	248
					2047	1111	86	1025

Follow-up references

Search based on:	Timespan	Where was the text found	Date of serach	Number of hits	Number screened	Included	Excluded
Articles from EMERGENCE corpus	1980-2014	Emergence corpus	06.02.2014	24	24	10	14
Follow up references / clue	1980-2014	Web of Knowledge	06.02 - 03.03 2014	10	10	10	0
Follow up references / clue	1980-2014	Online	12.02.2014	1	1	1	0
				35	35	21	14

	Number of hits	Number screened	Included	Excluded
IN SUM	2082	1146	107	1039

2nd stage screening:

Relevance based on topic, title, and potential in scope:

- Title of the article
- Year published
- Author
- Where was the text published
- Document type *(political report/book etc.)*
- Topic keywords
- Language
- How was the text found *(web search / reference follow-up)*
- Search words
- Date search conducted
- Traces of debate/struggle/negotiation pertaining to educational neuroscience?
- Is the text relevant as regards discursive concept of hegemony?
- Reason for inclusion/exclusion

A total of 107 texts were evaluated in this stage, and 65 texts went through to the next stage

3rd stage screening:

Relevance based on topic after reading abstract/full text:

- Does the text have traces of hegemonic relations?
- Does the text bear signs of debate, conflict, and/or struggle?
- Reason for inclusion/exclusion
- Additional notes

A total of 65 texts were evaluated in this stage, and 29 texts went through to the next stage

4th stage screening:

The third stage screening was the actual critical discourse analysis of the 29 texts in the corpus for analysing educational neuroscience's hegemonic relations. All the 29 texts where read thoroughly in this stage, and a separate and more detailed data extraction sheet for the analysis was used. To see the complete data extraction sheet used in the final critical discourse analysis of the 29 texts in the corpus, see appendix D.

RECONTEXTUALISATION ACROSS STRUCTURAL BOARDERS:
Four-step evaluation list for inclusion or exclusion of texts in the corpus

1st stage: General literature search at the internet, library catalogues, e-databases, and grey literature:

Relevance based on keyword searches and titles:

- Texts relevant to educational neuroscience
- Texts relevant to recontextualisation over structural boarders
- Texts relevant to the public and political level of the discourse
- Written texts mainly
- Texts in English
- Internet searches with different keywords:
  - education, neuroscience
  - classroom, learning, brain, neuroscience
  - brain-based education
  - Brain-based learning
- Specific searches at different internet portals (BBC, OECD, TLRP, the Royal Society, Brain Gym)
- Searching for books (internet portals) and library catalogues (e.g. for 'brain-based' learning industry)
- Searching additional and relevant texts by cues given in citations and reference lists.
- Searching additional 'grey literature' by cues given in citations and reference lists.
- Most cited (cf. texts witch have/have had the most impact on the recontextualised field)
- Focus on monument text and cruces in the discourse

A total of 364 740 739 hits showed up in this stage, and 1 979 of these were screened.
127 texts went through to the next stage

Data report table from the general literature search:

Internet searches, e-library etc. (grey-literature)

Keywords	Timespan	Search language	Field	Date of serach	Number of hits	Number screened	Included	Excluded
education, neuroscience	-2014	English	all	13.05.2014	77 523 540	150	16	134
classroom, learning, brain, neuroscience	-2014	English	all	13.05.2014	1 304 623	150	15	135
brain-based learning	-2014	English	all	13.05.2014	96 124 153	150	7	143
brain-based education	-2014	English	all	13.05.2014	191 064 900	150	8	142
					364 712 593	600	46	554

Other more target specific searches aimed at specific nett/library resources

Keywords	Timespan	Search language	Field	Date of serach	Number of hits	Number screened	Included	Excluded
Media articles relevant for neuro and learning/educ	1980-2014	English	Media	11.05-11.07	1	1	1	0
BBC	1980-2014	English	Media	14.05.2014	1125	300	12	288
The Times	1980-2014	English	Media	14.05.2014	7460	300	9	291
The New York Times	1980-2014	English	Media	14.05.2014	16680	300	8	292
Brain-based learning programs	1980-2014	English	Brain-based ed.indus	11.05-11.07	7	7	6	1
Texts related to politics and ed.neuro	1980-2014	English	Policy-makers	15.05-11.07	1	1	1	0
UK gov	-2014	English	Policy-makers	15.05.2014	136	136	3	133
US gov - dep of education	-2014	English	Policy-makers	15.05.2014	2702	300	7	293
Texts - other org/act/groups w.interest in ed.neuro	1980-2014	English	Interest actors	11.05-11.07	7	7	7	0
					28119	1352	54	1298

