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Educational Neuroscience

A Critical Discourse Analysis

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Preface

Mind the gap… The sweet singsong voice loomed over the speakers as I dragged my suitcases into the tube. Exhausted after a tedious journey I squeezed into a vacant seat between two serious looking businessmen, both with solemn faces, grey suites, and the smell of old tea and dry biscuits lingering in their presence. As the doors snapped the buzz of Heathrow Airport out, the reality hit me – London. Caught by the alluring prospect of academic autonomy and a world bustling of intriguing knowledge, I had chosen to spend my next five months in London so as to write my master thesis. Not only does the city tempt with a leading university of education and a breathtaking educational library; England can also coax with prevailing projects on the subject of *educational neuroscience* – the topic of my impending master thesis.

Educational neuroscience caught my attention a couple of years ago, when I took a course in neuroscience at my home university. The neuroscience course itself had nothing to do with education. In fact; I was the only educationist in the entire class and my professor repeatedly wondered how a social science student such as myself, had managed to stumble into "*this* field of study". At the time it was the wonders of the remarkable brain which enthralled me; later, however, it became the wonders of the 'two cultures' which captivated my curiosity. For these reasons I started searching for litterateur on the topic, and by the time the writing of my master thesis loomed in the horizon, my focus of attention had settled on the debate of the linkage between education and cognitive neuroscience. However, it soon became clear that there was not much literature as regard educational neuroscience in Norway. To ensure an academic adequacy I thus felt it apposite to seek more information abroad.

The previous enthralling rationalities for my choice to study educational neuroscience abroad were, however, faltering as the foggy landscape whooshed past the stained tube windows. In front of me lay not only the vast city of London; ahead were also an unwritten master thesis which unknown depths I did not even dare think about. As the tube sped ahead, my suitcases wobbled vigorously in the corner of the carriage. Like two overfed rhinos they stood – stuffed, as they were, with warm clothes my mum had forced on me, the fire-detector my dad had given me strict instructs to install in my new flat, my sister's emergency provisions on Norwegian chocolate, my friends wishes, and my tutor's words of wisdom. The semester had barely begun, and already I felt the need to clutch to this serene kindness and wonderful

wishes as if they were a life buoy. I did not know it then, but this support – given from many miles away – did indeed help me to keep my head above water in the forthcoming months. Especially have my mum's comforting words, my dad's encouragement, and advices given from my tutor, Nina Volckmar, guided me through this academic maze.

As the tube came to a halt in Bloomsbury, I could not help letting a smile dance over my face. The venture ahead was indeed unknown, but again, that *is* the beauty of the alluring future. The discourse of educational neuroscience seemed like a mountain, albeit, a mountain apposite to be crossed. As the singsong voice once again asked me to 'mind the gap', I clung on to my pack of rhinos. The scene we made were *definitely* not as pleasing to the eye as Hannibal Barca and his herd at the foot of the Alps, albeit, I gave it an honest try (the prospect to elegantly maneuver two suitcases out of a wagon holds its limitations).

Cautiously we stomped out of the tube…

London, April 25th 2011,
Fride Røe Flobakk

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1. Introduction

At the late 20th and early 21st century we entered what commonly have been known as 'the Knowledge Age', an era conceding *knowledge* as a significant capital for national economic and societal growth (Geake, 2005). The last decades have also been labelled under another name; *the decades of the brain*[1] (Ansari, Coch & DeSmedt, 2011). 'The decades of the brain' commenced, by and large, with the burgeoning availability of innovative technologies – technologies which made it possible to scientifically observe structures and mechanism of the human brain previously 'hidden' from scientific observations (Howard-Jones, 2007). Since the late 90's, numerous neuroscientific findings have thus been postulated and our understanding of how the brain works is continuously increasing. Innovative neuroscientific researches have furthermore caught genuine interest to politicians and to the society at large. This curiosity is evident in everything from medias focus on scientific results, the growing amount of popular scientific books on how the brain works (Ansari et al., 2011), and politicians demand for scientific based practices (OECD 2007a; Meld. St. 19, 2009-2010). Fascination of the brain has also commenced in academia, making numerous scientists from different scholastic disciplines pore with curiosity over neuroscientific reports. In medicine, for instance, cognitive neuroscientific findings have lead to significant enhancements. Even academics from different social sciences have found aid in neuroscience. Psychology might be the field which most commonly is perceived interlinked with cognitive neuroscience, but also disciplines such as economic (i.e. neuroeconomics), communication, political science, and sociology make use of neuroscientific studies (Varma, McCandliss, & Schwartz, 2008).

One would expect that findings on how the human brain works would be of highly interest also amongst educational academics. That is, however, not the case. Lack of notice is surprising due to pressure the 'Age of Knowledge' indirectly puts on educational institutions, as politicians constantly stress the importance of improved (and scientifically based) teaching. Lack of interest is also unexpected seeing that the entire nature of education is anchored in our ability *to learn* – a facet one ought to think were profoundly linked to studies on how the brain works (Geake, 2011). Insofar numerous educational theories are indeed built upon cognitive models (e.g. those of Piaget and Vygotsky), but these models can be seen based on hypothesis of the *mind*. The problem, however, is that many of these hypotheses of the mind

[1] It was the U.S. government who designated the 1990's as "The Decade of the Brain" – the idiom became, almost immediately, a catchphrase (Varma, McCandliss, & Schwartz, 2008).

have been altered due to innovative neuroscientific studies on the *brain* (Varma et al., 2008). Regardless, cognitive neuroscience does not seem to catch the attention to educationists.

> In the vast mountains of educational policy, curriculum and outcomes documentation, there has been, until very recently, no mention of the human brain, the organ most central to the educational enterprise. It is as though education has been regarded as having little to do with how learning actually take place in the brains of students (Geake, 2011 p.44).

Numerous educational academics are, however, shifting their position and several have started advocating for benefits connecting education with recent findings on how the brain works. As a consequence of this shift, new educational research is initiated; "a new area of research that is coming to be known as educational neuroscience" (Patten & Campbell, 2011 p.1)[2].

Educational neuroscience as a scholastic discipline aims to connect cognitive neuroscience with education; albeit reciprocated collaboration is highly stressed so that one discipline is not reduced under instruct from the other. In his latest article Campbell (2011) offers a specific definition, stating that "educational neuroscience [is] an area of educational research that draws on, as being informed by, theories, methods, and results from the neuroscience, but unlike an applied cognitive neuroscience, is *not restricted* to them" (p.8). The aim is, as it is commonly entitled, to "bridge the gap" between education on one side and cognitive neuroscience on the other (Bruer, 1997).[3]

With this transdisciplinary endeavour as a focal core, educational neuroscience has become prominent in education. Not only is it relevant as regards eminent educational issues of theoretical, methodical, philosophical, and practical value; educational neuroscience is also highly relevant as to current political and societal concerns (Geake, 2005). Subsequently, one can detect increased international interest on the topic. Scientific articles on educational neuroscience are mounting, numerous transdisciplinary collaborations are founded, and significant project on the topic has been initiated (e.g. OECD (2007b) and TLRP/EDRC[4] (Howard-Jones, 2007)). Traces of this novel field of study can also be found in Norway. Even if the term 'educational neuroscience' not yet has been established as a familiar idiom

[2] Even if this transdisciplinary aim has, to some extent, been given different names ('educational neuroscience' and 'neuroeducation' being the most used in the UK; whilst 'Mind, Brain, and Education (MBE)' mostly is used in the U.S.), this thesis will hence forth refer to the discipline as 'educational neuroscience'.

[3] It appears that the metaphor 'bridging of the gap' has been eminent in the educational neuroscience debate since John Bruer's (1997) notable article '*Educational and the Brain: A Bridge Too Far?*'. This thesis will continue using this metaphor, seeing the idiom's prominence and frequency in the debate.

[4] The report 'Neuroscience and Education; Issues and Opportunities' were authored by Paul Howard-Jones on behalf of Teaching & Learning Research Programme and Economic & Social Research Council.

amongst Norwegian academics and politicians, aspects of the international debate are evident. Insofar these outlines have mainly been manifested in educational policy documents (e.g. in Meld. St. 19, 2009-2010), in the debate on evidence-based education[5], and the establishment of NAFOL and 'Programme for Educational Research' (i.e. 'Utdanning 2020'). Even if this only is fragments of an international trend, there is reason to believe that the debate on educational neuroscience soon will reach Norway with a bigger vigor than up to date[6].

Educational neuroscience's expansion, both nationally and internationally, notwithstanding; the discipline's road has been, and is still, covered with both petals and thorns. Even if numerous academics advocate for the endeavour to "bridge the gap" between education and neuroscience, this venture has also met ambivalent feelings, even reluctance, amongst some educationists. At present, a profound international debate takes place in academic circles and different camps bicker on benefits, problems, possibilities, and dangers regarding educational neuroscience. First we have advocates who cautious claim that educational neuroscience can contribute to vital advances in educational theory, practice and policy. Then we have the more hesitant camp who acknowledge the importance to connect neuroscientific findings with education, *but* they do not think the discipline of educational neuroscience sufficient can link the two fields together – it is "a bridge too far" (Bruer, 1997). Thirdly one have sceptics who argue that connections between the two are downright impossible due to profound differences between the field of neuroscience and the one of education – 'the gap' should therefore not be crossed at all (Willingham, 2009). A forth group which can be found in the dispute is a group eagerly leaping 'the gap' in one swift jump, as they enthusiastically make business selling neuromyths and so called 'brain-based teaching programs' to ignorant teachers. What is more, and what makes this debate even more intriguing, is that this debate can be seen interlinked with more profound and deep-rooted disputes in academia. This underlying dispute is the eminent conflict between natural science and social science; the "two proud kingdoms lying alongside in chaste self-sufficiency ... Between the two a gulf of mutual incomprehension – sometimes … hostility and dislike, but most of all lack of understanding" (Snow, 1959 p.4f).

Educational neuroscience, and the ongoing debate as regards, makes a fascinating subject for analysis and interpretation. Not only is the topic of current interest amongst international

[5] Requests for evidence-based education, e.g. from OECD (2007a), must *not* be misinterpreted as demands for universal classroom formulas, but rather requests for more *scientifically grounded approaches* to learning (Ogden, 2008).
[6] Read more p.18.

politicians and educational academics; the debate on educational neuroscience also encompasses an entangled web of ideologies and conflicts worth further scrutinising – an undertaking this master thesis modestly attempt to take. The research question is, as follow;

> Which discoursive positions, ideologies, conflicts, and interdiscoursive connections can one locate in the debate on educational neuroscience?

By answering this question, the thesis aims to elucidate on both the academic *discipline* of educational neuroscience and the *international debate* as regards the 'bridging of the gap' – 'gap-ambiguities' which moreover implies both discoursive and interdiscoursive aspects. It must further be stressed that the aim of this thesis is neither to explicate on educational neuroscientific classroom practice, nor to offer a content review on arguments being voiced. These restrictions are due the fact that I am no expert on neuroscience. My field of study is education, and it is from an educational standpoint this thesis is written. Besides, the limited scope a master thesis holds is further restricting a well-founded elaboration on explicit examples on how neuroscientific findings are fused with educational theories and practice. Focus in this thesis will thus largely be restricted to the *discourse* of educational neuroscience, and focal aspirations will be to elucidate underlying structures and issues; Why do we find a resolute reluctance amongst some educational academics to take novel knowledge of the brain into consideration? What do the 'problems of the gap' encompass? Can these conflicts derivate from a more profound interdiscursive ambivalence seeping through the core of the overarching scholastic discourse? And last, have we become trapped in our discourse and subsequently fallen victims to our own illusions?

Considering this thesis aim to elaborate upon structures embedded in the educational neuroscience debate, a critical discourse analysis can be seen as an adequate theoretical and methodological approach. The method might be profitable since "[t]he aim of the discourse analysis is not to prove which of these readings is correct but to consider them all as evidence of the text's inherent ideological ambiguities, distortions and absences" (Codd in McCulloch, 2004 p.47). It is therefore not a review of educational neuroscience, as such, but a critical analytical approach aiming to illuminate dominant representations, ideologies, hegemonic struggles, power relation, interdiscoursive entanglement, and aspects of discoursive change in educational neuroscience. This methodological framework can find beneficial aid in discoursive theories derived from both Foucault (1970; 1972) and Fairclough (1992). A more throughout elaboration on methods and theories will be provided in the next chapter, followed by a chapter where educational neuroscience is attempted placed in a historical perspective.

Following this, a brief outline of the different discoursive positions in the debate is offered, before educational neuroscience will be attempted associated with interdiscoursive facets. The last aspect assessed will be to critically consider the role of language in the discourse of educational neuroscience. My endeavour is to provide a brief overview – an introduction, as such – to the emerging discipline of *educational neuroscience*.

2. Critical Discourse Analysis

This master thesis' aim is to elucidate the subject of educational neuroscience. A clarification of such a topic can be achieved using numerous different methodological approaches; different approaches which often look at a topic from different perspectives. Educational neuroscience is a relative new discipline in academia and has, insofar, mainly become visible as an international academic debate. Different viewpoints, arguments, and ideologies are thus easily detectable. Moreover, the international debate on educational neuroscience can be linked to both political trends and trends in the society, in addition to more profound conflicts in academia (Geake, 2005). To review and analyse such aspects and structures, the method of critical discourse analysis can be of profitable use. As a means to establish a theoretical and methodical foundation for this thesis, this chapter will attempt elucidating on the concept of discourses and its analysis. Discourses are, however, not a simple concept to make explicable with a few pages restriction – its intricate nature requires more than a brief tête à tête. As Fairclough (1992) notes: "Discourses is a difficult concept, largely because there are so many conflicting and overlapping definitions formulated from various theoretical and disciplinary standpoints" (p.3). I will, nevertheless, make an effort to explain the concept abundantly. A brief assessment of theory and method are therefore first provided, before critical discourse analysis is linked more explicitly to my master project.

Critical Discourse Analysis as theory and method

Socio-constructivism can be seen as one of the philosophical cornerstones in discourse analysis, as its epistemological notion of knowledge, truths and reality seeps through the very concept of *a discourse.* Socio-constructivism entails the idea that our concept of 'reality' can be understood as subjective and changeable *images* of reality. Reality, truths, and knowledge are social constructed and will vary depending on contexts – time, place, and culture aid shaping our perceptions of the world. An objective account of 'the real world' is consequently unattainable. What we can attain, however, is an identification of our different *representations*

of reality (Neumann, 2001). This brings us to the concept of *discourses* – a term which seeks to make the constantly changeable 'reality' more comprehensible.

A discourse can, generally speaking, be understood as "a specific way to talk about and perceive the world" (Jørgensen & Phillips, 1999 p.9), although, the simplicity of this account does not sufficiently manage to identify a discourse's scope. Toews (2004) elaborates and divide the term in two different approaches; discourse understood as *text*, and discourse understood as an overarching *structural dimension*. The former approach is concerned with systems of categorizations and codes in a communicative process. Text and language are relevant in the latter approach as well, albeit in the second understanding the focal aspiration is an analysis of the discourse's underlying dimensions. It is, as Toews (2004) notes, the "discourse as the historical *a priori* of thought, speech, and action" which is attempt analyzed (p.8917). This latter discoursive approach can further be linked to Michel Foucault (1970; 1972) and his theories as regards representations, order of discourse, hegemonic dimensions, and discoursive power. One essential account in Foucauldian theories is 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). An identification of *what* is acknowledged as truths, in addition to discover *who* has the power to craft these truths, implies profound and critical insight into a discourse. The question is thus; how can one examine structural and abstract aspects which are imbedded in a discourse? Foucauldian theories answer this inquiry by presenting the *critical discourse analysis* (CDA).

> 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 discoursive 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 p.30f).

In others, and maybe more comprehensible, words; "CDA reveal 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)[7].

Even if Foucault often is perceived as 'the father' of critical discourse analysis, numerous theorists have postulated renowned analytical methods derived from it. Norman Fairclough (1992), for instance, altered and built upon Foucault's original theories so as to corporate aspects such as interdiscoursive relations and change. *Interdiscourse* is derived from the Foucauldian term 'order of discourse'; a concept which conveys 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). These interdiscursive links are central in critical discourse analysis, as it aims to analyse and disentangle this discursive net (ibid.). Also Faircloughs concept of *discoursive change* is built upon Foucauldian discourse theories – especially upon aspect such as power and discoursive hegemony. As Fairclough (1992) notes; "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" (p.93). Hegemonic struggles in a discourse can therefore be seen to facilitate change.

Discoursive change, hegemonic struggles, and effects of dominant representations are significant facets in critical discourse analysis, although, critical discourse analysis does not only encompass theories and methods postulated by Foucault and Fairclough. Numerous authors have contributed with major works in this field, such as Jørgensen and Phillips (1999), Neumann (2001), and Toews (2004). These theories cover a range of different discoursive aspects and can aid in an analysis of the discourse of educational neuroscience.

An analysis of educational neuroscience as a discourse

Critical discourse analysis elaborates on *discoursive structures* which contribute to shape how we think and speak, and as such, direct our knowledge, truths, and representations (Neumann, 2001). Discourse theories can therefore be appropriate to analyze the discipline of educational neuroscience. Discourse analysis does, however, comprise numerous different theories and methods. Subsequently a selection has to be made as to manage analyzing elements of the educational neuroscience discourse in a practicable manner. The sections which follow will

[7] Foucault's work is often alleged as quite intricate and difficult to grasp. In this thesis I have used Foucault's original literature, but have nevertheless tried to corroborate my understandings with supplementary literature so as to prevent falling under inaccuracies and misinterpretations as regards Foucaults theories.

try to justify *why* certain discoursive aspects are applied in this thesis and *how* critical discourse analysis is attempted utilised in this master-project.

Specific clarifications for this thesis

There are some clarifications which ought to be made as to prevent misapprehensions. What first need to be noted is that critical discourse analysis encompasses both discourse *theories* and *methods*. Foucault (1979; 1972) has, for instance, chiefly postulated discoursive theories (e.g. on order of discourse, power relations, and language). Fairclough (1992) has also put forward theories (e.g. on interdiscourse and discoursive change), but has additionally postulated analytical methods on how to execute such analysis. Following this, and my second clarification, is that I will not draw on *one* single discourse theory or method. Instead I will be inspired by several – ranging from Foucault (1970; 1972) to Fairclough (1992); from Neumann (2001) to Jäger and Maier (2009). Seeing that all of these authors elaborate on different discoursive aspects and to different extent, the span of theories might be proven copious for an abundant analysis. What thirdly ought to be stressed is that even if critical discourse analysis offers specific analytical methods, this thesis will not follow any methodological step-by-step recipe. This is because "CDA is not a rigid formula that can be followed mechanically to produce result. Depending on the research question and the type of material used, different procedures are appropriate" (ibid. p.56). Fairclough (1992) states as much himself, claiming that "one cannot simply 'apply' Foucault's work in discourse analysis; it is … a matter of 'putting Foucault's perspective to work" (p.38). Critical discourse analysis – both its theories and methods – will therefore function more as frameworks and guide-lines in this master project, rather than applications of specific method-procedures. Due to what is mentioned above, it should also be noted that the *theoretical* framework in this project will comprise discoursive theories and not theories extracted from educational neuroscience itself. Again we are falling back at the focal point in Foucauldian premises – neutral and objective theories do not exist; what one can allocate, on the other hand, are different representations (Jäger & Maier, 2009). Theories concerning educational neuroscience must therefore be perceived as *analytical entities* in this discourse analysis.