Follow-up references

Search based on:	Timespan	Where was the text found	Date of serach	Number of hits	Number screened	Included	Excluded
Follow up references / clue	1980-2014	Online	13.05-11.07	27	27	27	0
Follow up references / clue	1980-2014	Books	-	0	0	0	0
				27	27	27	0

	Number of hits	Number screened	Included	Excluded
IN SUM	364 740 739	1979	127	1852

2nd stage screening:

Relevance based on topic, title, and potential in scope e.g:

- Title of the article
- Year published
- Author
- Where was the text published
- Document type *(political report/book etc.)*
- Topic keywords
- Language
- How was the text found *(web search / reference follow-up)*
- Search words
- Date search conducted
- Traces of educational neuroscience being recontextualised to the public/political field?
- Is the text relevant as regards discursive recontextualisation?
- Reason for inclusion/exclusion

A total of 127 texts were evaluated in this stage, and 77 texts went through to the next stage

3rd stage screening:

Relevance based on topic after reading abstract/full text, e.g.:

- Is the text explicit showing trace of recontextualisation of educational neuroscience across structural boundaries to the public or the political level?
- Which field?
- Which country? *(UK, USA, International)*
- Is the text *relevant* as regards recontextualisation of educational neuroscience?
- Reason for inclusion/exclusion
- Additional notes

A total of 77 texts were evaluated in this stage, and 27 texts went through to the next stage

4th stage screening:

The third stage screening was the actual critical discourse analysis of the 27 texts in the corpus for analysing the emergence of educational neuroscience. All the 27 texts where read thoroughly in this stage, and a separate and more detailed data extraction sheet for the analysis was used. To see the complete data extraction sheet used in the final critical discourse analysis of the 27 texts in the corpus, see appendix D.

RECONTEXTUALISATION ACROSS SCALAR BOARDERS:
Four-step evaluation list for inclusion or exclusion of texts in the corpus

1st stage: General literature search at the internet, library catalogues, e-databases, and grey literature:

Relevance based on keyword searches and titles:

- Texts relevant to educational neuroscience
- Texts relevant to recontextualisation over scalar boarders to Norway
- Texts relevant to the academic, public, and political field in the Norwegian level of the discourse
- Written texts mainly
- Texts in English or Norwegian
- Internet searches with different keywords:
    - Pedagogic, education, neuroscience, brain science [Pedagogikk, utdanning, nevrovitenskap, hjerneforskning]
    - Classroom, learning, brain, neuroscience [Klasserom, læring, hjerne, nevrovitenskap]
    - Education, brain, learning [Utdanning, hjerne, læring]
    - Pedagogic, brain, learning [pedagogikk, hjerne, læring]
- Specific searches at different internet portals (NRK, Dagbladet, VG, Kunnskapsdepartementet etc.)
- Searching for books (internet portals) and library catalogues (e.g. for [utdanning, nerovitenskap])
- Searching additional and relevant texts by cues given in citations and reference lists.
- Searching additional 'grey literature' by cues given in citations and reference lists.
- Most cited (cf. texts witch have/have had the most impact on the recontextualised field)
- Focus on monument text and cruces in the discourse

A total of 452 849 hits showed up in this stage, and 3 716 of these were screened.
203 texts went through to the next stage

Data report table from the general literature search:

Internet searches in Google.no (grey-literature)

Keywords	Timespan	Search language	Field	Date of serach	Number of hits	Number screened	Included	Excluded
Pedagogisk nevrovitenskap	-2014	Norwegian	all	15-16 Oct. 2014	3970	50	2	48
Pedagogikk, hjerneforskning, utdanning, nevrovitenskap	-2014	Norwegian	all	15-16 Oct. 2014	1440	50	11	39
Klasserom, hjerne, læring, nevrovitenskap	-2014	Norwegian	all	15-16 Oct. 2014	8590	50	7	43
Utdanning, hjerne, læring	-2014	Norwegian	all	15-16 Oct. 2014	257000	50	14	36
Pedagogikk, hjerne, læring	-2014	Norwegian	all	15-16 Oct. 2014	77500	50	4	46
					348500	250	38	212

Other more target specific searches aimed at specific nett/library resources

Keywords	Timespan	Search language	Field	Date of serach	Number of hits	Number screened	Included	Excluded
Kunnskapsdepartementet - diff. keyword searches	-2014	Norwegian	Policy-makers	16 Oct. 2014	145	145	8	137
Regjeringen (inkl. NOU & St.mld) - different keyword searches	-2014	Norwegian	Policy-makers	16 Oct. 2014	319	198	3	195
Utdanningsdirektoratet - different keyword searches	-2014	Norwegian	Policy-makers	16 Oct. 2014	7	7	0	7
Solbergregjeringens plattform	-2014	Norwegian	Policy-makers	18.02.2015	0	0	0	0
Atekst - different keyword searches	-2014	Norwegian	Media	16-21 Oct. 2014	37850	571	27	544
NRK - different keyword searches	-2014	Norwegian	Media	16-21 Oct. 2014	2724	164	7	157
VG - different keyword searches	-2014	Norwegian	Media	16-21 Oct. 2014	11477	409	42	367
Dagbladet - different keyword searches	-2014	Norwegian	Media	16-21 Oct. 2014	27658	373	20	353
Dagens Næringsliv - different keyword searches	-2014	Norwegian	Media	16-21 Oct. 2014	703	138	14	124
Google Scholar.no - different keyword searches	-2014	Norw. & English	Academia	21 Oct. 2014	8376	214	0	214
Kunnskapssenteret for Utdanning - diff. keyword searches	-2014	Norw. & English	Academia	21 Oct. 2014	187	187	0	187
Bibsys/NTNU library cataloufges - diff . keyword searches	-2014	Norw. & English	Academia	21 Oct. 2014	48	48	0	48
Idunn - different keyword searches	-2014	Norw. & English	Academia	21 Oct. 2014	730	275	8	267
ERIC - different keyword searches	-2014	Norw. & English	Academia	21 Oct. 2014	5757	180	0	180
Web of Knowledge norw*- different keyword searches	-2014	Norw. & English	Academia	21 Oct. 2014	84	84	0	84
Nordart - different keyword searches	-2014	Norw. & English	Academia	21 Oct. 2014	12	12	0	12
PsycNET - different keyword searches	-2014	Norw. & English	Academia	21 Oct. 2014	849	200	0	200
Taylor Group	-2014	Norw. & English	Academia	18.02.2015	7252	119	0	119
Scopus - different keyword searches	-2014	Norw. & English	Academia	21 Oct. 2014	135	106	0	106
					104313	3430	129	3301

Follow-up references

Search based on:	Timespan	Where was the text found		Date of serach	Number of hits	Number screened	Included	Excluded
Follow up references / clues in text	1980-2014	Online	all	17-22 Oct. 2014	36	36	36	0
					36	36	36	0

	Number of hits	Number screened	Included	Excluded
IN SUM	452849	3716	203	3513

2nd stage screening:

Relevance based on topic, title, and potential in scope:

- Title of the article
- Year published
- Author
- Where was the text published
- Document type *(political report/book etc.)*
- Topic keywords
- Language *(Norwegian/English)*
- How was the text found *(web search / reference follow-up)*
- Search words
- Date search conducted
- Traces of educational neuroscience being recontextualised to the Norwegian academic/public/political field?
- Is the text relevant as regards discursive recontextualisation to Norway?
- Reason for inclusion/exclusion

A total of 203 texts were evaluated in this stage, and 108 texts went through to the next stage

3rd stage screening:

Relevance based on topic after reading abstract/full text, e.g.:

- Is the text explicit showing trace of recontextualisation of educational neuroscience across structural boundaries to the public or the political field in Norway?
- Which field?
- Is the text *relevant* as regards recontextualisation of educational neuroscience in Norway?
- Reason for inclusion/exclusion
- Additional notes

A total of 108 texts were evaluated in this stage, and 31 texts went through to the next stage

4th stage screening:

The third stage screening was the actual critical discourse analysis of the 31 texts in the corpus for analysing the emergence of educational neuroscience. All the 31 texts where read thoroughly in this stage, and a separate and more detailed data extraction sheet for the analysis was used. To see the complete data extraction sheet used in the final critical discourse analysis of the 31 texts in the corpus, see appendix D.