Clarifications must also be made as regards the notion of discourse, and why the discipline of educational neuroscience independently can be seen as a discourse. Fairclough (1992) note:

> 'Discourse' is widely used in social theory and analysis, for example in the work of Michel Foucault, 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) (p.3f).

Drawing on this account, the discipline of educational neuroscience can thus be defined as 'a discourse'. Not only can it be seen as an entity evolving around specific areas of knowledge and social practice; educational neuroscience also structure knowledge and social practice as to shape relations, hierarchies and discoursive positions. This new discipline does, furthermore, position people in accordance to this (e.g. scientist, academics, teachers, and pupils). Educational neuroscience can, as such, be understood as a discourse in itself and a discoursive analysis can subsequently be utilized at this topic.

Clarification of educational neuroscience as a 'discourse' generates another issue; where does the discourse of educational neuroscience begin and where does it end? Neumann (2001) states that discoursive boundaries are neither prearranged nor constant. The analyst must therefore take stance with regard to this.

> A discourse cannot be entirely separated from other discourses. How discourses are delimited in accordance to others, and how social sequences are assigned different discourses, depends upon its advocates and the shared meaning they allocate the discourse at hand. Discoursive delimitation is therefore in itself a research question for the discourse analyst (p.56 [my translation]).

Given that this thesis is anchored in educational neuroscience, it is reasonable to focus on the focal aspiration and the shared meaning allocated 'educational neuroscience'. Considering that numerous authors concur that the aim of the discipline is to craft reciprocal collaborations between education and neuroscience (Patten & Campbell, 2011), this shared meaning will be the discourse's focal core. In this thesis an *international debate* on educational neuroscience is additionally attempted covered. It will therefore be profitable to draw the discoursive boundaries so that they encompass different standpoints in the debate as well. This imply that the *discourse* of educational neuroscience, as it will be used in this thesis, encompass more than the academic *discipline* of educational neuroscience. Consequently it will not be the enterprise of educational neuroscience which will be analysed – i.e. specific examples on how cognitive neuroscience is applied in educational theories and practice – but rather different opinions as regards this enterprise[8].

[8] My attention on *the debate* regarding educational neuroscience does *not* imply that I do not see necessity of analytical research on *the enterprise* of educational neuroscience. On the contrary; I will deem that scientific elaboration and analysis of explicit connections between cognitive neuroscience and educational are of highly importance. The scope of this thesis does, however, not grant me the opportunity for the profound elaboration such an undertaking requisite.

Critical discourse analysis and educational neuroscience

A critical discourse inspired analysis of educational neuroscience implies an analysis of aspects such as different discoursive positions, ideological struggles, and interdiscoursive connections. All these facets make interesting aspects of study since they affect how one thinks and what is perceived as 'truths' in the discourse of educational neuroscience. Revealing these structures, on the other hand, is easier said than done. Neumann (2001) has postulated three general steps towards a sufficient discourse analysis which can aid as profitable guidelines: "delimitation of the discourse, identification of the discourse's representations, and identification of its stratifications" (p.50). When it comes to the first aspect, this has already been done earlier in this chapter where educational neuroscience were defined as a discourse and its boundaries were drawn as to encompass aspects profitable for the research question at hand. Neumann's second step includes an identification of representations allocated in the educational neuroscience discourse. Considering that educational neuroscience already has become a prominent international debate, the different representations allocated can be many. Had there not been numerous representations conflicting with one another, there would not have been a debate to analyze in the first place. The task is therefore to group different arguments, pin-point representations, identify ideologies, and draw relations between them. It is, in other words, an attempt to map the discourse; to sort out the chaotic murmur of different voices so as to distinguish *who* is saying *what*, with what *authority*, and with what *effect*? This endeavor will aid to discern different discoursive positions. Identification of discoursive positions and different representations will furthermore lead to Neumann's (2001) third analytical aspect – that of discoursive stratification. This term do, to some extent, entail relations one can find between different discoursive positions; relations which both Foucault's (1970; 1972) theories on power, order of discourse and dominant hierarchies, and Fairclough's (1992) theory on interdiscoursivity, can aid elaborating. Discoursive stratification additionally encompasses relations between a discourse's representations. Neumann (2001) elaborates, stating that "some discoursive representations are more difficult to change than others; sign which are "easy to think with" and representations of material objects are among these" (p.66). Discoursive stratification can thus be linked to Faircloughs (1992) theories on discoursive change – a term which moreover is linked to interdiscourses.

> The boundaries between elements may be lines of tension … [C]ontradictions between such domains may become the basis for struggles to redefine their boundaries and relationship, struggles to extend the properties ... Social and discoursive tendencies are established through struggle, and they are furthermore

> established with only a limited stability, with the prospect that their own heterogeneous elements will be experienced as contradictory and lead to further struggle and change (p.68ff).

Even if Fairclough elaborates on discoursive change, he does not give considerably notion to factors which usually *generate* predicaments in the first place. Thomas Kuhn (1962), on the other hand, expands on this with his theories on 'scientific revolutions'. Kuhn is not an author usually characterized as a discourse analyst. His theories on scientific revolutions can nevertheless be apposite illuminating upheavals in education neuroscience, and will therefore briefly been referred to in this thesis.

An analysis of the educational neuroscience discourse can, as previously mentioned, be achieved at two different levels. One approach reflects on linguistic analysis, whilst the other considers aspects regarding more overarching discoursive structures (Toews, 2004). In this thesis I have chosen the latter approach, making discoursive facets such as discoursive positions, ideologies, dominant representations, power relations, and interdiscursive entanglement the focus of study. Texts, in the form of academic articles, will still be the general data material, but no linguistic analysis will be provided. Instead different discoursive and structural aspects are attempted reveled by critically analyzing literature on educational neuroscience. Literature used as analytical material in this project will therefore chiefly consists of international articles published in prominent scientific journals[9] and educational neuroscience reports such as the ones published by OECD/CERI (2007b) and TLRP/EDRC (Howard-Jones, 2007). Articles on educational neuroscience are not the only literature which has been reviewed. Since a prominent aim in this thesis is to analyze interdiscoursive connections, also articles exterior to the discipline itself have been included. This literature do mainly consist of the works by Carl N. Degler (1991) and C.P Snow (1959; 1962), in addition to later articles elaborating on divisions between natural and social sciences[10]. The literature being used in this thesis is thus ranging from different academic fields – from education to psychology, and from articles on cognitive neuroscience to articles in general social science. A broad range of text-material has been chosen in order to include as many, and as different, voices as possible so as to strengthen the analysis representativeness [11]. Foucauldian theories on discoursive power stress this point, in view of the idea that "certain groups and individuals

[9] Journals such as 'Educational Philosophy and Theory', 'Educational Researcher', 'Life, Sciences, Education', 'Nature Reviews Neuroscience', 'Mind, Brain, and Education', and 'Research Intelligence'.
[10] DiMaggio (1997), Bergesen (2004), and Johnston (2007), just to mention a few.
[11] It should also be noted that I in search for relevant literature have received supportive recommendations from contacts at 'Center for Educational Neuroscience' (i.e. Prof. A. Tolmie), and at 'Neurosociety' (i.e. Dr. T. Schneider at 'University of Oxford').

have more power over discourse than others, for example because they have privileged access to the media or greater financial recourses. Exclusions inherent to the structure of discourse can thus be amplified by institutional conditions" (Jäger & Maier, 2009 p.39). A discourse analysis thus requests a literature scope which is representative for the discourse at question, in addition to attentive and critical readings of the literature at hand.

One last note must be made before moving onwards with this thesis: Educational neuroscience is a broad topic and the international debate encompasses numerous different voices. I have therefore found it practical to make some categorizations and labels as to make the entanglement more comprehensible[12]. Categorization of arguments and viewpoints into restricted discoursive positions is, however, a simplification. Advocates sited in one position can, for instance, agree upon some aspects whilst bickering on others. Moreover, different discoursive position can fuse into each other or even overlap with other discourses. What is more, and what is important to stress; the different discoursive positions in the debate are *abstract* positions. Not only will such categorizations be simplistic generalization; names given in this thesis are also labels made as to distinguish one group from the other. Peep in at a discussion-panel on educational neuroscience, and I can assure you will not see any people walking around with discoursive nametags around their necks. Names and illustrations provided in this thesis, both as regards discoursive positions and of different 'gaps' between these positions, are therefore merely designed as to aid elucidating the entanglement of discoursive structures in educational neuroscience. Labels have been given and simplifications have indeed been made; albeit these generalizations are difficult to elude. Hovering above the discourse from an observer's point of view, I have thus seized the delightful opportunity to group, label, and simplify the discourse's buzzing life. To ease my conscience for putting pieces of reality into labeled boxes, I will end by stressing that this truly has been attempted done in a most objective[13] and legitimate way as possible.

[12] Such as labels for the different discoursive positions (i.e. 'misguided enthusiasm', 'pessimistic skepticism', 'hesitant optimism' and 'cautious optimism'), and the 'gap' found between them (i.e. 'the peripheral gap' and 'the underlying gap'). Names given to different discoursive positions are, however, inspired by names frequently used by authors *in* the discourse themselves. The name '*cautious optimism'* is, for instance, derived from numerous advocates who stress the fact that one ought to be *cautious* in the linking of education and neuroscience (Varma et al., 2008).

[13] One cannot look away from the claim that unadulterated objectiveness is a concept of impossibility. Besides, and as Jørgensen and Phillip (1999) note; "critical discourse analysis does not perceive itself as political 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"(p.76). The reader ought to bear this in mind.

3. Educational neuroscience as an academic discipline

This master thesis does not only aim to critically analyse the *discourse* of educational neuroscience; the thesis also seeks to offer an "introduction" of sort, to this novel academic *discipline*. Both endeavours do, nevertheless, require an account of educational neuroscience – its historical frame, international and national expansion, and the discipline's core and aim.

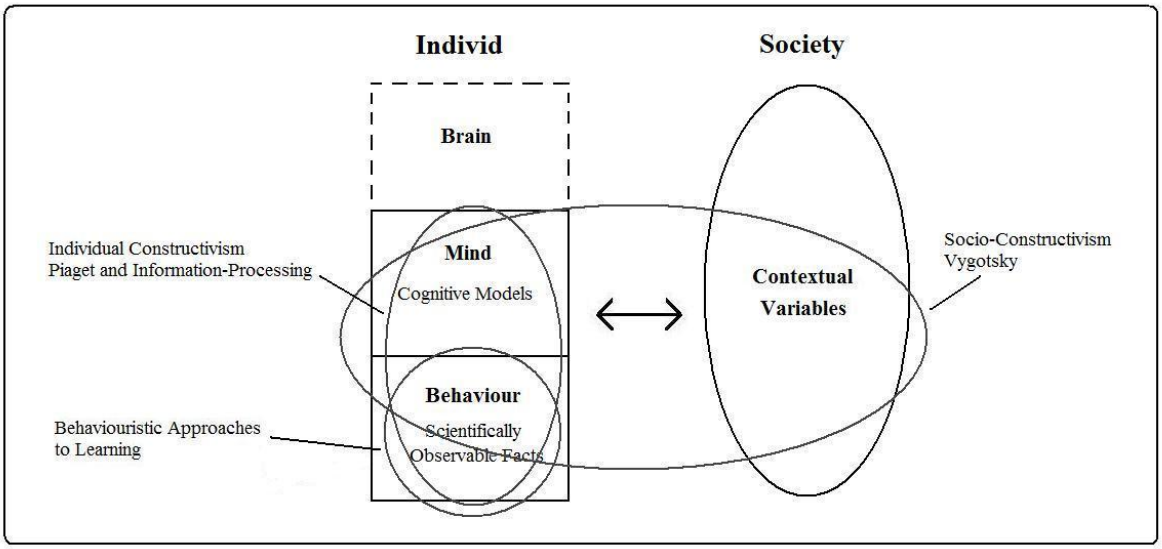
The historical framework of educational neuroscience

Foucault (1972) states that a discourse cannot fully be comprehended without linking the discourse to a historical frame. Anchoring educational neuroscience to the past can be conducted in numerous ways, and with different profundity of analysis, depending on one's focus of attention. Due to relevance, only previously traces concerning the relation *brain-mind-behaviour* will be taken into account. This section will therefore start by briefly reassess the behaviouristic approach to learning, before drawing attention to individual cognitive theories, socio-constructivism, and subsequently educational neuroscience.

The linking of cognitive neuroscience and education is unquestionable innovative, but the connection brain-mind-behaviour is however not an original thought. The history of education reveals an inclination to understand *why* children act as they do – how children come to learn and incorporate new knowledge. At the turn from the 19th to the 20th century, a behaviouristic approach to learning held a central position in the educational discourse. At this time, learning was understood as a direct cause from outer stimuli (cf. Skinner), and learning methods such as Thornidikes 'drill and skill' approach were common (Ferrari, 2011). Behaviouristic approaches met, however, critique during the early 1900 from more pragmatic approaches, such as learning theories postulated by Dewey. Parallel with this tension between behaviourism and pragmatism, the discipline of educational psychology emerged – a discipline which interrelated psychological findings with educational practice. At first this new academic field did not get any strong roothold in education, but by the 1960s educational psychology increased its influence. Accordingly models from cognitive information-processing approaches and constructivist learning theories from Piaget captured the interest of educational academics (ibid.). These approaches focused on the individual child, as they tried to explain how individual cognitive processes generate learning (Woolfolk, 2006). At the same time one can also find commencement of positivism in the educational sector (Telhaug & Mediås, 2003). Positivistic approaches did, however, meet profound critique from numerous authors in social science. Not only did the positivist approach interfere with well

established boundaries between social and natural science (cf. the nature-nurture dispute), it also gave theory precedence over practice (ibid.). A positivistic perspective also committed the crime of reductionism, as it tried to reduce social studies by forcing them to subject to nature scientific methods and philosophies (Choudhury, Nagel & Slaby, 2009). Aversion to positivism amongst social scientist was clear, and resulted in a disclamation of the positivistic approach in the 80's (Telhaug & Mediås, 2003). Following this, socio-constructivist theories derived from Vygotsky won ground in education around the 1990's. Compared to for instance Piagetian individualistic approaches to learning, Vygotsky took more consideration to contextual factors such as environment and culture in the process of cognitive development and learning. As the years have elapsed, the strong significance assign societal factors have maintained in the educational discourse, and socio-constructivism has subsequently become a well proverbial account in educational learning theories (ibid.; Bergesen, 2004).

Educational Theories of Human Development and Learning



This model is built upon the brain-mind-behaviour model presented in TLPR (Howard-Jones, 2007) and Howard-Jones (2011) 'level of actions' model. I chose to fuse these two models as to better illustrate how behaviouristic approaches to learning tend to consider individual behavior, how individual constructivism often focus on individual mind and behaviour, whilst socio-constructivism consider societal variables in addition to individual mind and behaviour in learning.

At the turn of the 21st century we seem to have reached a new era in the history of cognitive science. Numerous authors have entitled this new era a 'scientific revolution' (Ferrari, 2011; Ansari et al., 2011), referring to the advance of new technologies and the possibilities these technologies bring forth[14]. Tools such as Positron Emission Tomography (PET), Transcranial Magnetic Stimulation (TMS), and functional Magnetic Resonance Imaging (fMRI) have not only assisted in the corroboration of disciplines such as cognitive neuroscience; these tools also offer new insight into the secrets of the brain. Subsequently, what previously were merely hypothesis of the mysterious brain have now become observable (Howard-Jones, 2007). New technologies present the human brain in a new light, revealing some of its structures and functions. The vague dotted-lined box marked 'brain' is no longer a locked box of mystery.

Even though some mysteries of the brain have become scientifically observable, the 'answer' to the conundrum of the brain-mind-behaviour relation is not necessarily endowed.

> High resolution imaging such as functional Magnetic Resonance Imaging (fMRI) have probably attracted the greatest popular interest. However, such techniques only provide us with an image of the biological changes occurring in the brain, such as blood flow. They do not allow us to 'see' thinking or learning directly. To understand what such an image has to do with learning, we need a psychological model to help us relate it to our mental processes – i.e. a cognitive model. When cognitive models and our knowledge of biological processes inform each other, we can feel more confident about both (Howard-Jones, 2007 p.17).

In other words and for the sake of simplicity; 'the mind' lies between scientifically *observable* facts of the brain and *observable* facts of behavior (see model). Our technologies do not allow us to observe processes of this middle step; e.g. thinking and learning. What new technologies do provide us with, is innovative knowledge of *the brain* – knowledge which further can anchor models of *the mind* in more profound ways. Cognitive neuroscience is one of the disciplines which have undertaken this quest, as it links brain biology with cognition of mind (Howard-Jones, 2007). So far this discipline's endeavour has succeeded fair enough, as it has engendered numerous scientific cognitive models and theories[15]. Furthermore, new knowledge of the brain and mind do not merely provide supplementary theories; they also call forth adjustment of *old* cognitive theories. Subsequently, and inevitably, these new theories shake the foundation to concepts related to the cognition of mind (ibid.).

[14] Drawing on Thomas S. Kuhn's theories on scientific revolution, this clam of a 'scientific revolution' might be well grounded. Limited space restrains me to elaborate further, albeit one can read more in Kuhn (1962) *The Structure of Scientific Revolutions*.

[15] For brief examples of some of these theories see page 20-22.

> The rapid development of functional neuroimaging techniques has give researchers unprecedented access to the behaving brains of healthy children and adults. The result has been a wave of new insights into thinking, emotion, motivation, learning, and development. As these insights suffuse the social sciences, they sometimes inspire reconsideration of existing explanations (Varma et al. 2008 p.140).

Unlocking the box of the brain has thus crafted a domino reaction in science; As the veil of mystery fell and secrets of the brain were reviled, cognitive models of the mind became altered, causing nearby and following pieces to waver. Educational theories built upon aged cognitive models of the mind hold no immunity to this domino effect – the ground of the educational field has thus started to shudder.