Appendix C

EMERGENCE: Reference list for the corpus

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Appendix D

EMERGENCE: Data extraction sheet for the critical discourse analysis

Discourse analysis:

What are the main themes/the narrative of the text? ....
....
....

How is the relationship between education and neuroscience represented? ....
....
....

Any issues or problems addressed in this document? ....
....
....

What are the proposed arguments/'results' (of the problem stated)? ....
....
....

How is the text 'justifying' its particular view of ed.neuro/the world?..
....
....

Which discursive position can the author seem to have? ....
....
....

Are any other 'main parts of the world' mentioned? E.g. social, media, political - cf. recontext.?
....
....

Are there any gaps in knowledge, areas of new research needed or novel ideas in the article? (can often be detected in the summary) ....
....
....

What are the key sources/relevant references cited for this text? ....
....
....

Number of pages: .... Journal impact factor? ....
How should the text be ranked in order of importance? Is it a monument text? (1-5) ....

Other:..

Emergence:

Any traces of the emergence and development of educational neuroscience?

Is the text new or is it building on existing, old ideas?

Are there any interdiscursive or intertextual statements?

What external discourses are drawn upon and how are they combined in new articulations?

Is there any evidence of crossing of discursive boundaries?

Are there any notions in the text of changes in social practice, social agents, organisations and so forth?

Has any emergence strategies been used?

Where can one locate this text within the field of prior discourses?

Which web of relations can one find within and between this text and other texts (e.g. texts in the discourse of education, psychology, neuroscience, medicine, cognitive science etc.)?

Can this text/work be regarded to significantly have developed the discourse?

Other:

Critical discourse analysis:

What is the ideology of this text?

What is the author’s political, ideological, theoretical, methodological position?

Are there any ‘taken for granted’ truths, premises, key ideas in the text?

What are the key epistemological and ontological grounds for the discipline?

Other:

Hegemony:

Any traces of hegemony in the discourse of educational neuroscience?

Are there any traces of power in the text?

Power: in what way can the language in the text be directive for a certain reality?

Power: in what way can the text’s language be directive for social action?

Which particular perspective/positions are available within the text and how can it be located in the overall discourse of educational neuroscience?

Other:

Recontextualisation:

Any traces of recontextualisation in the discourse of educational neuroscience?

Other:

HEGEMONY: Data extraction sheet for the critical discourse analysis

Critical Discourse Analysis:

Text: ....
....

Number of pages: .... Journal impact factor? ....
How should the text be ranked in order of importance? Is it a monument text? (1-5) ....

Main topic of the text: ....
....

How is the relationship between education and neuroscience represented? ....
....
....

Are there any 'taken for granted' truths, premises, key ideas in the text? ....
....
....

How is the text 'justifying' its particular view of ed.neuro/the world?...
....

Which particular positions/perspectives are available within the text and how can it be located in the overall discourse of educational neuroscience? ....
....
....

Which discorsive position can the *author* seem to have? ....

What is the author's political, ideological, theoretical, methodological position? ....
....

What are the key epistemological and ontological grounds for the discipline? ....
....

What general knowledge/representations are *accepted?* How concretely or abstractly, specifically or generally, are they represented? ....
....
....

What general knowledge/representations are *problematized*? How concretely or abstractly, specifically or generally, are they represented? ....
....
....

How are the complexities of reality reduced and condensed, what aspects of those parts of the world that are represented are included (and given greater or lesser salience) or (significantly) excluded?
....
....

What available alternative discourses/narrations are significantly *not* drawn upon? ....
....
Other:...
....