What then, has this shift in the scientific field resulted in? What consequences have these new theories of the brain and mind crafted in education? First of all it can be noted that innovative knowledge of the cognition of mind has shaken profound educational believes as regards learning and cognitive development. This alteration is due the notion that numerous educational theories build upon elderly cognitive model which now are questioned (Varma et al, 2008). Secondly, scientific findings of the brain have captured the interest of the society at large, causing politicians to call for scientifically grounded practices in institutions such as education (OECD, 2007a)[16].

> *Educational neuroscience is generating valuable new knowledge to inform policy and practice:* On many questions, neuroscience builds on the conclusions 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. On other questions, neuroscience is generating new knowledge, thereby opening up new avenues (OECD, 2007b p.17).

For these reasons, numerous academics began advocating for the importance of taking neuroscientific findings into consideration in education. By the early 90's, the first stones in the foundation of what soon would become *educational neuroscience* were thus laid.

Educational neuroscience as a growing international discipline

Educational neuroscience commenced in the 90's in the same way as almost every other novel field of study; old believes were questioned, arguments for a 'new way' were postulated, which again lead to profound debate in academia as regards this recent subject of matter – the possible link between *education* and *cognitive neuroscience* (Kuhn, 1962; Schwartz &

[16] OECDs call for scientifically grounded education and evidence-based practice must not be misunderstood as a demand for a *universal classroom formula*, but rather a request for more *scientifically grounded approaches* to learning (read more Ogden, 2008).

Gerlach, 2011). In the early 90's these voices of change were mainly manifested in the form of international academic articles. As the decennium elapsed, educational neuroscience grew from being a topic of interest to becoming defined as an academic field of study. Recently, numerous authors have even claimed it a new *discipline* (Petitto & Dunbar, 2004; Patten & Campbell, 2011). Labels of scholastic ranking notwithstanding; the increased consideration paid to educational neuroscience is notable. Not only does the significant amount of scientific articles on the subject demonstrate as much; also foundations of numerous transdisciplinary collaborations[17], launching of the scientific journal *Mind, Brain, and Education* in 2007, TLRP/EDRC's report on *'Neuroscience and Education'* (Howard-Jones, 2007), and OECD's seven years protracted project "Learning Science and Brain Research" (2007b) contribute underlining the notion of educational neuroscience. Additionally one should note that a masters and a doctoral program in 'Mind, Brain, and Education' were established at Harvard University Graduate School of Education in 1999, whilst at present numerous similar graduate-level programs in educational neuroscience are commenced – e.g. in Cambridge (England), China, and Texas (at Arlington/Dallas) (Stein & Fischer, 2011).

Educational neuroscience has not only advanced within educational academic spheres; this novel discipline is also highly relevant as to current political and societal concerns (Geake, 2005). In the society at large one can find increased curiosity as regards our brain and how it works (Ansari et al, 2011). Popular-science books ornament windows of bookstores and not one day goes past without a neuroscientific article is recited in media. This interest has further led to increased attention as regards the connection between education and the brain – both politically and in the media (ibid.). Inclinations towards the topic are for instant evident in the significant amount of attention OECD has paid to educational neuroscience. OECD/CERI's seven years protracted project *'Learning Science and Brain Research'* (2007b) evinces as much. Not only does this report scrutinise the discipline of educational neuroscience, it also concludes that "Educational neuroscience is generating valuable new knowledge to inform educational policy and practice" (OECD, 2007b p.17). This opinion is of essential note considering that OECD holds an international position of prominence. As Karlsen (2006) states; "OECD has a significant and unique position as premises contractor … OECD appears as independent and generally apolitical; facets which gives its reports, declarations, and

[17] *International Mind, Brain, and Education Society* (IMBES); *Centre for Educational Neuroscience* (CEN) in London; *Centre for Neuroscience in Education* (CNE) in University of Cambridge; *Brain, Neuroscience and Education* (BNE, SIG); *Research Schools Network* (RSN) in Texas – just to mention a few.

recommendations more strength" (p.202f [my translation]). Altogether this contributes to underline the concept of educational neuroscience.

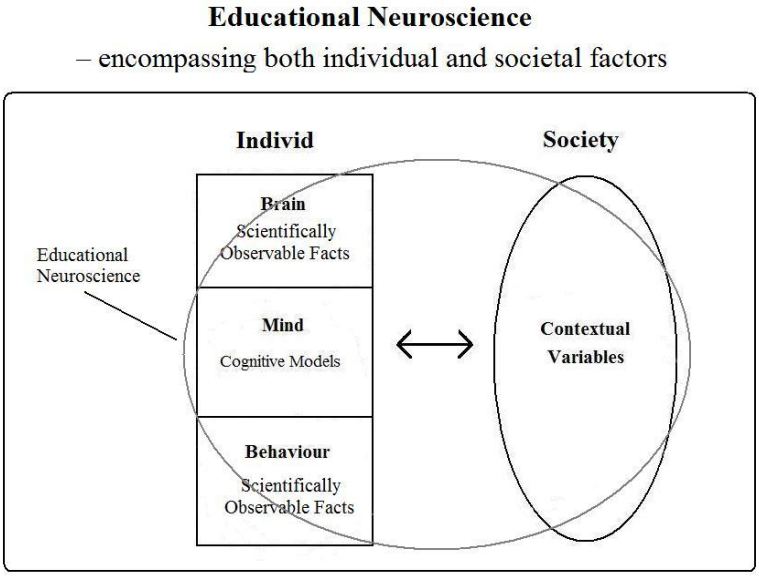
There is little doubt that educational neuroscience has grown internationally both in extent and in strength over the last two decades. On this note, I will also convey the impression that the debate on educational neuroscience also can be expected to reach *Norwegian* educational spheres. In fact, traces can already be found in academia, in the society at large, and in educational policy. Even if the term 'educational neuroscience' not yet has been established as a familiar idiom amongst Norwegian academics and politicians, aspects of the international debate are evident. Not only has a national debate on the division between natural and social science once again caught numerous academics attention[18]. These outlines have also been manifested in educational policy documents, as numerous Norwegian politicians repeatedly necessitate science based research in educational tuition and practice[19]. "New knowledge as regards learning and school-development is not systematically taken into consideration in schools" it is stated in St.meld nr.11. (2008-2009 p.10). Subsequently it is required "increased requisites as regards academic quality, better practice, increased focus on professionalization, and more scientifically grounded education" (Meld. St. 19, 2009-2010, p.28 [my translation]). Assertions on the importance of more scientifically grounded education and teaching have furthermore led to establishment of NAFOL[20] and Programme for Educational Research ('Utdanning 2020'). These trends in national educational policy can further be seen interlinked with the ongoing debate on evidence-based education (Utdanningsforbundet, 2008). Both the debate concerning evidence-based education, and scientific based requisites in political documents, can therefore be suggestive of discoursive strains *en route* a debate on educational neuroscience. This assumption is strengthened by the notable significance OECD as a premises contractor allocates educational neuroscience (cf. Karlsen, 2006). Subsequently this conveys the impression that OECD's accentuation of the importance linking education and cognitive neuroscience most likely will, or will continue to, inflict Norwegian education.

[18] This recent academic debate were amplified by NRK's popular-scientific program '*Brainwash*'; a program which further crafted considerable attention in media due to its nature-nurture problematization.
[19] Requests for science based education must not be misinterpreted as demands for universal classroom formulas and teaching recipes, but rather requests for more *scientifically grounded approaches* to learning. (Cf. the national debate as regards evidence based education. For further reading see Ogden, 2008).
[20] The Norwegian National Post Graduate School in Teacher Education (NAFOL) were established in 2010 to strengthen a research based perspective in education.

The core and aim of educational neuroscience

So far the historical foundation of educational neuroscience has been clarified and the discipline's international expansion has been elucidated, but *what* defines the discipline of educational neuroscience? What core does it evolve around, which aims does this new discipline seek to venture, and how is the connection education-neuroscience attempted achieved?

Numerous advocators coincide as regards the discipline's focal aspiration; educational neuroscience venture to bring together educational theories and practice with neuroscientific research, theoretical knowledge, methods, and techniques, with the intention to generate better teaching and learning (Patten & Campbell, 2011; OECD, 2007b). Even if this new transdisciplinary field has been labelled *educational neuroscience*, the collaboration expands over a variety of different disciplines – ranging from cognitive neuroscience, neurobiology, social cognitive neuroscience, cognitive psychology, and educational theory, practice and policy (Howard-Jones, 2007). What this collaboration implies, in short, is a common inclination to connect biology of the brain, cognitive science of the mind, and educational theories and practice. The venture of educational neuroscience is thus a 'bridging-project', as it commonly is referred to, as it aims to link brain-mind-behaviour in favour for improved educational theories and practices. Social aspects are accordingly accentuated in this enterprise, so that the centre of attention does not exclusively rest on cognitive neuroscience but also consider social aspect relevant for education (ibid.). If one conveys this to the model previously postulated, the discipline of educational neuroscience can thus be seen to draw a circle encompassing the mind-brain-behaviour relation *in addition* to social aspects.



When it comes to the fulfilment of these goals, numerous contributions have been postulated linking neuroscience and education. Some of these contributions elaborate on a theoretical level as regards educational neuroscience; others draw theories down to more accessible approaches to classroom practice. What appear to be in common for all these studies is that they anchor cognitive models of mind relevant to education, with new scientific results on how the brain works. As Petitto and Dunbar (2004) notes; "Because cognitive neuroscience have identified the major brain sites involved in memory, learning, attention, and reasoning, it is now possible to understand the types of cognitive and neural changes that occur in educationally relevant learning" (p.11). Furthermore, and what is a crucial point for educational studies, is that numerous of these neuroscientific studies accentuate the function of *environmental* factors when it comes to alterations in the brain.

> Neuroscientists have well established that the brain has a highly robust and well-developed capacity to change in response to environmental demands, a process called *plasticity*. This involves creating and strengthening some neuronal connections and weakening or eliminating others. The degree of modification depends on the *type* of learning that takes place, with long-term learning leading to more profound modification. It also depends on the *period* of learning, with infants experiencing extraordinary growth of new synapses. But a profound message is that plasticity is a core feature of the brain throughout life (OECD, 2007b p.13).

Social and environmental factors, such as teachers, different learning methods, and other societal aspects, *can* contribute to enhanced learning and cognitive development (OECD, 2007b; Howard-Jones, 2007). Blakemore and Firth (2005) concur, and additionally stress the notion that plasticity in the brain happens throughout life. This little word '*throughout'* is easy to overlook, but it has profound consequences for education. A common assumption amongst numerous academics, both in neuroscience and in education, has been that the adult brain is incapable of change. This claim is due to the belief that adult brains neither do produce new cells, nor make new neural connections; a hypothesis which again were seen to explain deterioration in learning, performance, and memory in elders. "But research is beginning to show that this view of the brain is too pessimistic: the adult brain is flexible, it can grow new cells and make new connections ... The brain's plasticity depends critically on how much it is used" (ibid. p.460;). These new insights on the brain's adaptive plasticity and its possibility to change due to environmental factors throughout life, have further crafted numerous studies relevant for education: Studies on sensitive periods[21] have resulted in significant knowledge

[21] *Sensitive periods* must not be mistaken for *critical periods*; the latter an old term for fixed and rigid 'windows for learning', whilst the former and newer term comprises "subtle changes in the brain's ability to be shaped and changed by experiences that occur over a lifetime" (Blakemore & Firth, 2005 p: 460).

on cognitive development and how different types of learning are beneficial at different periods (Blakemore & Firth, 2005). Geake (2011) carried out a fMRI study on neural correlates of creative reasoning, concluding that fluid analogical thinking[22] aids and enhances creative intelligence. Other researches explore related aspect relevant to education, such as dyslexia, dyscalculia, and ADHD (Howard-Jones, 2007), genetic links between brain, mind, and education (Plomin, Kovas & Haworth, 2007; Koizumi; 2011), emotional influence on cognition (Patten, 2011), and the importance of mirror-neurons in our ability to learn from observing others (Jong, Gog, Jenks et al., 2009). OECD's (2007b) report on educational neuroscience, in addition to the report postulated by TLRP/EDRC (Howard-Jones, 2007), designate similar conclusions.

> This and dozens of other studies indicate that delineating how the mind/brain represent knowledge and how learning changes this underlying knowledge is central to designing and implementing educational practice (Petitto & Dunbar, 2004 p.10).

Together this underscore that recent knowledge of the brain can craft new cognitive models of mind, which in turn can engender new or strengthen old educational theories (OECD, 2007b). Understanding of mirror-neurons role in social processes for learning has, for instance, emphasized socio-constructivist theories such as those to Vygotsky and Bandura[23] (Jong et al., 2009).

New knowledge of the brain and mind have also *challenged* old and well established educational ideas. In their recent fMRI-study, Petitto and Dunbar (2004) investigated conceptual change and anomalies[24] in learning. "The main untested assumption in much of contemporary science education is that students' naïve theories can be eliminated through presenting students with anomalies. Researchers argue that by presenting students with anomalies, students will realize that their naïve theory is incorrect and will reorganize (restructure) their knowledge, eventually arriving at the "correct" theory." Petitto and Dunbar continue by noting that "Through intensive teaching using anomalies it is thought that naïve theories are eliminated. The use of anomalies has therefore been a cornerstone of

[22] Fluid analogizing is, in short, the ability to make analogies without limited 'answers'; hence a term which incorporate a creative aspect in analogy-making. For further reading see Geake's (2011) article *Positron Statement on Motivations, Methodologies, and Practical Implications of Educational Neuroscience Research: fMRI studies of the neural correlates of creative intelligence.*

[23] Vygotsky stressed the importance of social interaction in cognitive development and learning, whilst Bandura's learning theories focused on the importance of observing and modelling others behavior.

[24] Anomalies are concepts which conflicts with ones prior believes and theories.

constructivist education" (ibid. p.11). In their study, however, they came to a conclusion which, to some extent, differs from this well-acknowledged constructivist assumption.

> [P]resenting students with information inconsistent with their theory (i.e. anomalies) results in *inhibition* rather than a restructuring of knowledge. Thus presenting students with anomalies may not be as effective a teaching strategy in science education as is currently thought (ibid. p.12).

These results are noteworthy. Not only do they provide significant new knowledge on how people learn; these results also question well-held believes in education. This crafts notable outcomes in the educational field. First of all; when novel insights of the brain and mind challenge old cognitive theories, this emphasize the fact that 'truths' are not written in stone – previously held believes *can* falter and new ideas will take their place (Foucault, 1972 ; Kuhn, 1962). Secondly; when old and well-profound educational *theories* quaver, it subsequently affects views on how educational classroom *practice* ought to be conducted. A third consequence crafted by new understandings of the mind and brain, is a profound upheaval amongst educational academics. This upheaval has gradually accumulated over the last two decades, leading to the advance of an international debate on educational neuroscience in academia. This debate does not only question if educational neuroscience is beneficial or not; the discussion also evolve around the query if the linking of education and neuroscience even is *possible*. Different standpoints towards this new discipline are many; different arguments being voiced even more. The debate on educational neuroscience thus makes an intriguing discipline for further examination and analysis.

4. The debate – discursive positions in educational neuroscience

The idea of *representations* is a focal point in critical discourse analysis, as it underlies the concept of a changing world where no truths can be perceived as neither objective, static, or universal (Neumann, 2001). In some discourses one can find a state of hegemony, where one representation of the world is perceived as 'undisputable' and is thus unchallenged. Other discourses, however, hold different representations which constantly strive to be acknowledged as 'the true' account of the world (ibid.). Educational neuroscience with its recent entry in academia is, as would be expected, a discourse of the latter. Conflicting discursive positions are thus inevitable. Which different positions can be located, and what representation these positions hold, are tasks for a discourse analysis to explicate. On this note it must be stressed that discourse analysis do not endeavour to provide detailed content

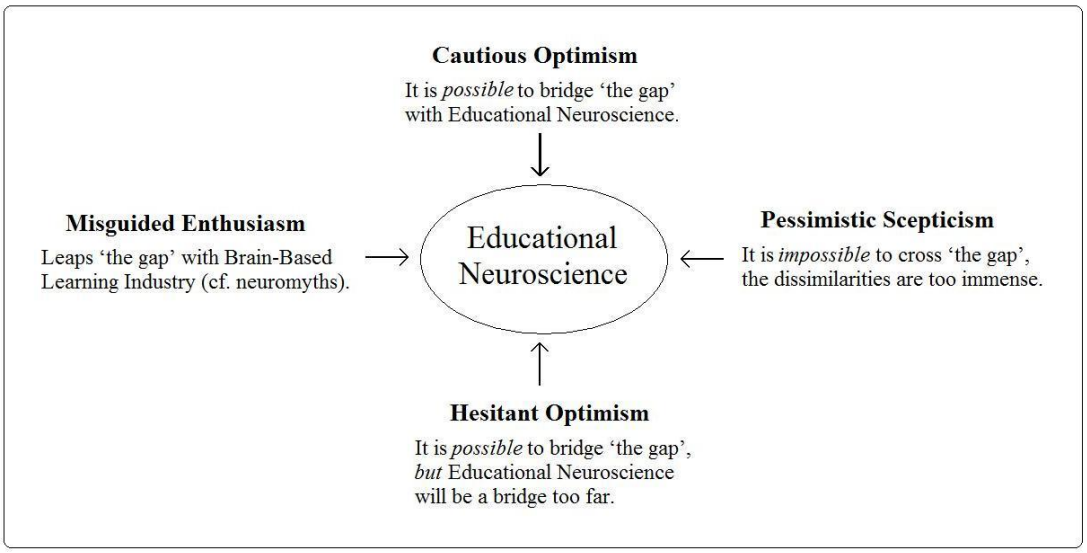
reviews as such, but instead attempt to go *behind* the discursive standpoints. Only a brief overview of the different educational neuroscience positions will thus be provided.

I am, after examining academic articles related to the ongoing debate on educational neuroscience, alleged to deem that one can identify four main discursive positions in the debate. Diametrically opposed each other one can find what I have chosen to label *pessimistic scepticism* and *misguided enthusiasm*. The other two positions are allocated somewhere in-between these two camps, and could be labelled *hesitant optimism* and *cautious optimism*[25]. Geake (2005) illustrate a similar categorisation by claiming that:

> On the one hand, there are those aging education academics who, after a lifetime of not understanding and disparaging all science, see no need to change their ways now. On the other hand, there are the 'brain-based' enthusiasts who hope that the current fads of left-right thinking, brain gym, etc., will address the complexities and daily challenges of the mixed-ability classroom. A middle-way would seem to involve neuroscientific education for both groups so that the education profession can shape a professionally informative educational neuroscience research agenda for the future (p.10).

As to illustrate the different discoursive positions which can be allocated in the debate on educational neuroscience, I have made a basic illustration. The simplicity of the model must be noted. The figure does, nonetheless, comply with the following sections where the four discoursive positions are reviewed.

Different discoursive standpoints towards the discipline of Educational Neuroscience



[25] Even if I have chosen to simplify, generalise, and label the debate into these categories, this is done by drawing on similar accounts from other authors – e.g. Geake (2005) Varma et al. (2008).

Misguided enthusiasm

At the end of the 20th century cognitive neuroscience started to gain attention in the educational field. This increased interest correlates with both amplified public concerns in school affairs and with politicians call for "evidence" in education. A request for "proof", "what works", and "the best educational practice" soon became catchphrases in the society at large (Utdanningsforbundet, 2008). Consequently, some people attempt to answer these requests by creating teaching programs claimed to be based on neuroscience. With eager enthusiasm these advocators postulate theories on how left-and-right brained children ought to be taught, how children should be labelled either as 'visual', 'auditory' or 'kinaesthetic' learners, and how 'Brain Gym' and pressing certain 'Brain Buttons' can improve children's' learning (Goswami, 2006). These theories are not submissively put forward, but rather eagerly offered to teacher as answers to the pursuit of 'what works' in classroom practice. As such, 'brain based' teaching formulas and educational programs have become profitable facets in a 'brain based learning industry' (ibid.).

The problem, however, is that numerous of these educational programs are based upon inadequately links between neuroscience and educational practice. Instead of answering the society's plea for 'what works', these misguided enthusiasts craft '*neuromyths'* (ibid.).

> Although there is a growing body of peer-reviewed literature and websites that provides clear and accurate summaries of progress in the cognitive neuroscience of learning, there are at the same time questionable media reports and numerous other claims about 'brain-based learning' that, in our opinion, often oversimplify, misrepresent, and allow for 'neuromyths' to flourish (Ansari & Coch, 2006 p.147).

What appears to be the fatal inaccuracy committed by the misguided enthusiasts is the *lack* of reciprocal collaboration between education and neuroscience. Instead of a two-way association, a direct and downward route from the brain-mind-behaviour relationship is drawn. This direct route from cognitive neuroscience to educational practice can be a fallacy. By constructing a linear course of action from the individual brain, to the mind, and down to behaviour, one *reduces* individual behavior by forcing it to fit cognitive neuroscientific explanations of biological changes in the brain (Howard-Jones, 2007). Not only does this imply an educational reductionism under neuroscientific findings; it also implies that neuroscientific findings *uncritically* are transformed to educational practices (ibid.). Such

reductionism and inaccuracies can further be at risk replicating the same 'errors of the instrumentalism'[26] as Skjervheim warned about in the 1960.

Misguided enthusiasts, with their misguided teaching remedies, can therefore give the impression to leap 'the gap' between education and neuroscience to swiftly. This over-enthusiastic venture has consequently gained much critic, both from the neuroscientific field, from other educational academics, and from international organisations such as OECD.

> Over the past few years, there has been a growing number of misconceptions circulating about the brain – "neuromyths". They are relevant to education as many have been developed as ideas about, or approaches to, how we learn. These misconceptions often have their origins in some element of sound science, which makes identifying and refuting them the more difficult. As they are incomplete, extrapolated beyond evidence, or plain false, they need to be dispelled in order to prevent education running into a series of dead-ends (OECD, 2007b p.4).

Pessimistic scepticism

Whilst misguided enthusiasts leap 'the gap' in a too swift jump, the camp of *pessimistic sceptics* refuses to even cross it. It is therefore no surprise that the most profound criticism towards educational neuroscience comes from this discoursive position. By reviewing their arguments, the sceptics' criticism can be seen as to evolve around at least two aspects. Pessimistic sceptics do, first of all, condemn the misguided learning industry and their neuromyths. This censure is not only underscored by educational reductionism, it is also stressed by referring to studies where "brain-based learning" has failed in its attempt to improve children's learning (Varma et al. 2008). The whole discipline of educational neuroscience is, by the same token, condemned. The second critique voiced, are judgments concerning 'the gap' between education and cognitive neuroscience. This 'gap' is, in accordance to the sceptics, so profound and so unpleasantly vast that a bridging-project should not even be initiated. The camp of pessimistic sceptics does, for these reasons, dismiss the link between the two fields and the concept of educational neuroscience is exclusively declined (Howard-Jones, 2007).

Varma, McCandliss and Schwartz (2008) have consolidated this disinclination of educational neuroscience, and note that educational academics who take a sceptic approach often build their arguments around eight concerns. "One set of concerns is scientific; in-principle

[26] The Norwegian educationist Hans Skjervheim published in 1972 the article '*Errors of the instrumentalism*'. Skjervheims article has become a renowned criticism towards the positivism and the positivistic venture to apply natural scientific methods and philosophies on social aspects.

differences in methods, data, theory, and philosophy. The other set of concerns is pragmatic; considerations of costs, timing, locus of control, and likely payoffs" (p.140). An elaboration on these scientific and pragmatic differences is of significant value, seeing that these aspects evolve around 'the gap' between education on one side and cognitive neuroscience on the other. For the moment being, though, descriptions on disciplinary dissimilarities will be put at rest. More throughout explanation on these gap-problems will however be provided later in the paper, when reluctance towards educational neuroscience is more critically examined.

Hesitant optimism

In their article, Varma and his colleges (2008) challenge the pessimistic approach, asking if the differences between education and neuroscience truly "constitute a fundamentally unbridgeable divide?" (ibid. p.141). An answer to this question brings forth the two reminding discursive positions. If one starts by looking at the camp labelled *hesitant optimism*, its middle-ground position is evident. On the one hand, these hesitant authors concur with the pessimistic sceptics as regards condemnation of neuromyths. On the other hand, they criticise the sceptics for their refusal to take brain science into consideration in education. One of the foremost educational academics who give the impression to take a hesitating optimistic position is John Bruer. Bruer has gained much attention in the educational neuroscience debate and his article "*Education and the Brain: A bridge too far*" (1997), has become a noteworthy monument-text in this discourse. In his article, Bruer examine what he calls 'the neuroscience and education argument'. Drawing on research on synaptogenesis, critical periods, and the effect of enriched environments on synaptic growth, he concludes that a large extent of the brain-based educational practice and policy is built upon speculative applications of neuroscience (ibid.). "The [idea of] right brain versus the left brain and the educational promise of brain based curricula ... are often based on misconceptions and overgeneralizations of what we know about the brain, and have little to offer to educators" (p.4). Despite this objection, Bruer does *not* dismiss the idea of 'crossing the gap' as the pessimists do. On the contrary, he argues that "the brain does and should fascinate all of us, and we should find advances in neuroscience exiting. As educators, we should also be interested in how basic research might contribute to and improve educational practice" (p.15). 'The gap' between education and neuroscience is crossable, and it should be attempted crossed, Bruer argues.

This optimism notwithstanding, Bruer concludes that our knowledge on how the brain works is, up till now, not adequate enough to support *one* bridge (ibid.). Instead Bruer designates the

importance of cognitive psychology, and the *two* bridges which indirectly can link brain functions with educational practice.

> There is a well-established bridge, now nearly 50 years old, between education and cognitive psychology. There is a second bridge, only around 10 years old, between cognitive psychology and neuroscience ... Cognitive psychology provides the only firm ground we have to anchor these bridges. It is the only way to go if we eventually want to move between education and the brain (ibid. p.4).

Bruer's well-known article dates back to 1997 and much have happened in the field of educational neuroscience since then. Bruer does, nonetheless, argue for the same middle-step also in more recent work. "I do believe that eventually we will be able to bridge neuroscience at its various levels of analysis with education," he notes in 2006, "but I am convinced that all of these bridges will have a least one pier on the island of psychology" (p.109). The message from the hesitant optimists is clear – 'the gap' between education and neuroscience ought to be crossed, but *one* single bridge over this gap will be a bridge too far (Bruer, 1997).

Cautious optimism

Hesitant optimists are not alone in their critics towards brain-based learning industry on one side, and the overall disinclination of neuroscience on the other. The camp labelled 'cautious optimism' concurs to these claims (Geake & Cooper, 2003; Petitto & Dunbar, 2004; Ansari et al, 2011). Both camps can thus be seen as middle positions in this debate. What then, separates the hesitant and the cautious optimists? Looking back at the arguments uttered by hesitating optimists, it was stated that "as of now [1997] neuroscience has little to offer teachers in terms of informing classroom practice" (Bruer, 1997 p.4). Cautious optimists disagree. Instead they claim that neuroscience *can* inform education, arguing for a significant and rapidly increasing neuroscientific knowledge-base (Fischer, Daniel, Immordino-Yang et al., 2007).

> Bruer (1997) forcefully considered the relevance of neuroscience to education. His conclusion [was] that neuroscience is "a bridge too far"... Although it was in his best interest to find connections between the disciplines, he found instead poorly drawn extrapolations that inflated neuroscience findings into educational neuromyths. Since Bruer's cautionary evaluation, a number of commentators have considered the prospects for educational neuroscience. Many sound a more optimistic note (Varma et al, 2008 p.140).

Concurrently, where the hesitant argue for *two* bridges by claiming that educational neuroscience in itself is an inadequate link, cautious optimists beg to differ. "Educational Neuroscience has the fullest potential to fundamentally advance contemporary educational policy and practice – and soon" (Petitto & Dunbar, 2004 p.2). Cautious optimists can

therefore be seen to take a more positive approach to educational neuroscience than the camp of hesitant optimism. The question which thus follows is; what separates the camp of cautious optimists from misguided enthusiasts – both camps do, after all, argue for the importance of relating cognitive neuroscience with educational theory and practice?

Whilst misguided enthusiasm often is linked to commercial 'brain-based' learning industry and neuromyths, cautious optimists strongly censure these learning programs for their lack of neuroscientific scrutiny (Howard-Jones, 2007). In fact, condemnation of misguided learning industries is perhaps never uttered with so vigorous disapproval, as in the camp of cautious optimism. The abhorrence is understandable considering that misguided enthusiasts keep making an unfavourable repute of the link between education and neuroscience – a link the cautious optimists serenely encourage. Goswami (2006) voice this aggravation, stating that "neuromyths needs to be eliminated. The dominance of these myths obscure the important strides being made by cognitive neuroscience in many areas relevant to education" (p.3). Course of action recommended as to 'eliminate' these unfavourable neuromyths is, as Goswami further argue, to strengthen the discipline of educational neuroscience. Not only can a scientifically legitimate collaboration abet the endeavour to dispel neuromyths; by doing so, one can also direct educational neuroscientific studies towards more beneficial routes (ibid.).

Authors advocating for a cautious optimism do additionally, and forcefully, underline the importance of a *two-way collaboration* between the neuroscientific field and the field of education (Fischer et al., 2007). In doing so, they do not only stress the value of education and the significant knowledge base educationists have accumulated over the decades (Varma et al, 2008). They also emphasise the importance of educational practice, so that the enterprise of educational neuroscience does not become overruled by theories.

> Answering key questions about mind, brain, and education requires reciprocal interaction between scientific research and practical knowledge of educators and caregivers. There must be a dynamic interaction between scientific research and practical knowledge, with practice shaping scientific questions as much as research shapes practice (Fischer et al., 2007 p.1).

Thus, by accentuate reciprocal aspects in educational neuroscience, these academics seek to avert neuromyths, prevent educational reductionism under neuroscientific instructions, in addition to avert theoretical dominance over practice (ibid.).

Altogether it appear that the camp of cautious optimism separates itself from the three other discursive positions by stressing that education and neuroscience are indeed different fields of

study, albeit fields which *can* be bridged with educational neuroscience (Varma et al, 2008). Their point is that even if differences in theories, methods, and philosophies create limitations, *awareness* of these limitations is important so as not to draw misguided conclusions. More importantly; these limitations are merely limitations, and should not be perceived as unsolvable quandaries. Instead one should be conscious about dissimilarities and limitations – making issues into possibilities (ibid).

> Bridging the divide that separates the education and neuroscience *disciplines* requires bridging the divide that separates the education and neuroscience *communities* ... We should remain cautious in our optimism. Education research and neuroscience can inform each other, but within limits (ibid. p.149).

The debate – in brief

Four different discursive positions can be allocated when reviewing the debate on educational neuroscience – each position taking a somewhat different approach to the bridging of education and neuroscience. *Misguided enthusiasm* has been associated with neuromyths and commercial 'brain-based' learning industry. This discursive position has consequently been profoundly condemned amongst the other three standpoints. *The pessimistic sceptics* critique is founded in their overall reluctance of connecting findings from neuroscience with education. Their argument is that differences in theories, methods and philosophies cause a gap too immense to successfully be bridged (Varma et al., 2008). These problems are noteworthy and the majority in the educational neuroscientific debate acknowledge their nature. Although, acknowledging the 'dividing-problems' do not mean that one *rejects* the linkage of education and cognitive neuroscience. The camp of *hesitant optimism*, for one, argue that this gap should be attempted crossed. Trying to bridge the gap with the discipline of educational neuroscience will, however, be a bridge too far (Bruer, 1997). Numerous academics can respectably be allocated in these three discoursive positions, albeit the majority of the "commentators ... see reasons to be optimistic about the future of educational neuroscience" (Varma et al., 2008 p.150). The general opinion in the international debate thus appear to be a *cautious optimism* towards this novel discipline – educational neuroscience can bridge the gap between neuroscience and education, albeit a two-way collaboration and a cautious awareness are crucial so as to make this transdisciplinary field academically adequate (Howard-Jones, 2011).

This thesis has, up until now, focused on a discursive review over different positions, their ideologies, and the relationship between them. A *critical* discourse analysis elaborates, asking

if there are additional factors contributing in the shaping of the discourse. By scrutinizing further one can ask *why* neuromyths managed to gained acceptance in the first place, why is there so profound reluctance amongst the sceptics in taking neuroscientific findings into consideration, is there something else lying underneath these ideologies, and is there a possibility that the debate on educational neuroscience is a discursive strain drawn from a larger, interdiscursive dispute? The following chapter will elaborate on these and similar questions, as this discourse analysis take a more critical approach to educational neuroscience.

5. Problems of 'the gap' – why reluctance among some educationists?

Most academics who have taken an interest in the international debate on educational neuroscience seem to hold a cautious optimism towards this new discipline (Varma et al., 2008). Even those who take a more hesitant position stress the importance of taking brain-science into consideration (Bruer, 1997). These authors have nevertheless met profound reluctance amongst some educational academics who claim that neuroscience and education cannot be connected (Varma et al, 2008). Debates which have followed have mainly consisted of the optimistic camps trying to induce sceptics by drawing on impressive fMRI studies and mindboggling arguments. Despite the optimists strive to convince the pessimists, there seem to have been, at least until recently, few who have asked *why* one can find such profound reluctance amongst some academics in the first place. An all-through answer to this question will, certainly, imply a complexity and an extent which this thesis does not hold. This chapter does, nevertheless, strive to provide some analytic perspectives on the matter.

By critically reviewing and analysing the discourse of educational neuroscience, I will argue that one can classify reluctance being voiced into two different categories – categories I have chosen to label 'the peripheral gap' and 'the underlying gap'. The former is critiques commonly uttered towards 'explicit' difficulties bridging education and neuroscience. The latter, and slightly 'deeper' gap, can give the impression being associated with more implicit problems concerning the bridging of these two fields. The following sections will be structured accordingly, using the illustration of a peripheral and an underlying gap as to demonstrate the different 'levels' of reluctance. An additionally aspiration of mine is to see if the 'problems of the gap' can be linked to other discourses, and how educational neuroscience endeavours to bridge these divide. Expectantly this approach will reveal some of the core

structures, ideologies, conflicts, hierarchy, and interdiscursive relationships in the discourse of educational neuroscience.

The peripheral gap – problems and possibilities

Reluctance towards educational neuroscience can be seen related with what I have labelled 'the peripheral gap'. The reason why I have chosen to label this a *peripheral* gap is that aspects which can be categorized in this group often are apparent and well acknowledged problems in the educational neuroscience discourse. Advocates in different discursive positions are aware of these concerns and how they 'create' a divide between the educational discipline on one hand and the discipline of neuroscience on the other. Varma, McCandliss, and Schwartz (2008) and Willingham (2009) have elaborated upon some of these 'obvious' problems. Drawing on their articles, this section will highlight three aspects – the problems with neuromyths, educational de-professionalization, and vertical and horizontal problems – which can contribute to explain some of the censure towards educational neuroscience.

The problems with neuromyths

One peripheral aspect which can explain the reluctance towards educational neuroscience lies, as previously mentioned, in neuromyths and the 'brain-based' learning industry. Skeptics' censorious of these misguided myths are understandable. Misguided enthusiasts leap, first of all, too quickly from cognitive models of the brain and mind to recommendations for classroom practice; often without consulting experts in neuroscience or education. This leads to neuromyths since these cognitive models rarely are built upon adequate links between brain-mind-behavior (Howard-Jones, 2007). Secondly, brain-based learning industries convert these neuromyths to step-by-step formulas, consequently transforming neuromyths into tempting and easy understandable recipes for 'what works' in classrooms[27]. These neuromyths have therefore managed to get roothold amongst teachers, and in its wake spread misconceptions of the brain, mind, and how cognitive models can improve educational practice. A third aspect which can be mentioned is that the brain-based industry profits on selling these inadequate 'learning-programs' to ignorant teachers (ibid.). Subsequently, these

[27] Problems with misguided neuromyths and over-enthusiastic teaching-programs can also be linked to the critique evidence-based education has met in Norway. Both evidence-based and brain-based programs are commonly linked to unfavorable and poorly drawn scientific assumptions. However, and this is important to note, the term 'evidence based education' have often fallen under miss-translation in Norway. This is because the term commonly is misunderstood as 'universal step-by-step formulas' for 'what works' and *not* as scientifically grounded education. For more reading about this topic, see Ogden (2008).

misguided programs cause aversion and reluctance towards crossing 'the gap' between education and neuroscience (Varma et al., 2008).

Advocates promoting educational neuroscience have met the skeptics' critique, but not by trying to defend the neuromyths. Instead they coincide with the pessimists and concur with their disinclination (ibid.). "The current gulf between neuroscience and education is being filled by packages and programmes claiming to be based on brain science. The speed with which such packages have gained widespread currency in school is astonishing" Goswami (2006) note, before stating that "these neuromyths need to be eliminated" (p.3). Critique towards misguided learning industry is distinct – not only from the skeptic camp, but also from the optimists. The shared critique notwithstanding; it appears that the skeptics censure towards neuromyths and the brain-based learning industry contribute to reluctance to the *entire* discipline of educational neuroscience.

In itself this explanation as regards neuromyths is a sufficient justification for some of the reluctance – neuromyths and misguided learning industry are, by and large, perceived as highly unfavorable for education. However, this account seems to leave more questions unanswered than what it actually tries to counter. A more critical approach seeks further inquiry: The reluctance towards educational neuroscience can be viewed as one *consequence* of neuromyths, but what are the *sources* of these myths? What triggered the brain-based teaching industry in the first place? How did these misguided programs become so popular amongst teachers, and why do these myths hold so much power in the educational neuroscience discourse? Goswami (2006) have elaborated on the problems concerning neuromyths, and claims that the success of brain-based industries first of all lies in the general request for 'scientific facts' and pleas for 'what works'. The problem, however

> is that neuroscientist may not be those best placed to communicate with teachers in any sustained way … Most teachers prefer broad brush messages with a 'big picture', and being 'told what works'. Neuroscientist are not necessarily gifted at communication with society at large, and they are appropriately cautious about saying that something 'works'(p.6).

With their alluring teaching-programs, the 'brain-based' learning industry consequently became an "answer" to the common requisite for 'the best' teaching program (ibid.). Not only do these misguided enthusiasts claim to connect cognitive neuroscience with education; they also promote comprehensible teaching programs ready to be applied in every classrooms (Howard-Jones, 2007). The influence and power such promises hold are not difficult to imagine. Not only can the misguided learning-industry seem to hold power due to its alluring

remedies for ‘perfect’ teaching practices; it can also appear that these promises strengthen and extend the neuromyths roothold amongst educationists (Goswami, 2006).

Varma and his colleagues (2008) support Goswamis argument, but do additionally note that the very *existence* of neuromyths tells us something important: People are fascinated by the brain and how knowledge of the brain can aid better teaching and learning. Had there not been any interest in the first place, brain-based learning industries would probably never have gained such power. There is an inclination to take cognitive neuroscientific findings into consideration amongst teachers, this plea should be taken into consideration (ibid.). What is important, however, is that one should prevent misguided enthusiasts to make profit on teachers’ interest by promoting invalid brain-based programs (OECD, 2007b).

> It may be of most use to society if we as scientists foster and support a network of communicators of our research – individuals who can bridge the current gulf between neuroscience and education by providing high-quality knowledge in a digestible form ... [I]t might, ultimately, be of most value to society if we empower our own middlemen, communicators who know who to consult for expert advice on the latest claims of the brain-based learning industry, and who are clearly working in the public interest and not for profit. A network of such communicators would serve us all (and our children), and would prevent society from pouring precious educational resources into scientifically spurious applications (Goswami, 2006 p.7).

Advocates in educational neuroscience thus seek to solve the problems of neuromyths by offering a transdisciplinary academic field with trustworthy middlemen. Not only can this collaborating field of educational neuroscience contribute to eliminate misguided assumptions; the discipline can also replace these myths with more scientific and legitimate contributions connecting education and neuroscience.

Educational de-professionalization

Educational neuroscience is by some educational academics viewed as a possible threat to the educational discipline and profession. Seeing that this new transdisciplinary field connects cognitive neuroscience with educational practice, it has been claimed that the collaboration will become a top-down relationship – neuroscience looming on top, whilst education takes a negligible role (Varma et al., 2008). Consequently this has created a general concern that neuroscientists will end up with all control, cannibalize the educational field, and de-professionalize educational academics. These concerns can again indicate apprehensions related to reductionism. Considering that every discipline strives to maintain their academic position, reluctance towards educational neuroscience is understandable enough if this discipline is perceived correlated with de-professionalization.

The counter-argument being uttered amongst the optimists, however, is that this assumption of asymmetry is incorrect. One of the foremost goals of educational neuroscience is to initiate a two-way collaboration where neuroscience informs education *in unison* as education informs neuroscience (Geake & Cooper, 2003; Fischer et al., 2007; Howard-Jones, 2007).

> [A] cognitive neuroscience-education nexus should be a two-way street … Whereas cognitive neuroscience could inform education by providing additional evidence that confirms good practice, helps resolve educational dilemmas, or suggests new possibilities in pedagogy or curriculum design, education could inform cognitive neuroscience by providing a source of complementary behavioural data, especially on children, as well as posing new worthwhile lines of investigation (Geake, 2005 p.12).

Educational neuroscience therefore endeavors to bridge 'the gap' between the disciplines by creating a two-way alliance. In doing so, they attempt to construct a partnership where neither of the two cannibalize the other profession. Whether educational neuroscience manages to prevent an educational de-professionalization or not, is another inquiry. The success of this commission relies, in part, upon both fields willingness to equivalent collaborations.

Vertical and horizontal problems

Other aspects which can be labelled under 'the peripheral gap' are vertical and horizontal problems. These two aspects are mentioned by Willingham (2009), and can be seen to encompass what Varma and colleagues (2008) call differences in method, data, and theories. The argument being raised by the camp of reluctant sceptics is that these differences create an unbridgeable gap between education and neuroscience. First of all is the *method* used in the two disciplines profoundly different, as neuroscientific methods do not take consideration to contextual and cultural factors important for education (ibid.). Willingham (2009) refers to the differences in method as 'the vertical problem', pointing out how this different 'levels of analysis' creates problems linking education and neuroscience.

> The information that education researcher most often try to import from neuroscience concerns a single cognitive process in isolation, but the interactions with other systems will be part of the educational context (ibid. p.545).

Secondly; differences in methods also result in differences in *data*. The problem is that sterile neuroscience laboratory studies provide data connecting aspects of cognition to different brain networks, but *how* can these data inform education. "[K]nowing the location of an elementary cognitive function tells us nothing about how to design instruction for teaching that function, just as knowing where the alternator resides in an engine tells us nothing about how to teach driving" (Varma et al., 2008 p.142). The third problem which can be a cause to the reluctance

found amongst some educational academics is the differences in *theories*. Varma and his colleagues (2008) note how a discipline's theories contribute to a certain way to talk, categorize, and make meaning to its field of study.

> Every science evolves an appropriate vocabulary that supports meaningful generalizations within the domain of study while avoiding irrelevant distinctions. The vocabulary of education supports the description of learning as it occurs inside and outside classrooms. Neuroscience is a lower level science than education, and its vocabulary is therefore too microscopic to support useful generalizations for education (ibid. p.142).

Consequently difference in theory creates a vocabulary-gap between education and neuroscience. This problem is by Willingham (2009) defined as the 'horizontal problem', as it creates translation-problems between the two fields. The focal point is that this theoretical gap initiates *reductionism*, as it tries to reduce one field of study to the other (Choudhury et al., 2009).

Differences related to method, data and theory engender problems and consequently source reluctance towards educational neuroscience. How then, do the optimistic advocates try to bridge this gap? In their article, Varma and his colleagues (2008) attempt crossing the division by turning each of the issues into opportunities. First, where the sceptics argue that neuroscientific *methods* are of no use in education, optimists beg to differ. "Innovative designs can allow neuroscience to study the effects of variables of interest to education, such as context" (ibid., p.144). Blakemore, Winston, and Firth (2004) concur:

> 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 ... neuroimaging studies have provided some encouraging examples (p.216).

Instead of discharging new methods in the study of education, optimists try to look at the *possibilities* these new tools can provide. Even if most educational academics do not hold the knowledge on how to best apply these new tools, an educational neuroscientific collaboration can aid employing these methods so as to generate profitable educational research (Varma et al., 2008). Secondly, when it comes to differences in *data* the optimist use similar argument, claiming that "neuroscience data suggest different analysis of cognition and may therefore imply new kinds of instructional theories" (ibid. p.144). Instead of using a direct link from neuroscientific findings to educational theory and practice, optimists call for new kinds of theories *combining* these two fields (Howard-Jones, 2011). The third problem regarding differences in macro- and micro theories and how this create reductionism, is opposed by

claiming that "reductionism is a unifying principle of science: The macroscopic terms of coarse-grain science are coordinated with the microscopic term of fine-grain science. This is the time-honored process by which the sciences are stitched together ... What is problematic is *eliminative reductionism* "(Varma et al., 2008 p.145). Reductionism itself is not the problem; problems only arise if neuroscientific explanations *replace* behavioural explanations (Choudhury et al., 2009). Educational neuroscience averts this by avoiding direct links from neuroscience to educational practice and theory. Instead it is stressed, again and again, that educational neuroscience is a reciprocal collaboration. Neuroscientific findings do not replace education, instead cognitive neuroscience function as a supplementary ground which can anchor and enrich educational explanations.

> Biology provides a good example of how to maintain levels of analysis with a reductionist paradigm. It makes a corridor of explanations from molecular biology all the way up to ecology and zoology. Explanations at lower levels are consistent with those at higher levels but do not replace them. Rather, their relationships are complementary and supplementary ... One can imagine an analogous corridor of explanations from neuroscience to education (Varma et al., 2008 p.145).

'Vertical' and 'horizontal' differences, together with the problems as regards neuromyths and the assumption of an educational de-professionalization, can explain some of the reluctance educational neuroscience has met. These aspects can furthermore be viewed as components creating a peripheral gap between the disciplines of education and neuroscience. What is interesting when analysing this peripheral gap is that many of these problems indicate, as we have seen, a general aversion to *reductionism*. Censure of neuromyths, de-professionalization, differences in theory, data, and method – they all encompass troubled visions where education fall, in one way or the other, under neuroscientific instruct. If one links this reluctance to censure previously aimed towards positivistic approaches in education, another echelon of reluctance appears to be uncovered: History of positivism in education do not only witness of an approach where social studies were reduced by forcing them to subject to natural scientific methods and philosophies (Choudhury et al., 2009). The positivistic approach also endeavoured to uncover objective truths, gave theory precedence over practice, and interfered with well established boundaries between social and natural science (Telhaug & Mediås, 2003). As such, positivism was committed of the crime of reductionism and the approach became condemned under the label 'errors of instrumentalism' (ibid.). Whilst the years have elapsed, negative connotations linked to educational reductionism and positivism have not ceased to exist. Considering that the discipline of educational neuroscience can, at least on the

first note, bear resemblance with positivistic endeavours, sceptic aversion is more understandable.

Even if one can draw parallels between positivist approaches and the discipline of educational neuroscience, claiming that educational neuroscience commits to the same errors of reductionism as the positivists did in the 50s and 60s, is decidedly debatable. Previous positivistic attempts give the impression to fall into the commitment of two major errors: First, on has the error of allocating theory a supremacy over practice. Secondly, one has the danger of reductionism by forcing educational theories and practice into a position lined directly under natural scientific theories (Goswami, 2006). Favouring theory over practice and applying direct submissions from cognitive theories to educational practice can, indeed, appear to be the case with neuromyths and misguided brain-based learning industry (ibid.). It will, however, be an over-generalisation to assign such offences also to the discipline of educational neuroscience. If one examines the aims and goals of educational neuroscience, it becomes evident that this discipline not only *condemns* neuromyths' direct links, educational neuroscience also attempts to *prevent* reductionism by stressing the importance of reciprocal collaboration. As OECD (2007b) concluded in their project on educational neuroscience:

> Recent advances in neuroscience have produced powerful insight while educational research has accumulated a substantial knowledge base. A neuroscientific perspective adds a new, important dimension to the study of learning in education, and educational knowledge could help direct neuroscience research towards more relevant areas ... A new trans-disciplinarity is needed which brings the different communities and perspective together. This needs it to be a reciprocal relationship ... Educational neuroscience can help to drive the creation of a real learning science (p.12f).

Moreover; when educational neuroscience is met with reluctance due to problem caused by dissimilarities in theories, methods and philosophies, cautious optimists do *not* oppose to these dissimilarities. On the contrary; instead of *contradict* their sceptic opponents by rejecting differences between the discipline of educational and neuroscience, advocates of educational neuroscience *concede* to this 'gap' (Howard-Jones, 2007). Not merely do they acknowledge 'the gap'; advocates in educational neuroscience aim to accentuate these differences. To prevent too hasty drawn and erroneous mistakes the 'divides' and dissimilarities separating the fields are instead elaborated on (Varma et al, 2008).

> [T]eachers need to become 'neuroscience literate'; and, by the same token, cognitive neuroscientists need to become 'education literate' in order for strong links to be forged between fields ...We content that this can be achieved by moving beyond thinking about the direct application of neuroscience research results to classroom practice towards thinking about the constrains that need to be set in place in order to bring

> educators and neuroscientist together to collaborate and inform each other's thinking and practice. It will be important to communicate the potential and promise of such indirect links to policy makers, funding agencies, and universities (Ansari et al., 2011 p.41).

By emphasising dissimilarities between the two disciplines, it looks like advocates of educational neuroscience evade the errors of reductionism. Not only can awareness of disciplinary dissimilarities craft reciprocated collaboration; awareness of dissimilarities also underlines the importance of taking a cautious approach so as to sufficiently bridge the gap between the two academic fields.

This chapter has, insofar, examined what I have chosen to label 'the peripheral gap', since problems allocated here are suggestive of 'obvious' problems related to 'the gap' between the discipline of *education* and *cognitive neuroscience*. A review of educational neuroscience could stop here; a *critical* discourse analysis however, takes the analysis further. The question which follows is thus; are these aspects mentioned above the *source* of the reluctance, or is there something concealed underneath the surface? Is the 'gap-problem' between education and neuroscience merely a strain and a consequence of a more profound conflict?

The underlying gap

A crucial aim for critical discourse analysis is to illuminate how intern discursive structures are related to the web of extern interdiscursive connections (Jäger & Maier, 2009). An elaboration on interdiscursive relations in the discourse of educational neuroscience is thus apposite. In addition to this analysis on interdiscursive relations, I will here also argue that these connections create an 'underlying gap' which can be seen as an additionally source to the profound reluctance which occasionally is voiced as regards the discipline of educational neuroscience. My argument goes as follows:

Numerous authors have pointed to the 'obvious fact' that education can be classified as a social science whilst neuroscience is a natural science (Geake & Cooper, 2003; Varma et al, 2008). If one consents upon the link between education and social science and between neuroscience and natural science, I will allege that an additional account can be made. This account can be linked to Foucault's idea of 'orders of discourse', and Faircloughs (1992) elaborated term 'interdiscourse'. The focal point in both concepts is that discourses are *connected* (ibid.). This accordingly implies that educational neuroscience can be seen entangled with other related discourses. Seeing its transdisciplinary position, one can

therefore argue that educational neuroscience is profoundly connected to a *social* science discourse on one side and a *natural* science discourse on the other.

Foucault and Fairclough take the concept of 'orders of discourse' further, and argue that discourses entangled in one another can *affect* one another. This implies that the way one think, talk, and operate in one discourse, can impinge on how people in a connected discourse perceive, represent, and act upon this world (Fairclough, 1992). "What applies for boundaries between subject positions and associated discursive conventions applies generally for elements of orders of discourse. It applies also for boundaries between distinct orders of discourse" (ibid. p.69). Accordingly this indicates that different positions, ideologies, and boundaries in the discourse of *social* science will influence the educational discourse, whilst the discourse of *natural* science conversely will affect neuroscience. What is interesting is that educational neuroscience is a transdisciplinary field and consequently tries to *cross* these boundaries. As previously stated it is precisely this 'bridging of the gap', the crossings of discoursive boundaries, which creates debate – a debate which chiefly has evolved around problems linked to the crossing of 'the peripheral gap' between education and neuroscience.

Following this, I will make my crucial point; Foucault and Fairclough claim that a discourse connected to another will be influenced of this discourse's structures (Fairclough, 1992). Seeing the strong links between educational neuroscience and social science on one hand and natural science on the other, this must therefore imply that *different positions, ideologies, boundaries, and conflicts found in the discourse of educational neuroscience have connections to similar aspects between natural and social science.* In other words; the 'peripheral gap' located between education and neuroscience can be seen connected to 'the gap' located between social science and natural science. Struggles and conflicts uttered in the long-established dispute between natural and social science can thus be expected to seep through to the educational neuroscience discourse and inflict structures of this debate. If this assumption is correct, it must therefore be of most significance to consider and review conflicts between natural and social science, if on fully wants to comprehend underlying and deeply embedded structures in the educational neuroscience debate.

Before I elaborate on the dissidence between natural and social science, two additional reminders must be made. First of all it must be noted that Foucault talks about an *order* of discourses (Foucault, 1970). Considering that education and neuroscience are minor disciplines extracted from more profound academic fields of respectively social and natural

science, the hierarchic positioning is distinctive. The ‘gap’ between social and natural science can therefore be seen as ‘an underlying gap’ which the peripheral educational neuroscience gap is founded on. What is important to stress, is that these two ‘gaps’ do not imply two *separated* gaps which both lies between the educational and the neuroscientific fields of study. It is the same ‘gap’ I am referring to, albeit viewed at different *levels* of analysis. The ‘peripheral gap’ could thus be understood as a gulf viewed at a discursive analytic level, whilst the ‘underlying gap’ is an *inter*discursive gulf. The reason why I have chosen to represent these problems using illustration of ‘a gap’ is due to the eminent ‘gap-metaphor’ already used in the discourse of educational neuroscience. I thus spin further on this illustration, drawing interdiscoursive connections to extensive contexts.

What secondly is important to note is that by using the label ‘underlying’, I suggest precisely that – there is reason to assume that this gap often is imperceptible. This notion is built upon another central point in Foucauldian discourse theory – the relationship between discourse, knowledge, and power. “Discourses”, Jäger and Maier (2009) state, “exercise power in a society because they institutionalize and regulate ways of talking, thinking and acting” (p.35). These discoursive structures which shape consciousness and reality are furthermore not always apparent for individuals (Jørgensen & Phillips, 1999). What this implies is that interdiscoursive connections between the structure of educational neuroscience and those of social and natural science, not necessarily are obvious to its advocates. The links are, on the other hand, what Foucault calls abstract and underlying structures which “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). The illustration of an ‘underlying gap’ found between social and natural science thus serve its purpose, as it insinuate *underlying* conflicts which to a certain extent influence the educational neuroscience debate. Nonetheless, this does not essentially mean that individuals are entirely unaware these underlying conflicts. All the same; the topic is not frequently addressed.

The conflict between natural and social science

Critical discourse analysis aims to elucidate underlying and imperceptible discursive and interdiscursive structures concealed from the discourse’s own inhabitants (Jørgensen & Phillips, 1999). Thus far my approach to the discourse of educational neuroscience has tried to make some of these structures more apparent – for instance the interdiscursive relationship

between the peripheral educational neuroscience gap and the more profound gap between natural and social science. However, merely claiming that such a link exists does not provide any *explanations* for reluctance aimed towards educational neuroscience. If one wants to elaborate further as regards ideologies in the educational neuroscience debate, a more throughout review of the conflicts between natural and social science is required. An examination of interdiscoursive connections between educational neuroscience and natural and social science, led me to become aware of one eminent conflict – the dissidence between nature and nurture. This nature-nurture conflict goes far back in the history of natural and social science, but do nevertheless persist creating prominent debates in academia (Choudhury et al, 2009). The next section will thus try to critically review the dispute between natural and social science, between nature and nurture, with the aim to elucidate the depth of the 'gap' and reluctance connected to it.

The division between natural and social science is an ancient gap and has been the origin to numerous conflicts throughout the history of science. Newtonian physics bickered with Aristotelian physics (Campbell, 2011), Darwin's neuroscientific account opposed to Boas sociological view (Degler, 1991), realism contests constructivism (Choudhury et al., 2009), materialistic perspective conflicts idealistic (Campbell, 2011), and the individual brain is seen as opposed to the collective mind (ibid; Immordino-Yang, 2011). Different names notwithstanding, these conflicts can be seen as to evolve around the same profound divide – a divide which in brief, and simplistically explained, can appear extracted from different answers given to the question 'what cause individual differences'? On one side of the conflict the answer is *nature* – the camp which allocates biological factors a deterministic role in the shaping of human behaviour and physical traits. On the other side, however, the answer is *nurture* – the camp which claims that individual change, behavioural qualities, and physical differences are caused by social and environmental factors (Johnston, 2007). These different camps have insofar held profound different philosophies as regards ontological and epistemological questions, and have consequently created a vast gap stretching through the scenery of science – dividing the field of natural science from the field of social science. Encompassing a range of different problems, this profound nature-nurture gap is too vast to fully investigate in this thesis. I will however, try to elaborate on one aspect in this conflict – that is the dispute between biological factors and societal environments as a cause for individual change; an aspect which also is highly relevant for the educational neuroscience discourse.

History of science evinces a repetition as regards the notion of taking biological factors into consideration in social science. What further can be noted is that biological explanation chiefly has met reluctance in social academic fields (Bergesen, 2004). As to explicate this tendency in the overall scientific discourse, I will here draw upon theories to Carl N. Degler. In his book '*In search of human nature; the decline and revival of Darwinism in American Social Thought*' (1991), Degler reviews the history of 'social thought' and how this is embedded in social science[28]. One of his focal point is that 'nurture' has gained power over 'nature' in social science as the years have elapsed. According to Degler, biological aspects was questioned already in 1900 and the emphasis was instead "placed upon the role of social environment in bringing about physical and other changes" (p.66). This is also in accordance to C.P. Snow (1959; 1963). "As a cultural anxiety, concern about the divide between the 'two cultures'[29] essentially dates from the nineteenth century, and the modern form of this anxiety would have been barley intelligible in earlier periods" (p.ix). In the years which followed the reliance upon historical factors and cultural influence increased, whilst internal and biological explanations for human behaviour became less prominent. Alfred Kroeber, a prominent sociologist at the time, even proclaimed the necessity of a total separation between social science and biology (Degler, 1991). Later, in 1950, Durkheim the 'father of sociology' exclaimed that "the determining cause of a social fact should be sought among the social facts preceding it and not among the states of individual consciousness" (Durkheim in Varma et al, 2008 p.143). Twenty years later, the Norwegian sociologist Hans Skjervheim criticised the previous positivistic reliance upon technical rationality in social science, claiming that using natural scientific methods in human studies was an 'error of instrumentalism' (Telhaug & Mediås, 2003). Even recently, the prominent sociologist Griswold (1994) stated that "biology or our own nature gives little direction to our lives, so we have to develop our own guideline, and we do so in the course of our interactions with one another" (Griswold in Bergesen, 2004). The prominence of nurture in social thought is clear. The question, however, is *why* this profound change occurred? Why have numerous academics in social science so

[28] It must be noted that Degler write from an American point of view. Aspects of his theory on 'social thought' can therefore to some extent differ from the history of 'social thought' in for instance Europe.

[29] When Snow (1959; 1963) talks about 'the two cultures' he refers to "Literary intellectuals at one pole – at the other scientist" (p:4). These two cultures are what we today call humanities and sciences (Collini in Snow 1959; 1963). Education as a social science, one can argue, do not fit in any of these 'two cultures' but can instead be categorizes as 'a third culture'. Snows elaboration on the "gulf of mutual incomprehension" can, nevertheless, readily be linked to the gap between natural and social science, and thus function as a demonstration on the discourses profound conflicts. As Collini note: "At the heart of the concept of the 'two cultures' is a claim about academic disciplines ... the divide between two sorts of intellectual enquiry" (ibid. p:xliii).

reluctantly taken biological research into consideration, and why did this 'gap' between natural science and social science emerge in the first place?

"The triumph of culture across the spectrum of the social science", as Degler (1991) calls it, was due to an increased societal call for democracy, the ideology of equality, and the belief in self-determination (p.187ff)[30]. From the early 1900 and through the century which followed, these egalitarian ideas had particular strong influences on the society at large – an egalitarian ideology which the history of racism, the holocaust, and the Great Depression strengthened (ibid.). As a consequence, biological theories drawn on *genetic* explanations were perceived a 'threat' to these ideas.

> [O]ne of the prominent objections to eugenics was that people did not want to believe in the importance of heredity on the ground that it is a pessimistic and fatalistic doctrine ... [T]he environmental explanation was preferable, whenever justified by the data, because it was more optimistic, holding out the hope of improvement (ibid. p.188).

Genetic accounts challenged ideals of societal equality and 'deprived' humans the possibility of self-effort as to create changes in their lives. As a result, by the 1930's leading social scientist disclaimed biological and hereditarian explanations in favour for environmental and cultural aspects as a cause for individual change (ibid.). This 'gap' between nature and nurture has accordingly influenced the sociological discourse ever since. Bergesen (2004) elaborates upon this, stating that the hypothesis of 'society as the latest origin of mind' has been profoundly canonical eminent in sociological theory[31].

> From Mead and Cooley to the present, sociological theory endlessly repeats the hypothesis of a lack of significant cognitive structure before socialization ... Humans are not born social; we have to be socialized. We have to learn what it means to be human. Which particular aspect of society performs this work varies by preference of theorist: Durkheim emphasized totemic rites; G.H. Mead, symbolic interaction; Talcott Parsons, primary socialization through family; Bourdieu, habituated social behaviours; Gramsci, worldviews, Althusser, the ideological state apparatus, Foucault, bodies of institutionalized knowledge; and so forth. What is in the mind is what society has put there (ibid. p.397).

Drawing on Foucauldian discourse theory, one can claim that these sociological theories consequently has shaped, and been shaped by, the way one think and act in the social science

[30] Here it can be note that Norway has eminent and strong-held traditions of equality and social democracy. Question thus intriguing to ask, is if this will imply more profound reluctance towards biology in Norwegian social science? Is this why the debate on educational neuroscience is missing amongst educational academics in Norway? And can this also be linked to the strong reluctance one can find amongst Norwegian educational academics as regards 'evidence based' teaching and practice? I will leave these questions to linger, since this master thesis does not hold enough pages so as elaborate.

[31] The 'triumph of culture' from the mid 20th century can also contribute to explain why socio-constructivist learning theories (e.g. that of Vygotsky) have managed to maintain such a significant position in education.

discourse (Neumann, 2001). Neumann further states that "when a representation is moderately unchallenged in a discourse, it exist a state of hegemony. As any other situation, this hegemony has to be maintained by discoursive work; that is production of statements and practices which constantly confirm these representations" (p.178 [my translation]). The repeated acceptance of the representation of 'society as the latest origin of mind' can thus be seen as holding profound hegemonic power in the sociological discourse. However, the power of hegemony is not necessarily everlasting.

One can argue that the 'nurture over nature' hegemony in the sociological discourse has, once again, started to waver. There are numerous reasons behind this claim. One can first of all argue, as previously mentioned, that new technologies has unlocked the box of the mysterious brain and in this wake new cognitive models of the mind has been crafted. Secondly one can find a general inclination in both politics and in the society at large, towards more scientific findings and research (Ansari et al., 2011). Popular-science books are mounting and scientific article is recited in media. Even international organisations with significant political influence such as OECD, empathises the importance of taking scientific studies into consideration in more sociological fields such as education (OECD, 2007b). Thirdly; there is not only in politics and in general societal concerns one can witness this inclination; similar tendency to take more consideration to nature and biology is also to be found in academia (Ansari et al, 2011). As a result, debate has arisen and critiques have been aimed towards the deep-rooted sociological 'thought of mind'. Bergesen (2004) ends his articles by stating that "the Durkheimian theory of the social origin of mind has little empirical support and suggests that the sociology of mental life needs to be radically retheorized" (p.395); whilst Johnston (2007) close his article by stating that recent gene-studies "require us to re-think long-standing ideas about constancy and variability in behavior and to re-evaluate the idea of 'nature' as something fixed and unalterable" (p.126). Numerous academics concur to these critiques, and authors such as DiMaggio (1997), Cerulo (2009), and Choudhury and colleagues (2009) question the sociological favour of nurture in the 'thought of mind'. What is more, and what is highly relevant for this thesis, is the *conclusion* all these authors craft. Even if they criticize the strong hold nurture has over the sociological academic field, they do *not* oppose this nurture-hegemony by calling forth an equal powerful nature-hegemony which can conquest the supremacy. Instead, all these authors argue for 'a bridging of the gap' between nature and nurture, between biological explanations and environmental explanations, and between

natural science and social science (DiMaggio, 1997; Bergesen, 2004; Johnston, 2007; Cerulo, 2009; Choudhury et al., 2009).

> One way to avoid thinking of culture as inscribed in the brain, but to acknowledge social and cultural context, is to break down the dichotomy between nature and culture ... and to incorporate findings about cortical plasticity to view the brain as in constant interaction with culture and consider how 'meaning and mechanism' intersect via the brain (Choudhury et al., 2009 p.71).

The resemblance to the educational neuroscience debate is prominent. Resemblance to educational neuroscience is not only prominent, it also underlines the assumptions I have made earlier – different positions, ideologies, boundaries, and conflicts found in the discourse of educational neuroscience have connections to similar aspects between natural and social science. The 'peripheral gap' located between education and neuroscience can thus be seen as connected to the more profound 'gap' between social and natural science – both discourses holding a shared and deep-rooted reluctance towards biological explanations (Degler, 1991; Immordino-Yang, 2011). As to illustrate this connection between the educational-neuroscience 'gap' and the underlying gap between natural and social science, I will here allude to the concept of 'deterministic roofs'. It is usually pessimistic sceptics who have voiced such critics, claiming that cognitive neuroscientific studies are highly unfavourable since they determine what students can or cannot do. These critiques towards 'the destiny of biology' have mainly been voiced as regards neuroscientific studies on ADHA, dyslexia and dyscalculia (Howard-Jones, 2007).

> The existence of differences in brain structure or function between different groups of learners may inspire insight and contribute to more effective learning programmes and inventions. However, it can also lead to unhelpful notions of permanent deficits and of ceilings to performance that are biological determined ... [This] demonstrate how easily biological knowledge becomes incorrectly and unhelpfully associated with deterministic ideas (ibid. p.21).

Vohs and Schooler (2008) show to similar trends in academia, noting how new neuro-scientific findings have caused assumptions of an scientific denial of 'free will' (Vohs and Schooler in Choudhury et al., 2009 p.63). Advocates for educational neuroscience beg to differ, biology is *not* destiny (ibid.; Howard-Jones, 2007). On the contrary; new cognitive neuroscientific findings stresses the importance social factors has in the shaping of the individual mind (Choudhury, 2009; Ferrari, 2011). By stating this, the gap between

environment and biology, between education and neuroscience, and between sociology and natural science is attempted crossed.

> Evidence from social and affective neuroscience is shedding new light on the neural underpinnings of ... social processing, affective responses and their relation to learning. These new discoveries link body and mind, self and other ... They dissolve traditional boundaries between nature and nurture in development (Immordino-Yang, 2011 p.98).

As we have seen, the disagreement between biology and sociology is not a new one – the conflict between nature and nurture demonstrate as much. This debate rooted in the natural and social science discourse can further be linked to the discourse of educational neuroscience. Interdiscoursive connections hold not only the same 'gap'; one has lately seen parallel upheavals at both levels – upheavals which, to some extent, abide similar positions, ideologies, and arguments. Old boundaries are questioned and voices 'to bridge the gap' can be heard both in the underlying science-discourse and the discourse of educational neuroscience. Considering the rising inclination in academia to, once again, 'bridge the gap', it is therefore of interesting to note that these bridging-projects are ventured by attempting to craft reciprocal collaborations between the different fields. On that note, and as Snow already argued back in 1959;

> All the arrows point the same way. Closing the gap between our cultures is a necessity in the most abstract intellectual sense, as well as in the most practical. When those two senses have grown apart, then no society is going to be able to think with wisdom (Snow, 1959 p.50).

6. Discoursive change and scientific revolutions

Thus far we have seen that the aim of educational neuroscience is to build a two-way collaboration between cognitive neuroscience on one side and education on the other. This link has met profound reluctance amongst some sceptics due to the disciplines' dissimilarities. Reluctance being uttered can further be related to 'a peripheral gap' between neuroscience and education and 'an underlying gap' between natural and social science. The discourse of educational neuroscience thus witness of a complex entanglement of structures, connections, and conflicts. What is more, these discoursive and interdiscoursive aspects can further be allied with another prominent discoursive element – the element of *change*. This chapter will elaborate upon the aspect of change found in educational neuroscience by drawing on Norman Faircloughs (1992) theories on discourse and social change, and Thomas Kuhns (1962) theories on scientific revolutions.

Hegemony, power and discoursive dominance

A discourse is, according to Foucauldian theories, embedded with power-relations where different discoursive positions strive to attain hegemony, making their representation *the* representation of the world (Jäger & Maier, 2009). Discoursive power can further be linked with states of hegemony and dominant representations. "Discoursive power plays a crucial role in defining and maintaining certain representation within a given discourse" (ibid.). This ability to define which knowledge is valid at any given time is, according to Neumann (2001), the most significant prospect of power since it defines what is perceived as true and normal. These dominant representations and ideologies will furthermore shape out the discourse's boundaries (Fairclough, 1992). Kuhn (1962) entitles these boundaries 'rules', and notes how these 'established viewpoints' or 'preconceptions' "limit both the nature of acceptable solutions and the steps by which they are to be obtained" (p.38).

On this note, numerous authors in the literature of critical discourse analysis have argued as regard the extent of determinism discoursive power executes over individuals. Althusser see people as passive subjects deprived of possibilities to ideological resistance and action (Jørgensen & Philips, 1999). Foucault (1970; 1972) and Fairclough (1992) on the other hand, and numerous authors with them (Jørgensen & Philips, 1999; Neumann, 2001; Jäger & Maier, 2009), take another approach, claiming that one *can* oppose to powerful discoursive hegemonies, ideologies and representations. "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 stabile, but changing and unfinished" (Jørgensen & Philips, 1999 p.88 [my translation]). Resistance is possible – so is discoursive change. Given this to be true, how can discoursive resistance and change be linked to the discourse educational neuroscience?

Analysing educational neuroscience by drawing on these critical discourse theories, aids elucidating certain aspects. What first can be noted is the hegemonic position 'the social thought' seems to have held in sociological discourses over the last century. Degler (1991) demonstrated this 'triumph of sociology', and notes how nurture has obtained supremacy over nature in sociology from the 1930s and onwards. Similar, Bergesen (2004) evinces how this 'nurture' supremacy has influenced sociological and educational theories from Meads theory of symbolic interaction to Bourdieus concept of habitus. What this sociological hegemony secondly implies is that 'the social thought' has held a significant amount of *power* within the

discourse of social science – a power which subsequently has enabled this hegemonic position to define and maintain specific ideologies, representations, knowledge and boundaries. Given what have been stated thus far, it is reason to assume that these ideologies and boundaries has been defined and drawn in favour of nurture over nature. This corresponds with the reluctance one can find towards biological explanations in sociology in general, and towards cognitive neuroscience in education in specific. With regard to this, one can therefore argue that the sociological thought thus far has held a profound hegemonic power, shaping and maintaining discoursive boundaries within social science. How then, does educational neuroscience fit into this picture, and how can this be linked to discoursive change?

Discoursive change

”It takes profound discoursive work to maintain things the way they are. To make the world appear as stabile when it actually is in constant change implies that the possessing of power involves the capability to freeze meaning” (Neumann, 2001 p.143). Subsequently, this entails that discoursive dominance can cease to exist; hegemonic power can falter and change can occur. In his book ‘*Discourse and social change*’, Fairclough (1992) elaborates upon the timid line which easily can transfer hegemonic domination to discoursive change. One of the crucial factors which can tip the scale in one or the other direction – either towards continuance of hegemony or in favor of discoursive alteration – is voices of *disagreement* uttered against discoursive boundaries. “The immediate origins and motivations of change in the discoursive event lie in the problematization of conventions … Such problematizations have their bases in contradictions” (ibid. p.96). Fairclough elaborates further, and also clarify in more detail what discoursive change involves;

> 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 discoursive 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 (ibid. p.96f).

In other words; linking different discourses and crossing boundaries can create change. Further, changes in one discourse can affect other discourses. The interdiscoursive aspect is prominent in the process of change. Critical discourse analysis even stresses this by claiming that “high levels of interdiscoursive connections coincide with change, while few

interdiscoursive connections indicate reproduction of status quo" (Jørgensen & Phillips, 1999 p.94). How do this relate to educational neuroscience?

Interdiscoursive tangles in the discourse of educational neuroscience are eminent, and the problematization of discoursive boundaries even more so. Not only is the boundaries between education and neuroscience attempted crossed, also the more profound gap between social science and natural science – between nurture and nature – is questioned. Ansari, Coch and Smedt (2011) concluded their latest article exclaiming that "traditional academic boundaries need to be crossed and mutual respect developed" (p;41), Choudhury and colleagues (2009) state that we have to "break down the dichotomy between nature and culture" (p.71), whilst Immordino-Yang (2011) claims that new findings already have started to "dissolve traditional boundaries between nature and nurture in development" (p.98). Their message is clear; old ideologies and boundaries must be challenged. The advocators for educational neuroscience do indeed call for change.

Requests for change uttered amongst cautious optimists, corresponds with Hirschmans theories on personal discoursive strategies (Neumann, 2001). According to Hirschmans theory, advocates holding a 'cautious optimism' appear to possess a course of action labeled 'voice', as they oppose to their discourse's hegemonic representation and its boundaries. An expansion of this term, 'des-identification', can additionally seem to fit (ibid.). This term stresses that individuals voicing their opposition to the discourse additionally creates something *new*. In this case, this 'creating of something new', can be seen to be the discipline of educational neuroscience itself. Educational neuroscience can thus be perceived as an *effect* of discoursive and interdiscursive struggles, just as it can be seen as an *arena* of conflict.

Scientific revolution

Fairclough (1992) states that problematization of discoursive boundaries often generates discoursive change. However, Fairclough do not give considerably notion to the factors which usually *generate* this problematization in the first place. Kuhn (1962), on the other hand, elaborates upon this and states that "technology has often played a vital role in the emergence of new sciences" (p.16). Not only does innovative technology allow us to approach certain scientific aspects in different ways; they can conversely offer new methods, theories, and readjust knowledge. Old representations and ideologies held by the paradigm are therefore

likely to be challenge (ibid.). Drawing on notable scientific events in history, Kuhn (1962) elaborates as he demonstrates which factors are essential in scientific revolutions;

> …these display what all scientific revolutions are about. Each of them necessitated the community's rejection of one time-honored scientific theory in favor of another incompatible with it. Each produced a consequent shift in the problems available for scientific scrutiny and in the standards by which the profession determined what should count as an admissible problem or as a legitimate problem-solution. And each transformed the scientific imagination in ways that we shall ultimately need to describe as a transformation of the world within which scientific work was done. Such changes, together with the controversies that almost always accompany them, are the defining characteristics of scientific revolutions (p.6).

Looking at the discourse of educational neuroscience, new technologies have played a vital role in its formation. fMRI, for instance, has made it possible to allocate structures and functions of the brain previously unknown for man. New scientific observable facts of the brain have further resulted in adjustments of old cognitive models of the mind. These alterations have affected well-acknowledged educational theories. In some circumstances, these alterations have even led to outcomes where old cognitive theories no longer correspond with new neuroscientific findings. (Howard-Jones, 2007). Consequently questions arise and profound academic debates are generated. This have, in turn, lead to the fusion of two scientific fields as a mean to find more adequate theories which can solve the questions the old educational theories now fail to answer.

This domino reaction contains numerous of the factors mentioned in Kuhns (1962) chain of a scientific revolution – new technologies, rejection of old theories in favor of new and 'better' ones, and a shift in how the scientific field understands it boundaries. However, to define educational neuroscience as a 'scientific revolution' per se is a statement I will not craft in this thesis. This paper do neither hold the scope to adequately argue for such a statement, nor do I think one rightfully can call any event 'a scientific revolution' (in Kuhns standard, at least) at such an early stage as the discipline of educational neuroscience now holds. As Kuhn (1962) himself states as regards scientific revolutions: "[it] is seldom completed by a single man and never overnight" (p.7). Nonetheless; claiming that this discipline possesses a significant position in what can *become* a scientific revolution, or even calling it a *revolutionary discipline*, are statements more readily defendable.

Educational neurosciences' position as a revolutionary discipline has not slipped past the attention to numerous academic authors. Immordino-Yang (2011) notes that "the past decade

has seen major advances in cognitive, affective and social neuroscience that have the potential to revolutionize educational theories about learning" (p.98), whilst Ansari, Coch and DeSmedt (2011) frequently refer to educational neuroscience as a "revolution in education" (p.38). Kelly (2011) uses similar words, as she concludes:

> [W]e are beginning to see ... the basis for a revolution in theorizing about learning that designs and refines its measures, guides its hypotheses, informs its analyses and grounds its conclusions using data from cognitive neuroscience studies. I expect that current, apparently incommensurate, theories or general descriptions about learning will be decided more and more on the basis of this growing empirical record. Theories are never abandoned easily, of course, but the disambiguation of claims at the hypothesis testing level using cognitive neuroscience data is likely to place upward pressure on theories, which are too often contingent descriptions of learning with little specification of mechanism or grounding in the larger set of findings in science (p. 20).

Critical discourse theories do state that problematization of discoursive boundaries and ideologies, is the first step towards discoursive change (Fairclough, 1992). Kuhn's (1962) theory on scientific revolutions also concurs with this, and additionally shapes out the structure of scientific revolutions. However, the event of *change* is one thing – the event of *scientific revolution* another. Changes are certainly taking place in the field of education due to commence of the novel discipline of educational neuroscience. How profound these changes will be, if it can be labelled a 'scientific revolution', and which consequences this academic upheaval eventually will bring forth, are questions yet to be answered.

7. The illusion of 'a gap'

A critical analysis of the educational neuroscience discourse could have ended with what thus far have been examined: I have reviewed the core and aim of educational neuroscience, mapped out the different discoursive positions which can be allocated in the debate, and critically analysed discursive and interdiscoursive aspects such as hegemonic power, ideologies, conflicts, and discoursive change. All this are features of a discoursive structure which, to some extent, often remains imperceptible for subjects in a discourse and which, accordingly, are attempted illuminated by critical discourse analysis. As Fairclough evinces; "The point is to make visible through analysis, and to criticize, connections between properties of text and social processes and relations (ideologies, power relations) which are generally not obvious to people who produce and interpret those text, and whose effectiveness depend upon this opacity" (Fairclough in Neumann, 2001 p.97). Drawing on this, I have endeavored to clarify the discourse and the dilemmas of educational neuroscience. Constraints

as regards a master thesis scope and page-limitation imply that I ought to stop here; I am afraid I will not. There is another feature in the discourse of educational neuroscience which recently has caught my attention; a feature which can be suggestive of yet another imperceptible facet in the discourse. I cannot avert myself to accentuate this, and will thus continue with my analysis for just a few more pages.

Talk of *'the gap'* and building of *'a bridge'* are prominent facets in the discourse of educational neuroscience. Already in 1997 Bruer, with his renowned article '*Education and the brain: a bridge too far'*, inspired this metaphor by claiming that educational neuroscience would fail in the task to connect education and neuroscience as it was "a bridge too far". Ansari and Coch titled their article "Bridges over troubled waters" (2006), Varma and his colleagues (2008) look at the methodical, theoretical, and philosophical problems connected to 'the gap', and numerous authors who hold a cautious optimism argue for 'a two-way collaboration to bridge the gap between education and neuroscience'(Geake, 2005; Goswami, 2006; Campbell, 2011; Howard-Jones, 2011). The illustration of 'a gap' is, furthermore, not restricted to the debate on educational neuroscience alone. Literature pertaining to natural and social science reveal a similar metaphor, similar boundaries, and analogous bridging problems (Degler, 1991; Choudhury et al, 2009; Immordino-Yang, 2011). Accordingly, I am inclined to deem that the linguistic *metaphor* of 'a gap' in educational neuroscience can be an effect of interdiscoursive links to the similar metaphor of 'a division' between natural and social science. This assumption is again drawing on Fairclough (1992) and his theory on inter-discoursive relations, as structures in one discourse often affect discourses connected to it.

Metaphors are not uncommon in discourses. On the contrary, metaphors are often used as to illustrate abstract problems and phenomena – an aid, of sort, to paint a picture of a fairly incomprehensible world. By painting representations with common and spatial metaphors, phenomenon becomes more vivid and comprehensible (Neumann, 2001). The problem, however, is that metaphors are not neutral. By representing the world with the use of metaphors, subjects in a discourse conversely have to abide and obey to them. "By choosing a set of metaphors as to illustrate certain phenomena, one re-present the phenomenon in a certain way" Neumann (2001) states, before continuing noting that "language is a facet of re-presentation as it cannot be without meaning; language will, however, structure what is said, for instance by using the power embedded in metaphors" (p.41 [my translation]). Language creates discourses and discoursive boundaries, but discourses also *create* the language

(Jørgesen & Phillips, 1999). Language and discourses are thus embedded in one another; both holding a prominent notion of power as they structure what is and can be said.

The relation between power and language in a discourse is intriguing, but *individuals* ought to be considered in this relationship too. Individuals do not necessarily take a passive role in this relationship, as people are well capable to intentionally *use* linguistic power as a means to an end (ibid.). In his theory on power, Steven Luke (1974) argues that one can identify three different power-relations. The most radical power-appliance is, in accordance to him, the one where 'A' exerts power over 'B' without 'B' being aware of it (Luke in Neumann, 2001). Conscious use of language as to structure discoursive representations and 'a truth', can witness of such a three-dimensional power exertion. I am, however, in doubt that the use of a gap-metaphor in the educational neuroscience discourse is done *consciously* by any group as to wield power. In fact, I am more of a mind to deem the metaphor of 'a gap' in educational neuroscience as a *four-dimensional* power exertion. A four-dimensional power exertion is a concept postulated by Foucault, and can be seen as an extension of Lukes three-dimensional power model. In his theory, Foucault does not contradict the three different power-dimensions identified by Luke. He takes nonetheless a different approach. Where Luke claims that 'A' can exert power over an unknowing 'B', Foucault argues that sometimes not even 'A' is aware of the structural bias its action is a part of (Foucault, in Neumann, 2001). "The order of things appears as normal and consequently remains relatively unchallenged for both 'A' and 'B'. This normality affects the structure of action" (ibid. p.168). What this implies is that people sometime can abide by an 'imperceptible power' – a power, that is, which is manifested and embedded in the discourse. There is neither a man nor a group of people who hold this supremacy; instead it is *in* the discourse itself. Discourses can, therefore, exert power over its individuals as it makes certain things appear as true and beyond all doubt, even if this is not necessarily so. These discoursive power-executions can furthermore impinge language, which again can affect the way people think, act and talk (Jørgesen & Phillips, 1999).

What I insinuate, is that the metaphor of 'a gap' can be suggestive of what Foucault entitles a 'four-dimensional power exertion'. People in the discourse can thus be likely to use this linguistic gap-metaphor unconsciously, as it appears to be a part of an accepted and unquestioned 'order of things' (cf. Foucault, 1972).To strengthen my premise I will, once

again, confer on critical discourse analysis – this time on the note concerning *repetition of statements*. As Jäger and Maier (2009) affirm;

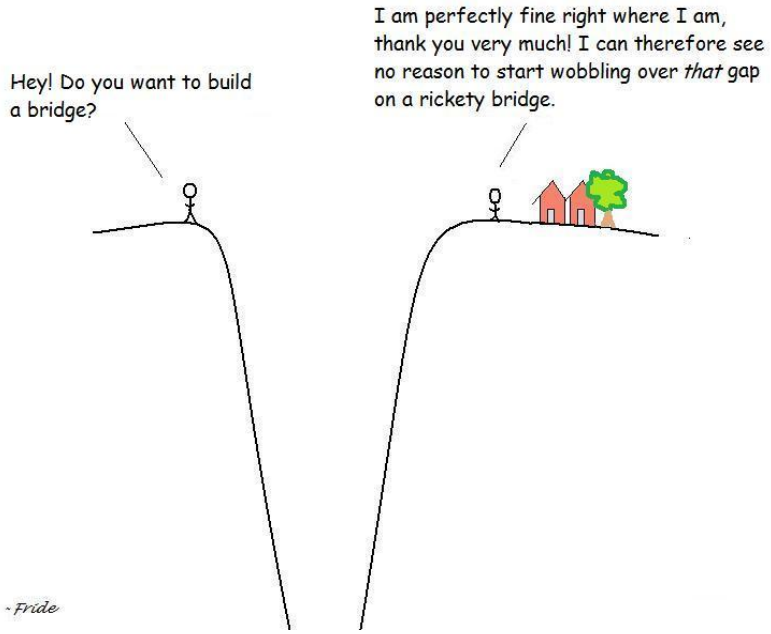
> [A] discourse, with its recurring contents, symbols and strategies, leads to the emergence and solidification of 'knowledge' and therefore has sustained effects. What is important is not the single text ... but the constant repetition of statements (p.38).

The continuous repetition of 'a gap' – both between education and neuroscience, and between natural and social science – are in this respect of significant note. According to both Snow (1959) and Degler (1991), this 'division' can be noted as far back as in the late 19th and early 20th century, when natural and social science started being perceived as opposites. The gap-metaphor has, henceforth, frequently been exploited. This continuous echo of 'a gap' can therefore indicate a deep-rooted linguistic structure which not only have been profoundly manifested in our discourses, the gap-metaphor also affect the way individuals in the discourse think, talk, and act (Jäger & Maier, 2009).

As to demonstrate, and as to substantiate my impending point, let us briefly look back in history when the world 'was' flat. This statement might craft some opponents – certainly the world was not *flat*. I beg to differ, claiming that for some cultures in the year 3000-1000 BC the world was indeed as flat as an ant just stepped on by elephants. The model of the Earth as a plane disk was for these ancient cultures an unquestionable and universal truth. How these cultures thought, acted, and talked was consequently structured in accordance to this representation. Why would it not? The sky was blue, oranges were round, and the Earth was *flat*. As long as individuals continued to perceive, talk, and act in accordance, these discoursive and linguistic structures were reinforced and the idea of the flat Earth maintained valid. A representation of a flat-planed Earth did not in itself craft any major problems; people thus continued with their lives, happily aware of the disk-shaped outline of the earth they were treading upon. Problems were, however, initiated when people started to question this model, claiming the Earth to be *spherical*. Statement of a spherical Earth did not affect everybody, though, as there certainly were those who could not have cared less if the world was shaped as a disc, a sphere, or like a squirrel for that matter. The same could not be said with regard to seafarers. For them the shape of the Earth was an essential matter – in fact, it was a matter of life and death. Insofar these seafarers had peacefully abided by 'the order of the world'; always making sure to keep an eye on the horizon as not to risk sailing over the edge of the Earth. A change of view thus crafted upheavals. Reluctance being uttered was probably not regarding the shape of the world itself; it was most likely due to the horrendous

prospect this new representation held. In one moment one lived in a flat world; in the next people started questioning 'the Earth' itself, hoisted their sails, and navigated straight into the infinite. Indubitably this created upheaval and reluctance. I cannot blame them; I would also be afraid falling over the brim of the world and into unknown vastness.

The same goes to the discourse of educational neuroscience. The repetitively *talk* of a gap *creates* a gap. Subsequently, and inevitably, one can locate reluctance to *cross* this vastness on a rigidity bridge – trip and you might risk falling into infinite unknowingness.



The point I am trying to make is that *there is no gap*. The metaphor of 'a gap' is precisely just that – it is an allegory, a representation, an illusion. The world itself does not hold any boundaries; neither does it hold any categorizations, labels, or gaps. Talk of categorical dissimilarities between natural and social science is only an old way to structure the world as to make it more comprehensible. When one constantly uses the metaphor of 'a gap' between, for instance, the discipline of education and neuroscience, this gap-illusion is reinforced. These linguistic and abstract *representations* are not pictures of the 'real world' itself. Moreover, when our language constantly keeps emphasizing a divide one will, as Foucauldian discourse theories imply, persist in thinking, acting, and structuring the world in accordance to this representation (Jørgensen & Phillips, 1999). As such, the linguistic gap-metaphor can be alleged to hold significant power. First of all does the metaphor of a gap 'structure action', as Foucault say. This linguistic notion of a 'divide' do secondly hold power as it, by and

large, is taken for granted as a natural order of the world. Thirdly, and following this, it can be noted that the gap-metaphor is relatively unchallenged[32]. Accordingly this entire state of affairs conveys the impression that individuals in the educational neuroscience discourse are affected by a four-dimensional power exertion – a power exertion which can, furthermore, be seen as interdiscoursive and linguistically linked with 'the division' between natural and social science. Boundaries, categorisation, and gaps are therefore suggestive of discoursive illusions which, unfortunately, generate restriction of thought. It can, in other and cruder words, appear that individuals are so profoundly caught in this discourse, that they have become victims of their own illusions.

By claiming that 'there is no gap', I do not claim that there are no dissimilarities between education and neuroscience; or between natural science and social science for that matter. Certainly there are dissimilarities between these academic topics; had there not been, there would not have been any 'disciplines' in the first place. One can find differences in theories, methods, and philosophies used by these different disciplines – almost every author in the educational neuroscience discourse concur on this point (Vama et al., 2008). Differences in method, theories, and philosophies notwithstanding; authors in the debate on educational neuroscience – regardless of their discoursive position – talk about a gap as if there actually *is* a clear division between education on one side and neuroscience on the other (or between natural and social science). The pessimistic sceptics claim that the differences are so profound that it is impossible to bridge the gap (ibid.). Misguided enthusiasts jump this gap in one eager leap, as they directly connect the two fields using 'brain-based learning programs'. Whilst optimist either take a hesitating position claiming one need to anchor the bridge using a middle ground such as cognitive psychology (Bruer, 1997), or by taking a more cautious approach calling forth a two-way collaboration as to bridge the gap (Howard-Jones, 2011). Regardless of their discoursive standpoint, numerous of these authors talk about a gap as if there actually is a gigantic gap dividing the scenery of science in two halves. This is, in my view, a severe fallacy as this illusory metaphor contributes to restrict how we think and act.

My statement might be severe. I do indeed believe it to be accurate, albeit, some justification might be apposite so that my proclamation does not fall victim of misapprehensions. My

[32] This correspond with Neumann (2001) assertion that metaphors of the spatial often remain unchallenged. This claim of a relatively unchallenged gap-metaphor does not mean that 'the gap' itself remain unchallenged – the debate on educational neuroscience evinces as much. The *metaphor* of a gap, on the other hand, is more apt to continue shaping out the way we think, talk, and act without us questioning it.

argument must, first of all, not be interpreted as if I deem *everyone* trapped in a linguistic supremacy, where neither thought nor action can elude metaphorical gaps. My statement should secondly not be read along the lines that I exclusively disincline the use of categorisations and metaphors. In fact, I do believe that exploiting categorizations and metaphors as an aid to comprehend the complex world can be a necessity. One should, however, be aware that language holds power as it can limit and confine how we think and act (Jørgensen & Phillips, 1999). As Foucault (1972) notes;

> We must also question those divisions or groupings with which we have become so familiar. Can one accept, as such, the distinction between the major types of discourse, or that between such forms or genres as science, literature, philosophy, religion, history, fiction, etc., and which tend to create certain great historical individualities? ... [T]hese divisions – whether our own, or those contemporary with the discourse under examination – are always themselves reflexive categories, principles of classification, normative rules, institutionalized types: they, in turn, are facts of discourse that deserve to be analysed beside others; of course, they also have complex relations with each other, but they are not intrinsic, autochthonous, and universally recognizable characteristics (p.24f).

Categorizations, labels, and gaps are not universally characteristics. Moreover, language and its metaphors hold power as they contribute to shape a discourse. This does not necessarily imply that we should *discard* the categorizations we insofar have used. We should, on the other hand, bear this in mind so that we do not get trapped in our own linguistic illusions.

> [N]eed we dispense for ever with '*œuvre*', the book, or even such unities as 'science' or 'literature'? Should we regard them as illusions, illegitimate constructions, or ill-acquired results? Should we never make use of them, even as a temporary support, and never provide them with a definition? What we must do, in fact, is to tear away from them their virtual self-evidence, and to free the problems that they pose; to recognize that they are not the tranquil locus on the basis of which other questions (concerning their structure, coherence, systematicity, transformations) may be posed, but that they themselves pose a whole cluster of questions (Foucault, 1972 p.28f).

What then, does all of this imply? If my assumption as regards discoursive and linguistic power relation bears strains of accuracy in it, my premise can abet elucidating the discourse of educational neuroscience at another level. The educational neuroscientific debate evolving around 'the problems of the gap' can thus not merely be seen as discoursive and interdiscoursive facets. The *linguistic metaphor* of a gap is, in itself, also entwined in this discoursive web. Not only can this be suggestive of an interdiscoursive and imperceptible illusion. The gap-metaphor do also exerts power as it contributes to shape out individuals' thoughts, knowledge, and acts. Different discoursive positions, ideologies, problematization

of boundaries, and the enterprise to 'bridge the gap' are therefore not the only discoursive aspects essential in the discourse of educational neuroscience. Language is also an imperative discoursive facet, as language is a powerful tool in shaping our thoughts.

> *Has not the practice of revolutionary discourse and scientific discourse over the past two hundred years freed you from this idea that words are wind, an external whisper, a beating of wings that one has difficulty in hearing in the serious matter of history?*
>
> Michel Foucault

8. A précis of the thesis with a note for the road ahead

Will educational neuroscience become "just another fad, a footnote in the history of the movement towards research-based education"? (Ansari et al., 2011 p.38). An answer to this question lies in the future, and only time can reveal the fate of educational neuroscience as a discipline. There are, however, some aspects which ought to be stressed in this final summary – a reminder, of sort, for the road ahead.

Over the last two decades we have witnessed significant accomplishment in the field of cognitive neuroscience, as new technologies have made it possible to scientifically observe structures and mechanism of the human brain. When long-hidden secrets on how the *brain* works are revealed, new understandings of *the mind* subsequently follow. These new cognitive theories do, furthermore, affect aspects relevant to education – aspects such as learning, thinking, and memorising (Howard-Jones, 2007). This alteration has accordingly, and inevitably, crafted a debate amongst educationists. Numerous academics claim that new findings of the brain should be taken into consideration in education – the majority of these optimists arguing for a transdisciplinary discipline labelled educational neuroscience (Varma et al, 2008). Others, on the other hand, are more reluctant. Not only do these sceptics censure misguided learning industries and their neuromyths; the sceptics are also reluctant to the very idea 'to cross the gap' between education and neuroscience. This gap, or rather, these gaps are assumed to lie between education and cognitive neuroscience, e.g. problems of theoretical, methodological, and philosophical nature (ibid.), between theory and practice (Stein & Fischer, 2011), and between the social and individual mind/brain (Howard-Jones, 2007)[33]. Furthermore, problems have also been pointed out as regards *reductionism*. When

[33] Some of these gaps can be seen as overlapping, interwoven, or even as interdiscursive relatives.

collaboration between two different spheres is entered into, there is always a possibility that one 'cannibalise' the other. Collaboration between education and neuroscience is no exception. Numerous educationists thus argue for a looming risk that education will fall under direct instructs from neuroscientists (Goswami, 2006).

The notion of 'a gap' – with the problems and possibilities a bridge might initiate – has become an eminent facet in the discourse of educational neuroscience. In this regard, it is also noteworthy that 'the gap-problems' also is suggestive of interdiscoursive links drawn to the 'division' between natural science and social science. This profound gap dividing 'the two cultures' has crafted conflicts for decades, and differences in methods, theories, and philosophies are frequently pointed out. The outcome connotes an opposition between the two sciences, as generally neither of the two acknowledge the importance of the other (Snow, 1959; Bergesen, 2004). Discoursive and interdiscoursive entanglements related to 'the gap' are of essential note considering that the very *core* of educational neuroscience is to 'bridge' this gulf (Campbell, 2011). What is striking, however, is that this gulf-metaphor seem impossible to elude. Snow (1959) and Degler (1991) note how the 'division' between the two cultures have been an eminent element in the scenery of science since the twentieth century. The continuously repetition of the same 'gap' in educational neuroscience, evinces the metaphors persistency. Drawing on critical discourse theories this enduring metaphor can, first of all, imply that the repeatedly statement of 'a gap' contribute to manifest a gap-representation in the discourse. Secondly, the profound representation of a gap can contribute to structure how individuals in the discourse think and act. As such, the powerful metaphor can convey the impression that this 'division' is perceived as a natural and unquestionable truth. But is this so? Does 'the gap' truly exist? There was no talk about such a division in science until the end of the Enlightenment (Snow, 1959). Can it thus be possible that we have overemphasised this division? Have we made the *abstract* metaphor of a gap become a *concrete* hindrance?

> The rigid divisions between disciplines, the lack of mutual comprehension, the misplaced feelings of superiority or disdain in different professional groups – these should be seen as *problems*, not fatalistically accepted as parts of the immutable order of things (Collini in Snow, 1959; 1963 p.lxi).

Virtues of illusions notwithstanding; the idiom of 'a gap' is eminent and it does hold power. Language represents the world; it makes certain facts become truths and it impinges how we think and act (Jørgensen & Phillips, 1999). What is important is that this metaphor and these categorisations do not become manifested as rigid truths as this can restrict our thoughts.

Claiming that a gap-metaphor might encumber how we think, does not imply that we ought to avoid such categories altogether. On the contrary; talk of 'a divide' between natural and social sciences is a way to make known the fields' dissimilarities[34]. In accordance to numerous academics, this acknowledgement is of highly importance. Regardless of authors' scholastic background or nationality – whether the message come from a teacher, a cognitive science researcher, or a renowned educational professor; even if the message come from international political organizations – the requests seem to be the same: To reject the discipline of educational neuroscience due to potential problems, will imply turning one's back on significant possibilities which can aid improving education. Nonetheless; these problems cannot readily be dismissed and awareness of disciplinary dissimilarities of theoretical, methodological, and philosophical nature are apposite (Varma et al., 2008). It therefore appears that a common inclination is *cautious optimism* towards the discipline of educational neuroscience.

Following this, and what is noteworthy in this respect, are the concluding messages to these cautious optimists. Two messages are particularly, and frequently, empathised. The first of these petitions is request for *reciprocated collaboration* between the discipline of education and the discipline of cognitive neuroscience. Educational neuroscience connects two academic spheres which for a long time have been seen as opposites. If this collaboration shall be proven successful, one sovereign cannot reduce the other under his power. What thus is needed is reciprocal partnership between the two. Equal partnership brings forth the second requisite; if one successfully wants to bridge 'the gap' and create reciprocated collaboration between education and neuroscience, one ought to *be aware disciplinary dissimilarities* (Varma et al, 2008; OECD, 2007b). *Lack* of knowledge as regards differences between education and neuroscience can contribute to craft, spread, or apply misguided classroom formulas based on neuromyths – recent occurrences in education do, unfortunately, witness of such inopportunes[35] (Goswami, 2006). To prevent too hasty drawn and erroneous mistakes these 'divides' thus ought to be elaborated on.

These requests are essential in themselves: awareness of disciplinary dissimilarities is important so that one successfully can achieve reciprocated collaboration between education

[34] These dissimilarities can also be seen as effects of discoursive structures manifested and sustained by language, since methods and theories are 'representations' themselves. I will, however, not draw my analysis too far along those lines, since one easily can get lost in epistemological socio-constructivisitc radicalism.
[35] I.e. inconveniences crafted by so called 'brain-based' learning industries.

and cognitive neuroscience. This endeavour can further prevent reductionism of education in favour of neuroscience, in addition to avoid misguided neuromyths in classroom practice. Furthermore, involvement in this venture is also crucial as to prevent educational reductionism under political and economical standards. Geake (2005) stresses this by asking; "If educationists refuse to become involved in the cognitive neuroscientific enterprise could they find themselves even further marginalised than some politicians and education bureaucrats seem intent on pushing them?" (p.11).

This is of importance, although I, as a Norwegian master student, cannot evade extract this message to another level: *Norwegian* educational values, traditions, and policies can also be reduced under *international* pressure. Prospects of international influence as regards educational neuroscience persuade are looming. Not only is the discipline relevant as regards eminent educational issues of theoretical, methodical, philosophical, and practical value; educational neuroscience is also of highly relevance to current political and societal concerns. Emphasis stressed by significant international organisations such as the OECD, also contribute to educational neuroscientific persuades (cf. Karlsen, 2006). I do not claim that Norwegian education is at danger for complete reduction. I do, however, point towards the luring probability of diminution – both as to neuroscientific instructs and to international educational and political standards. This can be unprofitable. I would therefore deem that it would be of most advantage if Norwegian educational academics – *regardless* of their standpoint towards this new discipline – get involved in the debate on educational neuroscience. Awareness, research, and participation in educational neuroscientific collaborations can emphasize national and educational traditions, values, and policies.This is crucial so that voices from Norwegian educationists do not get reduced to whispers in the international debate.

9. List of references

Ansari, D., & Coch, D. (2006). Bridges Over Troubled Waters: Education and Cognitive Neuroscience. *Trends in Cognitive Sciences, Vol.10* (4), 146-151.

Ansari, D., Coch, D., & DeSmedt, B. (2011). Connecting Education and Cognitive Neuroscience: Where Will the Journey Take Us? *Educational Philosophy and Theory; Special Issue: Educational Neuroscience.Vol.43* (No 1), 37-42.

Bergesen, A.J. (2004). Durkheim's Theory of Mental Categories: A Review of the Evidence. *Annual Review of Sociology, Vol 30,* 395-408.

Blakemore, S-J., Winston, J. & Firth, U. (2004). Social Cognitive Neuroscience: Where Are We Heading? *TRENDS in Cognitive Sciences. Vol.8* (5), 216-222.

Blakemore, S-J. & Firth, U. (2005). The Learning Brain: Lessons for Education: a Précis. *Developmental Science. Vol.8* (5) 459-471.

Bruer, J. T. (1997). Education and the brain: A Bridge Too Far. *Educational Researcher. Vol.26* (8), 4-16.

Bruer, J. T. (2006). Points of View: On the Implications of Neuroscience Research for Science Teaching and Learning: Are There Any? A Skeptical Theme and Variations: The Primacy of Psychology in the Science of Learning. *CBE – Life Science Education.. Vol.5*, 104-110.

Campbell, S.R. (2011). Educational Neuroscience: Motivations, Methodology, and Implications. *Educational Philosophy and Theory; Special Issue: Educational Neuroscience.Vol.43* (1), 7-16.

Cerulo, K.A. (2009) Minding the Intersection of Cognitive Sociology and Neuroscience. *Science Direct, Vol.38* 115-132.

Choudhury, S., Nagel, S.K. & Slaby, J. (2009) Critical Neuroscience: Linking Neuroscience and Society through Critical Practice. *BioSocieties. Vol. 4,* 61-77.

Degler, C.N. (1991). *In Search of Human Nature; The Decline and Revival of Darwinism in American Social Thought*. Oxford: Oxford University Press.

DiMaggio, P. (1997). Culture and Cognition. *Annual Review of Sociology. Vol. 23*, 263-287.

Fairclough, N. (1992). *Discourse and Social Change*. Cambridge: Polity Press.

Ferrari, M. (2011). What Can Neuroscience Bring to Education? *Educational Philosophy and Theory; Special Issue: Educational Neuroscience.Vol.43* (1), 31-36.

Fischer, K. W., Daniel, D., Immordino-Yang, M. H. et al. (2007). Why Mind, Brain, and Education? Why Now? *Mind, Brain, and Education. Vol 1* (1), 1-2.

Foucault, M. (2002). *The Order of Things.* London: Routledge. [Reprinted from the original English edition, 1970].

Foucault, M. (2002). *The Archaeology of Knowledge.* London: Routledge. [Reprinted from the original English edition, 1972].

Geake, J. & Cooper, P. (2003). Cognitive Neuroscience: Implications for Education? *Westminster Studies in Education, Vol. 26* (1), 7-20.

Geake, J. (2005). Educational Neuroscience and Neuroscientific Education: In Search of a Mutual Middle-Way. *Research Intelligence* (92) 10-13.

Geake, J. (2011). Position Statement on Motivations, Methodologies, and Practical Implications of Educational Neuroscience Research: fMRI Studies of the Neural Correlates of Creative Intelligence. *Educational Philosophy and Theory. Vol. 43* (1), 43-47.

Goswami, U. (2006). Neuroscience and Education: from Research to Practice? *Nature Reviews Neuroscience. Vol 7*, 406–413.

Howard-Jones, P. (ed.) (2007). *Neuroscience and Education: Issues and Opportunities. A Commentary by the Teaching and Learning Research Programme*. London: TLRP/EDRC.

Howard-Jones, P. A. (2011). A Multiperspective Approach to Neuroeducational Research. *Educational Philosophy and Theory; Special Issue: Educational Neuroscience.Vol.43* (1), 24-30.

Immordino-Yang, M.H. (2011). Implications of Affective and Social Neuroscience for Educational Theory. *Educational Philosophy and Theory; Special Issue: Educational Neuroscience.Vol.43* (1), 98-103.

Jäger, S. & Maier, F. (2009). Theoretical and Methodological Aspects of Foucauldian Critical Discourse Analysis and Dispositive Analysis. In Wodak, R. & Meyer, M. (ed.), *Methods of Critical Discourse Analysis*. London: Sage.

Johnston, T.D. (2007). The Role of Genes in Probabilistic Epigenesis: Rethinking the Nature of 'Nurture'. *European Journal of Developmental Science, Vol. 1* (1), 120-128.

Jong, T.D. Gog, T.van, Jenks, K. et al. (2009). *Explorations in Learning and The Brain.* New York: Springer Science.

Jørgensen, M. W. & Phillips, L. (1999). *Discourse Analysis as Theory and Method.* Frederiksberg; Roskilde Universitetsforlag. [Original Norwegian title: Diskursanalyse som teori og metode].

Karlsdottir, R. & Stefansson, T. (2005).The Constructivist Learning Process. In Sigmundson, H. & Bostad, F. (ed.), *Læring. Grunnbok i læring, teknologi og samfunn.* Oslo: Universitetsforlaget. [Original Norwegian title: Den konstruktivistiske læringsprosess].

Karlsen, G. (2006). Education, Government, and Market; Norwegian Educational Policy in an International Perspective Oslo: Universitetsforlaget. [Original Norwegian title: Utdanning, styring og marked; norsk udanningspolitikk i et internasjonalt perspektiv].

Kelly, A.E. (2011). Can Cognitive Neuroscience Ground a Science of Learning? *Educational Philosophy and Theory. Vol. 43* (1), 17-23.

Koizumi, H. (2011). Brain-Science Based Cohort Studies. *Educational Philosophy and Theory. Vol. 43* (1), 48-55.

Kuhn, T. (1962). *The Structure of Scientific Revolutions.* Chicago: The University of Chicago Press.

McCulloch, G. (2004). *Documentary Research. In education, History and the Social Sciences*.: London: Routledge.

Meld. St. 19 (2009-2010). *Time to Teach; a Conduct of Tidsbruksutvalget's Report* Oslo: Det kongelige kunnskapsdepartementet. [Original Norwegian title: Tid til læring; oppfølging av Tidsbrukutvalgets rapport].

Neumann, I. B. (2001). *Meaning, Materiality, Power; an Introduction in Discourse Analysis.* Bergen: Fagbokforlaget. [Original Norwegian title: Mening, materialitet, makt: en innføring i diskursanalyse].

OECD (2007a). *Evidence in Education: Linking Research and Policy*, Paris: OECD.

OECD (2007b). *Understanding the Brain: the Birth of a Learning Science*. Paris: OECD/CERI.

Ogden, T. (2008). Reluctance Towards Evidence in the Educational System. *Bedre Skole, Vol.4*, 75-79. [Original Norwegian title: Motvilje Mot Evidens i Utdanningssystemet].

Patten, K.E. & Campbell, S.R. (2011). Introduction: Educational Neuroscience. *Educational Philosophy and Theory; Special Issue: Educational Neuroscience.Vol.43* (1), 1-6.

Patten, K.E. (2011). The Somatic Appraisal Model of Affect: Paradigm for Educational Neuroscience and Neuropedagogy. *Educational Philosophy and Theory; Special Issue: Educational Neuroscience.Vol.43* (1), 87-97.

Petitto, L. A. & Dunbar, K. N. (2004). New Findings from Educational Neuroscience on Bilingual Brains, Scientific Brains, and the Educated Mind. *Conference on Building Usable Knowledge in Mind, Brain, & Education*. Harvard School of Education, 1-20.

Plomin, R., Kovas, Y. & Haworth, C.M.A. (2007). Generalist Genes: Genetic Links Between Brain, Mind, and Education. *Mind, Brain, and Education*. *Vol.1* (1), 11-19.

Schwartz, M. & Gerlach, J. (2011). The Birth of a Field and the Rebirth of the Laboratory School. *Educational Philosophy and Theory. Vol. 43* (1), 67-74.

Snow, C.P (2010). *The Two Cultures.* Cambridge: University Press [Reprinted from the original edition,1959; 1963].

Stein, Z. & Fischer, K.W. (2011). Directions for Mind, Brain, and Education; Methods, Models, and Morality. *Educational Philosophy and Theory. Vol. 43* (1), 56-66.

St. meld. nr. 11 (2008-2009). *The Teacher, the Role, and the Education.* Oslo: Det kongelige kunnskapsdepartementet. [Original Norwegian title: Læreren, Rollen og Utdanningen].

Telhaug, A.O. & Mediås, O.A. (2003). *Compulsory School as National Contractor; from State-Pietism to Neo-Liberalism.* Oslo: Abstrakt forlag as. [Original Norwegian title: Grunnskolen som nasjonsbygger. Fra statspietisme til nyliberalisme].

Toews, J. E. (2004). Linguistic Turn and Discourse Analysis in History. In *International Encyclopedia of the Social and Behavioral Sciences*, p:8916-8922.

Utdanningsforbundets (2008) *Evidence and Consequences of the Evidence Debate for the Educational System.* Temanotat 6/2008. Oslo: Utdanningsforbundet. [Original Norwegian title: *Evidens og evidensdebattens betydning for utdanningssystemet.*].

Varma S., McCandliss, B., & Schwartz, D. (2008). Scientific and Pragmatic Challenges for Bridging Education and Neuroscience. *Educational Researcher. Vol. 37* (3), 140-152.

Willingham, D.T (2009). Three Problems in the Marriage of Neuroscience and Education. *Cortex; Science Direct. Vol 45*, 544-545.

Woolfolk, A. (2006). *Educational Psychology*. (2. edition) Trondheim: Tapir akademiske forlag. [Norwegian title: Pedagogisk psykologi].