Hegemony:

In the text, are there any traces of hegemonic relations pertaining to the discourse of educational neuroscience?

Are there any notions of discursive *struggle* (e.g. dialogue, negotiation and conflicts)?

Are there any traces of strategies to *naturalise* certain ideologies, narrations, practices etc.? / Do any set of discourse conventions implicitly embody certain ideologies?

Are there any traces of strategies to *de*naturalise certain ideologies, narrations, practices etc.?

Successful or failing strategies? Is there resonance between values, representations, and practice in the discourse? Is the feedback-loop closed or open?

Are there any conflicts which especially can be seen as negotiations with more durable and institutionalised levels of social reality and social structures?

Does it seem that any narratives are hegemonic in the text? (can this be due to discursive struggle/ dialogue/negotiation?)

Are there any traces of power in the text?

Power: in what way can the language in the text be directive for a certain reality?

Power: in what way can the text's language be directive for social action?

Other:

Recontextualisation:

Any traces of recontextualisation in the discourse of educational neuroscience?

Other:

RECONTEXTUALISATION ACROSS STRUCTURAL BOARDERS:
Data extraction sheet for the critical discourse analysis

Critical Discourse Analysis:

Text: ....
....

Number of pages: .... Type of text: ....

Main topic of the text: ....
....

Recontextualisation:

Across which structural boundaries has educational neuroscience been recontextualised in this text?

☐ *Media* ☐ *Policy-makers* *Other:* ....

☐ *Brain-based progr.* ☐ *Other interest actors* ....

How can the text be seen as a recontextualisation of the educational neuroscience discourse? (traces of dissemination of ed.neuro to this public/political field) ....
....
....

How is educational neuroscience represented? (with cautious optimism/overly enthusiasm, as an issue/solution/argument etc.)
....
....

What general knowledge/representations are accepted? How concretely or abstractly, specifically or generally, are they represented? ....
....

How is educational neuroscience representation *articulated*? ....
....
....

How can educational neuroscience be seen *re*-articulated within/set in relation with the old public/political field? (c.f. crossing of discursive boundaries) ....
....
....

Notes re the text's presentation of educational neuroscience:

Which interest groups/agents in educational neuroscience does the text represent?

Why do they have an interest in educational neuroscience?

What is the relation between the agents of the *academic* educational neuroscience discourse and the agents in the respective public/politic field?

How can the discourse (and practices) of educational neuroscience be seen internalised within the particular field?

Any traces of 'colonisation' of educational neuroscience into this field?

Any traces of 'appropriation' of educational neuroscience into this field?

Noteworthy quotes from the text:

Other:

RECONTEXTUALISATION ACROSS SCALAR BOARDERS:
Data extraction sheet for the critical discourse analysis

Critical Discourse Analysis:

Text: ....
....

Number of pages: .... Type of text: ....

Main topic of the text: ....
....
....

Recontextualisation:

To which field in Norway can educational neuroscience be seen recontextualised to in this text?

☐ *Media* ☐ *Policy-makers* *Other:* ....
☐ *Brain-based progr.* ☐ *Academia* ....

How can the text be seen as a recontextualisation of the educational neuroscience discourse? (traces of dissemination of ed.neuro to this public/political field) ....
....
....

How is educational neuroscience represented? (with cautious optimism/overly enthusiasm, as an issue/solution/argument etc.)
....
....

What general knowledge/representations are accepted? How concretely or abstractly, specifically or generally, are they represented? ....
....

How is educational neuroscience representation *articulated*? ....
....
....

How can educational neuroscience be seen *re*-articulated within/set in relation with the old academic/public/ political field in Norway? (c.f. crossing of discursive boundaries) ....
....
....

Notes regarding the text's presentation of educational neuroscience:

Why do actors in this academic/public/politic field in Norway have an interest in educational neuroscience?

What is the relation between the agents of the *international academic* educational neuroscience discourse and the agents in the respective Norwegian field?

How can the discourse (and practices) of educational neuroscience be seen internalised within the particular Norwegian field?

Any traces of 'colonisation' of educational neuroscience into this field?

Any traces of 'appropriation' of educational neuroscience into this field?

Noteworthy quotes from the text:

Other: