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ATTACHMENT RELATIONSHIPS ACROSS PRESCHOOL TO SCHOOL AGE

Continuity, Self-Regulation, and Quantity of Childcare

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Abstract

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This thesis focuses on children's attachment representations across preschool to school age. By drawing on the screen-stratified sample from the Trondheim Early Secure Study (TESS, n = 997), we investigate *i*) the stability of secure attachment representations in children ages 4-6 (Study II), *ii*) the influence of such representations on the development of self-regulation (effortful control: Study I, and emotion regulation: Study II), and *iii*) the role of childcare in predicting change in attachment representations (Study III).

Focusing on moderators, we question whether a) gender interacts with attachment security in predicting effortful control in children ages 4-6 (in favor of boys); b) whether genetic reactivity (*5-HTTLPR*) moderates the effect of change in ages 4-6 attachment on change in ages 6-8 emotion regulation, and whether such moderation would resemble diathesis stress or differential susceptibility; and c) whether the dual risk of accumulated hours in childcare (ages 0-4) in combination with low parental sensitivity could decrease attachment security from ages 4-6.

Multi-informant (child, parent, day-care teacher, teacher, observer/coder) TESS data from wave I (T1), II (T2), and III (T3) is applied, at which time children were 4, 6, and 8 years of age, respectively. Among the measures are the observational Manchester Attachment Child Story Task (T1, T2), the Children's Behavior Questionnaire (T1, T2), the Emotion Regulation Checklist (T2, T3), and the observational Emotional Availability Scales (T1). Multiple regression models are run in SPSS and Mplus, and population estimates are calculated to generalize the findings.

The main results reveal that 1) secure attachment representations are modestly stable and girls displayed more secure representations than boys, and security normatively increased with age; 2) attachment security promotes self-regulation but not across the board: 2a) higher security predicts increased effortful control for only boys, and 2b) increased attachment security forecasts increased emotion regulation for all children, yet significantly more strongly for the presumably more reactive children (*5-HTTLPR* SS genotypes), a result in accordance with the differential

susceptibility hypothesis; and 3) the combination of high quantity of childcare and low-sensitive parental caregiving decreases attachment security.

By illuminating a less-studied developmental period and demonstrating *i*) the plastic nature of preschoolers' attachment representations, *ii*) the differential attachment effects on self-regulation, and *iii*) the cumulative risk of long hours in childcare and parental insensitivity in decreasing attachment security, this thesis extends contemporary attachment research. The findings may inform future practices and interventions for young children and their families.

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List of Studies/Papers

Study/Paper I

Viddal, K. R., Berg-Nielsen, T. S., Wan, M. W., Green, J., Hygen, B. W., & Wichstrøm, L. (2015). Secure attachment promotes the development of effortful control in boys. *Attachment & Human Development*, *17*, 319–335. doi:10.1080/14616734.2014.999098

Study/Paper II

Viddal, K. R., Berg-Nielsen, T. S., Belsky, J. & Wichstrøm, L. (2017). Change in Attachment Predicts Change in Emotion Regulation Particularly Among *5-HTTLPR* Short-Allele Homozygotes. *Developmental Psychology*, *53*, 1316-1329. doi.org/10.1037/dev0000321

Study/Paper III

Viddal, K. R., Wichstrøm, L., Skalickà, V., Berg-Nielsen, T. S., Solheim, E. & Belsky, J. Quantity of Childcare, Parental Sensitivity, and Development of Attachment Representations. *Submitted*.

Abbreviations

5-HTT	Serotonin transporter
5-HTTLPR	Serotonin-transporter-linked polymorphic region
(5-HTTLPR) L	Long allele
(5-HTTLPR) S	Short allele
A	Avoidant attachment
AAI	Adult Attachment Interview
ACC	Anterior cingulate cortex
ADHD	Attention Deficit/Hyperactivity Disorder
B	Secure attachment
C	Ambivalent attachment
CBQ	Children's Behavior Questionnaire
cGXE	Candidate Gene by Environment
CI	Confidence Interval
D	Disorganized attachment
E	Environment
Df	Degrees of Freedom
DNA	Deoxyribonucleic acid
EAS	Emotional Availability Scales
ERC	Emotion Regulation Checklist
GXE	Gene by Environment
ICC	Intra-Class Correlation
IWM	Internal Working Model
k	Kappa
M	Mean
MCAST	Manchester Child Attachment Story Task
NICHD ECCRN	National Institute of Child Health and Human Development Early Child Care Research Network

NICHD SECCYD	National Institute of Child Health and Human Development Study of Early Child Care and Youth Development
OMPFC	Orbito medial prefrontal cortex
OR	Odds Ratio
PCR	Polymerase chain reaction
PPVT	Peabody Picture Vocabulary Test
REK	Regional Committee for Medical and Health Research Ethics
SD	Standard Deviation
SDQ	Strengths and Difficulties Questionnaire
SE	Standard Error
SES	Socioeconomic status
SLC6A4	Serotonin transporter gene
SSP	Strange Situation Procedure
TESS	Trondheim Early Secure Study

The principal main effects are likely to be interactions

Urie Bronfenbrenner

1   INTRODUCTION

1.1   Current Context and Focus

Attachment theory is among the most researched theories in the field of psychology (Barbaro, Boutwell, Barnes, & Shackelford, 2017; Fearon, Groh, Bakermans-Kranenburg, van Ijzendoorn, & Roisman, 2016), and it has even been defined as a *fact* (Ezquerro, 2016, p. xxxvi). Sixty years after the introduction of attachment theory, it is generally accepted that children need caregivers who provide safety, comfort, and support. Attachment is now considered to be one of the main adaptive systems for fostering human resilience (Masten, 2014, p. 150), with implications for policy and practice that continue to progress and inform services, childcare, interventions, and legal decisions (Cassidy, Jones, & Shaver, 2013). These implications have been illustrated in an official Norwegian report (NOU 2012), in which better protection of children's development is discussed in light of research on attachment; the report cites the work of John Bowlby and Mary Ainsworth in particular. Here, an expert committee recommends that attachment bonds should be regarded as even more important than biological bonds, and the report highlights the role of attachment in the development of emotion regulation (NOU 2012, p. 22; 24).

By contrast, Elizabeth Meins (2017) has argued that attachment is the most overrated phenomenon in psychology. According to Meins, there is no strong evidence to support the role of attachment in development. In fact, Meins claimed that "secure attachment is wrongly being set up as a benchmark for all toddlers to attain" (Meins, 2017, p. 22), which is a perspective that she shares, to some extent, with Jerome Kagan (e.g., 2012; 2013), who has been rated one of the most renowned psychologists of the 20th century (Haggbloom et al., 2002). Thus, the alleged impact of attachment relationships continues to be debated within the research community (Madigan, Brumariu, Villani, Atkinson, & Lyons-Ruth, 2016).

In point of fact, even if attachment research is a mature discipline, several issues are still poorly understood, conflicting, or scarcely studied, hence attachment research cannot rest on its laurels (see e.g., Fearon et al., 2016; Waters, Petters, & Facompre, 2015). First of all, the predictive value of attachment appears to be less substantial than previously hypothesized (see Groh, Fearon, van Ijzendoorn, Bakermans-Kranenburg, & Roisman, 2017). Recent meta-analytic work (Fearon, Bakermans-Kranenburg, van Ijzendoorn, Lapsley, & Roisman, 2010; Groh et al., 2014; Groh, Narayan, et al., 2017; Groh, Roisman, van Ijzendoorn, Bakermans-

Kranenburg, & Fearon, 2012; Madigan et al., 2016) has demonstrated that the role of attachment varies across outcomes (e.g., internalizing problems versus social competence), that some classic attachment predictions do not hold true (e.g., resistant attachment is associated with neither internalizing nor externalizing behavior), and that evidence of the role of disorganization in psychopathology is inconclusive (Groh et al., 2012; Madigan et al., 2016; and see also Brumariu & Kerns, 2010).

Relatedly, the ever-increasing evidence that environmental effects may apply differently to different individuals, either in a diathesis-stress manner or in a "for better, for worse" manner known as differential susceptibility (see Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2007), has only been sparsely investigated in the context of attachment (as a proxy for the caregiving environment). In fact, moderational processes remain generally understudied in this field (Fearon & Belsky, 2016) and may thus lead to over- or underestimated effects across individuals. For example, attachment insecurity may be a stronger predictor of externalizing behavior among boys (Fearon et al., 2010). Crucially, the purported significance of attachment in the development of *self-regulation* may therefore be less straightforward than what often is communicated. On this basis, the possible *differential* attachment effects in the development of self-regulation is a focus of this thesis (**Studies I and II**).

Moreover, there remain concerns with how we can understand the role of attachment if attachment itself *changes* (e.g., Pinquart, Feussner, & Ahnert, 2013), and how such changes can be predicted. These are questions still to be answered (Fearon & Belsky, 2016; McConnell & Moss, 2011). Some evidence even points to predictors that were never part of attachment theory (e.g., gender[7] [Gloger-Tippelt & Kappler, 2016; George & Solomon, 2016]; genetics [Fearon, Shmueli-Goetz, Viding, Fonagy, & Plomin, 2014]). Additionally, whether *childcare* can influence attachment is a controversial idea that has recently been revitalized (see Cárcamo, Vermeer, van der Veer, & van Ijzendoorn, 2016; Hazen, Allen, Christopher, Umemura, & Jacobvitz, 2015; Umemura & Jacobvitz, 2014). However, childcare research has often addressed the context of the United States (see Howes & Spieker, 2016) and is typically limited to the very early years of infancy and toddlerhood. For this study, we investigated change in attachment per se (**Study II**) as well as the role of (Norwegian) childcare in predicting change in attachment beyond toddlerhood (**Study III**).

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[7] Please note that throughout this thesis, the term "gender" always refers to children's biological sex.

Finally, little is known about attachment development across the important *ecological transition*[8] from preschool to school, especially regarding attachment measured at the *representational level* (Stievenart, Roskam, Meunier, & Van de Moortele, 2014) including the issues of stability and change. For this reason, throughout our work, we discuss attachment at the level of mental representations and by focusing upon the shift from preschool to early school years (**Study I-III**).

1.1.1 Overarching Research Questions

Based on the issues presented above, the work reported herein aims to answer three main research questions:

I. **Are children's attachment representations characterized by stability or change during the transition from preschool to school age?**

II. **Does preschoolers' attachment security affect their developing capacity for self-regulation and do potential effects apply equally to all children?**

III. **Can childcare interfere with attachment development beyond the initial years of infancy and toddlerhood?**

In the introduction to follow, these research questions are integrated with a more general outline of the attachment framework and organized within three topics: a) attachment theory and methods, b) attachment and the development of self-regulation, and c) antecedents of attachment security with a focus on childcare. A historical timeline of a selection of the major publications that have informed this thesis is provided in Table A (see appendix).

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[8] Bronfenbrenner (1979) emphasized that developmental research should focus on stages in life that represent *ecological transitions* such as starting school. In Norway, children start school in the year they become 6 years of age.

1.2   Attachment Theory and Methods

1.2.1   Historical Background

I haven't attempted to deal with the universe—just certain fundamentals

John Bowlby

Although many scholars have contributed to our current understanding of close relationships (e.g., S. Freud, M. Klein, M. Mahler [see e.g., St. Clair, 1996]; S. Ferenczi [1995]; D. Winnicott [1971]; A. Green [see Kohon, 2005], J. Sandler [see Fonagy, Cooper, & Wallerstein, 1999], and D. Stern, [1985/2003]), attachment theory is the comprehensive intellectual work of Edward John Mostyn Bowlby (1907-1990), which originated first and foremost with the "Attachment and Loss" trilogy[9] (Bowlby, 1969/1982; 1973; 1980, see also 1951; 1958).

Among Bowlby's collaborators and sources of inspiration (e.g., J. Robertson, K. Lorenz, H. Harlow, and R. Hinde [see e.g., Ainsworth & Marvin, 1995]), Mary Dinsmore Salter Ainsworth (1913-1999) is considered the most important (Bretherton, 1992). Bowlby even shared with Ainsworth his groundbreaking 1958 paper entitled, "*the Nature of the Child's Tie to His Mother*," and attachment theory is also presented as the Bowlby-Ainsworth attachment theory (Ainsworth & Bowlby, 1991; Bretherton, 1992; Waters & Cummings, 2000). Ainsworth and colleagues' classic publication *"Patterns of Attachment. A Psychological Study of the Strange Situation"* (Ainsworth, Blehar, Waters, & Wall, 1978/2015) has now reached more than 20,000 citations (Google Scholar, 2017).

The roots of attachment theory can be traced back to the 1930s (Bretherton, 1992) during the interwar period and the postwar years of Second World War, which left about 400,000 U.K. children without their fathers and often separated from their mothers. It should therefore come as no surprise that loss and separation were cornerstones of the theory (Bretherton, 1992; Ezquerro, 2016). Attachment theory was also colored by Bowlby's personal experiences, such as the loss of his primary caregiver (the nursemaid Minnie) before the age of four, the distant relationship with his troubled father, the less distant relationship with his mother, and the negative experience of being sent to boarding school (see Ezquerro, 2016).

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[9] The trilogy was based on Bowlby's initial attachment papers, which were rejected by his co-members of the British Psychoanalytic Society (Ezquerro, 2016).

Bowlby aimed to understand children's normative responses to the (temporary) loss of the mother, as prospectively observed—or retrospectively inferred—from children and youths' behavior in hospitals and institutions. Bowlby emphasized that, in order for children to adapt, they must "experience a warm, intimate, and continuous relationship with their mothers (or permanent mother substitute) in which both find satisfaction and enjoyment" (Bowlby, 1969/1982, p. xi). Attachment theory thoroughly describes and explains this fundamental need and how threats to the attachment system can result in deviating personality development and psychopathology, which, ultimately, was what Bowlby had in mind: "The psychology and psychopathology is found to be in large part the psychology and psychopathology of affectional bonds" (Bowlby, 1980, p. 40).

Attachment theory was framed within psychoanalysis (Bowlby, 1969/1982 p. xv), particularly object relations (Bowlby, 1988; Bretherton, 1991), but the Bowlby-Ainsworth approach was highly eclectic; it involved, for example, evolutionary theory, ethology, and systems theory, in addition to cognitive, social, and personality psychology theory (Ainsworth & Bowlby, 1991; Bretherton, 1992; Cassidy, 1999). Today, attachment theory may be described as an evolutionary theory of social behavior (Simpson & Belsky, 2008), and the theory's interdisciplinary foundation can be recognized in the field of developmental psychopathology (see e.g., Cicchetti & Sroufe, 2013).

1.2.2 Central Theory and Concepts

"Attachment"[10] refers to a *behavioral system* and an *affectional bond* that gradually develop between the child and the caregiver (and later between adults) (Bowlby, 1980, p. 39; see also Bowlby, 1988). Whereas the bond only can be inferred, the behavior can be observed:

> Attachment behavior is conceived as any form of behavior that results in a person attaining or retaining proximity to some other differentiated and preferred individual, who is usually conceived as stronger and/or wiser. Whilst especially evident during early childhood, attachment behavior is held to characterize human beings from the cradle to the grave (Bowlby, 1979, p. 154).

The *instinctive behavior* of seeking proximity to a protective caregiver in times of distress is a genetic characteristic that promotes the survival of humans (Bakermans-Kranenburg & van

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[10] The etymology of this concept relates to the French "estachier/atachier," which means to connect (Ezquerro, 2016). Notably, Sigmund Freud discussed how the infant attaches itself to "the object": the mother's breast.

IJzendoorn, 2016) as well as nonhuman primates (Warfield, Kondo-Ikemura, & Waters, 2011). According to Bowlby (1969/1982), the *exploratory behavioral system* is the antithesis of the attachment behavioral system, and throughout one's lifetime, an individual operates within this dynamic of needing attachment as well as exploration. In adolescence, this dynamic is seen as the development of relatedness as well as autonomy (Oudekerk, Allen, Hessel, & Molloy, 2015).

From early on, a child is at the mercy of the *caregiver system* in terms of whether and how attachment needs are welcomed and supported. Bowlby (1958) highlighted the importance of the mother's acceptance of the attachment behaviors of clinging and following. More broadly, parents provide a *secure base* from which children can explore their surroundings as well as a *safe haven* in which the children can seek comfort and protection (Ainsworth, 1963; Ainsworth et al., 1978/2015).

The attachment behavioral system may be compared to the physiology of body temperature. Whenever the attachment system becomes activated, due to stress, fear, novelty etc., the child seeks proximity to the attachment figure to regain homeostasis (see Bowlby, 1980) with the goal of achieving *felt security* (Sroufe & Waters, 1977, p. 186). The latter point illustrates the crucial role of *emotions* in this theory. Not only are emotions involved in this homeostasis, but the strongest emotions one experiences typically occur within attachment relationships (Bowlby, 1969/1982; 1979).

1.2.2.1 Internal Working Models

Of importance to this thesis is the concept of *internal working models* (IWMs; Bowlby, 1969/1982). As detailed elsewhere (e.g., Bretherton, 1987; 1991), the pioneer of artificial intelligence, Craik (1943), suggested that organisms that can develop complex IWMs of their environment are able to predict the future, hence they can more flexibly adapt and, ultimately, *survive*. Bowlby came to know this concept via a biologist (Young) and, in line with its originator, Bowlby's use of IWMs was generic and not limited to attachment relationships (Bretherton & Munholland, 2016). However, it was the application of IWM as the child's *internalized representation* of the attachment relationship (Bowlby, 1973) that was elaborated (Ainsworth, 1990) and which is implied in the research herein.

In contrast to the classic psychoanalytical focus on projections and fantasies, Bowlby emphasized that children's *real* experiences with caregivers truly matter and that such experiences form IWMs that forecast the attachment figure's accessibility and responsiveness

(Bowlby, 1973). In this way, whether and how the attachment figure provides a safe haven and a secure base influence the future and inform the child of whether the caregiver typically is "available—occasionally, frequently, or most of the time*"* (Bowlby, 1973, p. 237). Some children become confident that their attachment figure is there for them, others less so, and this is essentially the intended measurement in attachment research: is the child's attachment a secure one?

Moreover, Bowlby believed that IWMs are crucial to the child's perceptions of self and others: "A much-loved child may grow up to be not only confident of his parents' affection but confident that everyone else will find him lovable too" (Bowlby, 1973, p. 238). The impact of felt security is thus rather crucial. Paradoxically, however, the issue of love and longing has been nearly neglected within this research field (Bretherton & Munholland, 2016), and IWMs remain one of the vaguer issues within attachment theory (Ainsworth, 1990; Waters, Ruiz, & Roisman, 2017), also due to its different interpretations (see Grossmann, 1999; Thompson, 2016a). Nevertheless, in order to extend attachment research beyond the very early years of childhood, a focus on IWMs became important (Fearon et al., 2016).

Interestingly, the issue of real experiences and mental representations resembles Stern's (1985/2003) concept of infants' *representations of interactions generalized*. Although such representations relate to very early sensomotoric recognition (e.g., how it feels to be held by the caregiver), they may be a precursor of the more sophisticated schemata of the relationship (see Bretherton, 1991, for a discussion).

It has been argued that attachment development can be recognized in particular brain networks (e.g., Schore, 2003a, 2003b). Because the brain is experience-dependent (Greenough, Black, & Wallace, 1987), such that "what fires together wires together"[11], patterns of attachment-related experiences should somehow leave neurobiological traces. Research using neuroimaging techniques has shed light on the mechanisms that *could* be involved in IWMs, and two structures of the prefrontal[12] cortex have been especially highlighted: The orbital medial prefrontal cortex (OMPFC) and the anterior cingulate cortex (ACC) (see Bretherton & Munholland, 2016 for a review). In short, the OMPFC is highly sensitive to face-to-face communication and eye contact; it organizes the "emotional brain" and matures from around 9 months of age (Schore, 2000; Schore, 2003b), which parallels

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[11] Known as Hebb's rule (Hebb, 1949)
[12] The ACC is often but not always regarded a part of the prefrontal cortex (Bretherton & Munholland, 2016).

Bowlby's attachment ontogenesis (see further below). The effects of early attachment disruptions on brain activity consistently implicate the OMPFC (see Galynker et al., 2012). Connected to the OMPFC is the ACC, which modulates autonomic activity and emotional responses and engages in effortful control mechanisms (Pessoa, 2009); the ACC is considered crucial to initiation, motivation, and goal-directed behaviors (Devinsky, Morrell, & Vogt, 1995). These are also the core features of IWMs (Bretherton & Munholland, 2016). For example, studies of the ACC have shown that positive and negative emotions monitor and guide individual strategies in social relationships, which again may relate to the role of emotional appraisal in IWMs (Bretherton & Munholland, 2016).

Based on Bretherton (1987), another branch of research has shown that IWMs may consist of a *secure base script,* which refers to the child's implicit knowledge of attachment related experiences in terms of generalized cognitive scripts (Waters & Waters, 2006), and an *autobiographical narrative*, which is the child's explicit memories of attachment-related episodes (see Waters, Ruiz, Roisman, 2017). It is noteworthy that Stern (1985/2003) added the "narrative self" to his revised model of children's self-development from the age of three, and children's narrative capacities are highlighted in identity research as well (e.g., Fivush & Zaman, 2015). Indeed, one's attachment history can be considered the co-construction of one's identity formation (Pittman, Keiley, Kerpelman, & Vaughn, 2011).

The present work is based on the understanding that attachment relationships become internalized and that these representations[13], at least to a certain extent, can be observed when the attachment system is evoked, as with doll play and story stem procedures (see e.g., George & Solomon, 2016; Robinson, 2007; Solomon & George, 2016) applied herein. An approach that can be conceptualized as *story completion play narrative* methods (Yuval-Adler & Oppenheim, 2014) (see also further below).

1.2.3 Attachment in the Preschool Years

Attachment theory is a lifespan theory (Bowlby, 1969/1982), but the characteristics of attachment behavior primarily develop from birth through the age of four. A thorough outline of the ontogenesis[14] of attachment is beyond the scope of this study, but, in short, Bowlby

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[13] This is not to say that older children "move from the level of behavior to the level of internal representations: They become able to process and manipulate plans and goals at that internal level and increasingly to control behavior with that internal processing. We must remember that the function of an IWM is to organize behavior in more flexible ways" (Marvin, Britner & Russell, 2016, p. 284).
[14] "The development of an individual organism or anatomical or behavioral feature from the earliest stage to maturity" (oxforddictionaries.com).

(1969/1982) argued that four[15] developmental phases can be observed. In the last stage, which parallels the research herein, IWMs become increasingly sophisticated:

I. *Pre-attachment* (from birth): characterized by orientation and signals with limited discrimination of persons.

II. *Attachment-in-the-making* (from 4-12 weeks): characterized by orientation and signals directed towards one (or more) discriminated persons.

III. *Clear-cut attachment* (from 6-7 months): characterized by maintenance of proximity to a discriminated person by means of locomotion as well as signals. From about 1.5 years of age, attachment becomes organized.

IV. *Goal-corrected partnership* (from 3-4 years).

Children gradually develop primitive cognitive maps of the attachment figure as an independent object (Bowlby, 1969/1982), and with increased mobility, communication skills, and a developing "mind," inhibition or delay of attachment behavior become possible (Cicchetti, Cummings, Greenberg & Marvin, 1990). During the preschool years, children can feel secure when the attachment figure is out of reach (Marvin, Britner & Russell, 2016), and between the age of 3 and 4 years, the onset of a simple theory of mind enables the child to understand some of the caregiver's own motivations and plans such that attachment turns into a *goal-corrected partnership* (Bowlby, 1969/1982). From then on, the child and parent negotiate their different needs and plans (see e.g., Ainsworth, 1989; Cicchetti et al., 1990), and even though the need for contact and proximity never vanishes, children realize that the attachment relationship continues independently of physical proximity (Marvin, et al., 2016). Based on strong affective-laden attachment memories, and with ever-growing cognitive capacities, the child's IWMs organize his or her behavior more flexibly (Marvin et al., 2016).

Despite these interesting changes in attachment development beyond toddlerhood, most socioemotional research has focused upon developmental tasks other than attachment (e.g., self-control, socialization) (Marvin et al., 2016). Historically, most attachment research has been conducted with infants or adults (Waters & Cummings, 2000), and like developmental research in general, the late preschool years and middle childhood years have been studied far less frequently (see e.g., Colle & Del Giudice, 2011; Mah & Ford-Jones,

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[15] Ainsworth (1989) suggested another major shift in development of attachment with the onset of adolescence (due to hormonal changes).

2012). This research neglect is particularly the case for attachment measured at the representational level (Stievenart, Roskam, Meunier, & van de Moortele, 2011).

By following a cohort from 4 years of age, the present work aims to extend existing knowledge on the presumed "final stage" of attachment development, the goal-corrected partnership. Notably, there is no gold standard for measuring IWMs in the current age group (Barone & Lionetti, 2012; Yuval-Adler & Oppenheim, 2014). Moreover, due to the high level of abstraction in the construction of IWMs, cognition and language may play a (confounding) role (Solomon & George, 2016; McElwain, Booth-LaForce, Lansford, Wu, & Justin Dyer, 2008; Stievenart et al., 2014). We therefore controlled for the children's language comprehension, which was the most relevant control variable available in our dataset.

Girls' more secure narratives?

Although few gender differences have been found at the level of attachment behavior (van Ijzendoorn, Schuengel, & Bakermans-Kranenburg, 1999), there is a recently increased awareness that gender may play a role in children's narratives of their attachment relationships. Given the role of gender in lifespan identity development, as well as the vast body of attachment research, it is surprising that gender has been given relatively limited attention[16]. Nevertheless, and as reviewed by Gloger-Tippelt & Kappler (2016), some gender differences have been indicated (see Bretherton & Page, 2004; Gloger-Tippelt & König, 2007; Granot & Mayseless, 2001; Pierrehumbert et al., 2009; Steele, Hodges, Kaniuk, Hillman, & Henderson, 2003; Toth, Lakatos & Gervai, 2013). Overall, compared to boys, girls' attachment narratives seem to be more secure, coherent, and organized than boys, even across different cultures (Pierrehumbert et al., 2009).

Thus far, we do not know whether girls develop more secure narratives because of, for example, the characteristic of mother-daughter conversations (and whether girls seek and prefer the more mentally and emotionally focused conversations with their mothers) (see Fivush & Zaman, 2015). Regardless of the mechanisms, we expected that children in our sample would follow the same pattern, such that girls would display higher attachment security scores. At any rate, because girls may express richer personal narratives (Fivush & Zaman, 2015), articulate more coherent narratives (von Klitzing, Kelsay, Emde, Robinson, &

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[16] An evolutionary model of attachment gender differences has been proposed, in which hormonally driven reorganization of attachment is suggested to take place during middle childhood (Del Giudice, 2008; 2009; Del Giudice & Belsky, 2010). However, we measured attachment no later than at age 6, and we did not explore the avoidant (A) and ambivalent (C) pattern, which is relevant for this model (see Del Giudice, 2008).

Schmitz, 2000), and even score higher than boys on security when using story stems (Gloger-Tippelt & Kappler, 2016), we thus controlled for gender[17].

1.2.4 Measuring Individual Differences in Attachment

With Ainsworth's sophisticated methodological work, including the thorough naturalistic observations of mother-child interactions in Uganda (Ainsworth, 1963; 1967) and the USA, which were validated in the laboratory with the Strange Situation Procedure (SSP; Ainsworth et al., 1978/2015), the focus on *individual differences* came to dominate attachment research (Marvin et al., 2016). This thesis is no exception. To investigate individual differences, we relied on the Manchester Child Attachment Story Task (MCAST; Goldwyn, Stanley, Smith, & Green, 2000; Green, Stanley, Smith, & Goldwyn, 2000), which was developed on the foundation of the gold standards[18] of attachment research: the SSP and the Adult Attachment Interview (AAI; George, Kaplan & Main, 1984; Main & Goldwyn, 1985–1994).

As thoroughly described by Ainsworth et al. (1978/2015), the SSP is a laboratory procedure that classifies children into organized and disorganized attachment: When the attachment system is activated and the child and parent are observed in a reunion situation, children with secure (B), insecure avoidant (A), and insecure resistant (C) attachment show organized strategies as to whether and how they use their caregiver to regain emotional homeostasis.

Securely attached children are typically calmed by the parent and can easily return to exploratory behavior. These children use their parent as a safe haven as well as a secure base, which is in contrast to insecure avoidant children who, despite physiological distress, continue to explore rather than seek their parent. The insecure ambivalent children do seek their parent, but the strategy is not efficient for regaining homeostasis, hence these children do not easily resume exploration.

In addition to these three patterns of behavior, some children display a more confusing pattern of behaviors that appear to be bizarre or contradictory. These children do not display an organized or predictable strategy towards the caregiver and are therefore considered to

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[17] Gender was not controlled in Study II (see also Section 4.5.6).

[18] Ainsworth herself emphasized *naturalistic* observations. The SSP was first and foremost a validation (see Waters & Cummings [2000] for a discussion). Clearly, attachment measures have caused significant debate. The AAI has been named the Adult *Semantic Coherence* Interview (Kagan, 2013, p. 110), and the validity of the SSP has been criticized from the viewpoint of cultural psychology (see Keller [2013], as well as by Bronfenbrenner [1977]). At any rate, attachment theory is not a theory about measures (see Waters, Bretherton & Vaughn [2015]).

have a disorganized (D) attachment relationship (Main & Solomon, 1986; 1990; see also Lyons-Ruth & Jacobvitz, 2016; Reisz, Duschinsky, & Siegel, 2017). Notably, though, some of these children show secondary patterns of organized behavior and are therefore classified as, for example, disorganized/avoidant (see Granqvist et al., 2017). In normative samples, the expected rate of B is greater than 55% (see e.g., Benoit, 2004) and about 15% for D (Zeanah, Berlin, & Boris, 2011). However, the rate of D varies with socioeconomic status (SES; van Ijzendoorn et al., 1999), and in clinical high-risk samples, the rate of D may even come close to 90% (Cicchetti, Rogosch, & Toth, 2006; van Ijzendoorn et al., 1999; Zeanah et al., 2011). Based on their meta-analysis, Cyr, Euser, Bakermans-Kranenburg, and van IJzendoorn (2010) concluded that the chance of not developing D is very low among maltreated children.

Whereas the SSP measures attachment at the behavior level, the AAI measures attachment at the level of representation (Main, Kaplan, & Cassidy, 1985). With a protocol of questions and follow-up probes, the AAI focuses on the adult's attachment-related memories (the autobiographical narratives as mentioned above [see also Waters et al., 2017]). The interview encourages the adult to choose five adjectives that describe his or her relationship with each parent, and the adult is asked to illustrate the chosen adjectives with memories and episodes. When coding the AAI, it is the *coherence* and *clarity* of the interview that are classified into attachment representations: Autonomous, Dismissing, Preoccupied, and Unresolved, which parallel those of the SSP: B, A, C, and D, respectively. As such, both children and adults typically display organized secure, organized insecure, or disorganized patterns of attachment behavior or representations (see Hesse, 2016 for a recent overview of the AAI).

The MCAST measures attachment at the level of representation (Green et al., 2000), and MCAST ratings of narrative coherence are modelled on the coding in the AAI (Green et al., 2008, p. 22). As one of several story completion play narrative methods, the MCAST builds on a rich tradition of methods applied in therapeutic settings with children, which can be traced back to pioneers such as Melanie Klein and Virginia Axline (see George & Solomon, 2016; Yuval-Adler, S., & Oppenheim, 2014). As outlined by Yuval-Adler and Oppenheim (2014), when drawing upon *story-completion techniques*, the child produces a *play narrative*, which, in the current work, refers to an attachment narrative (i.e., the representation of the relationship with the caregiver).

Similar to the SPP, the MCAST classifies children's attachments to the established categories (B, A, C, and D). It should be noted, however, that except for some post-hoc analyses of disorganized attachment (D) (Study II), this thesis focuses primarily on

attachment *security* (B). Given our low-risk community sample, the security score is descriptive for most children. However, we applied a continuous analytical approach to the ABCD categories by using information from all of the four attachment vignettes, including secondary classifications within vignettes. As such, we indirectly embrace the other categories that are associated with low security. The issue of categorical versus continuous approaches is highlighted below.

1.2.4.1 A Continuum of Felt Security?

Attachment has traditionally been viewed as categorically distributed, which implies that patterns of attachment behavior differ qualitatively between children. It should be noted that Ainsworth and colleagues argued that *subcategories* of attachment could prove very useful (Ainsworth et al., 1978/2015, p. 245, see also Ainsworth, 1990, p. 481) and that even new main categories of attachment behavior could be detected in other or larger samples (see Ainsworth & Marvin, 1995). Moreover, the ambivalent pattern (C) has been infrequently observed in small samples (Ainsworth, 1990, p. 481).

The categorical view has, however, been challenged, first and foremost by the work of Fraley and Spieker (2003a): By applying taxometric techniques (see e.g., Meehl, 1995) to the large sample (n = 1,139) from the U.S. National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD), Fraley and Spieker found that variation in attachment patterns were *continuously* rather than categorically distributed. This fundamentally different finding of individual distinctions raised important debates (Cassidy, 2003; Cummings, 2003; Fraley & Spieker, 2003b; Sroufe, 2003), and among these arguments was the issue that some children's attachments are less clear-cut than others (e.g., on the border between A and B). Not only do borderline cases remain hidden with categorical approaches (Cummings, 2003; Futh, O'Connor, Matias, Green, & Scott, 2008), but statistical power is also reduced (Roisman, Fraley, & Belsky, 2007; see also, MacCallum, Zhang, Preacher, & Rucker, 2002). As such, effects of attachment can be misspecified. In fact, beyond the issue of infancy, there is also evidence for continuously distributed attachment insecurity in studies of adult (Bakermans-Kranenburg & van IJzendoorn, 2009; see also Roisman et al., 2007) and romantic attachment (Fraley & Waller, 1998).

According to Cummings (1990, p. 317), the ABC categories from the SSP can be placed on a "security continuum" but preferably as complementary to the categories. Thus,

even within categories, some insecure categories are more secure than others, and vice versa. This line of thought is also reinforced by the original findings that subcategories were associated with variations in caregiving (Ainsworth, 1971; 1990).

For this study, we chose an approach that considers the notion that patterns of behavior vary not only across individuals but also *within* individuals. Consequently, to capture the natural variability in attachment (Roisman et al., 2007), we analyzed the *degree* of attachment security and thus increased the statistical power and decreased the risk of a Type II error.

1.2.5 Stability and Change in Attachment Security

Even though Bowlby suggested that developmental pathways could involve change in attachment quality (Bowlby, 1973; see also Kobak, Zajac & Madsen, 2016), relatively stable attachments have been the promise of attachment theory (Pasco Fearon & Roisman, 2017). Meta-analytic findings have supported this notion to some extent: Fraley (2002) estimated a moderate stability from infancy to adulthood (correlation of .39), and Pinquart et al. (2013) concluded the same overall strength of a stability estimate. However, in the latter meta-analysis, there was no significant stability with intervals greater than 15 years. Moreover, in a comprehensive study, Groh and colleagues (2014) identified an estimate as low as .12 from infancy to late adolescence, which means that security in infancy explained less than 1.5% of the variance in adolescent security. Consequently, attachment seems, at best, moderately stable over shorter intervals in younger years, but it is likely not stable over longer periods. However, several factors should be taken into account: Pinquart et al. (2013) reported that stability was higher with low-risk samples and representational (rather than behavioral) measures. Thus, stability coefficients may differ across sample characteristics, time intervals, and methods.

Although there is increased focus on stability and change in attachments, there is a gap in the literature regarding attachment development across early to middle childhood and at the representational level. To our knowledge, there are only two relevant studies to consult: Green et al. (2000) and Stievenart et al. (2014). Green et al. (2000) reported high stability (i.e. 76.5%) in attachment representations as measured with the MCAST. However, the sample size (n = 33) and measure interval (6 months) was limited, and children's ages varied (ages 5-7). Moreover, percentage stability tends to overstate stability compared to methods that take into account base rate distributions (e.g., kappa). By contrast, Stievenart et al. (2014) reported a modest to moderate stability (r = .32 and intra-class correlation [ICC] = 38%). The latter

study applied the Attachment Story Completion Task (Bretherton, Ridgeway, & Cassidy, 1990). The age range in this study also varied (ages 3-8), but the sample size (n = 358) and measure interval (two years) were larger. For these reasons, these two studies are inconclusive, perhaps due to follow-up time, age, sample, number of children studied, or assessment method. To extend the research on this matter, we applied a large sample (n = 821[19]) of preschoolers whose attachment representations were measured at the ages of four and six.

1.3   Attachment and the Development of Self-Regulation

1.3.1   The Role of Attachment in Development

The major longitudinal attachment studies (see Grossmann, Grossmann & Waters, 2005) shed light on attachment sequelae but also on development itself (e.g., Main, Hesse & Kaplan, 2005; Sroufe, Egeland, Carlson & Collins, 2005). One conceptualization of the role of attachment in development emanates from the Minnesota Longitudinal Study of Risk and Adaptation, as well as theoretical contributions by Sroufe and Waters (1977). Building on a hierarchical view of development (Werner, 1948) and Bowlby's idea that attachment forecasts a more complex organization of behavior (Bowlby, 1973), Sroufe and Waters claimed that the simple stability of attachment is of less interest than is its *organizational* function. The way attachment is embedded in development can be illustrated, for example, by statistical mediation. In the Minnesota study, (a) early attachment predicted (b) parent support at age 13, which in turn predicted (c) conflict resolution in young adulthood (Sroufe et al., 2005). This model was fully mediated, thus there was no prediction from a to c, but rather a fully mediated model of development.

Another conceptual contribution is based on the Berkeley Longitudinal Study. Main et al. (2005) proposed three models of attachment→outcome linkages: 1) stability, 2) functional equivalence, and 3) "pure" predictability. First, attachment may impact development because of attachment's *stability* in and of itself. Secondly, *functional equivalence* is a model in which the outcome strongly reflects attachment itself, but the modality is different. For example, insecurity could be reflected by low trust in romantic partners. Thirdly, attachment's *pure prediction* is a model in which the outcome is clearly differentiated from attachment. One could imagine attachment insecurity as a predictor of low academic success, for instance.

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[19] Number of children with valid data on MCAST at TI (n = 668 at T2).

A common challenge with a grand theory, such as attachment theory (Waters & Cummings, 2000), is that its predictions may become so general that it no longer serves the purpose of a theory. Based on the work of Bowlby, attachment security should first and foremost promote emotion regulation; positive views of self, others, and relationships; the ability to receive and give support; and an overall well-functioning personality (Sroufe, 2016). Although these predictions are generally supported in the literature (Thompson, 2016a), no one has an entire picture of the attachment field (Cassidy, 1999), and research findings across decades hold immense complexity (Fearon et al., 2016). Nevertheless, meta-analytic efforts have documented that attachment security promotes *social competence* ($d = .39$, Groh et al., 2014) and attachment insecurity predicts *externalizing behavior* ($d = .31$, Fearon et al., 2010; $d = .49$, Madigan et al., 2016), *internalizing behavior* ($d = .15$, Groh et al., 2012; $d = .58$, Madigan et al., 2016), and *negative temperament* ($d = .13$, Groh, Narayan et al., 2017) (for further discussion, see Groh et al., 2017; Fearon et al., 2016; Madigan et al., 2016).

No meta-analytic work has targeted self-regulation per se. In fact, conceptual confusion may very well impede meta-analyses of self-regulation. Notwithstanding, the role of attachment in emotion regulation has perhaps been particularly demonstrated by the Minnesota Longitudinal Study of Risk and Adaptation, which measured early attachment and later emotional development (see Sroufe, 2005; Sroufe et al., 2005). By focusing on a different developmental time, and with different methods (community sample and representational measure), the present work aims to extend the longitudinal work on attachment and self-regulation (Study I-II). After all, it has been claimed that attachment and self-regulation are intricately interconnected (e.g., Fonagy, Gergely, Jurist, & Target, 2004; Reisz et al., 2017; Schore, 2000; Sroufe, 1996). Moreover, self-regulation is, in turn, involved in nearly all psychiatric disorders (Nigg, 2017). As such, the findings herein may indirectly shed light on developmental psychopathology as well. Finally, because little is known about the effects of later measured attachment and of change in attachment itself (i.e., low stability), we investigated the effect of change in secure attachment representations (Study II) and predictors of such change (Study III).

1.3.2 The Significance of Self-Regulation in Development

Self-regulation is a developmental cornerstone that cuts across all behavioral domains and which has a strong impact on an individual's functioning level (Bridgett, Oddi, Laake, Murdock, & Bachmann, 2013; Nigg, 2017; Phillips & Shonkoff, 2000; Thompson, 2016b).

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From early on, the growing capacity to self-regulate is typically seen in the domains of physiological arousal, attention, and emotion, and developmental tasks are varied, including, for example, emerging day-night wake-sleep rhythms and ever more complex understanding and regulation of emotions (Phillips & Shonkoff, 2000). With external regulation from caregivers and brain maturation, children naturally cultivate these capacities. Undoubtedly, though, and for a variety of reasons, individual differences in self-regulation are evident. For example, reactive children may be more difficult for caregivers to regulate, some children's attention is less focusable or less flexible, and some parents are better at guiding children's emotional development than others.

Here, the question is whether the child's internalized representations of the attachment relationship (IWMs) influence such self-regulatory capacities. Because self-regulation is related to all facets of life, from social developmental milestones and academic and occupational success to psychiatric and personality disorders (see Nigg, 2017), possible attachment effects may inform important prevention and interventions. What complicates this field, however, is the myriad of definitions, concepts, and scopes that are related to self-regulation. Indeed, self-regulation can be narrowed down to the "delay of gratification" as in the famous Stanford studies (Mischel, Ebbesen, & Raskoff Zeiss, 1972), or self-regulation can be broadly defined as follows:

> Those processes, internal and/or transactional, that enable an individual to guide his/her goal-directed activities over time and across changing circumstances (contexts). Regulation implies modulation of thought, affect, behavior, or attention via deliberate or automated use of specific mechanisms and supportive metaskills (Karoly, 1993, p. 25).

The multitudinous self-regulatory concepts[20] are in fact so confusing that clarifications and solutions have been called for by several scholars (e.g., Bridgett et al., 2013; Nigg, 2017; Zhou, Chen, & Main, 2012). Notably, a rather wide definition of self-regulation is applied for the present purpose. Here, self-regulation is studied in terms of *temperamental effortful control* (Rothbart & Bates, 2006) and *emotion regulation* (see e.g., Gross, 2013). For the sake of order, these two concepts are clearly related. For example, when we experience negative emotions, we often use attentional processes to distract ourselves, or, when becoming angry, we may inhibit aggressive responses (Eisenberg, Hofer, Spinrad & Smith, 2014). However, in

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[20] For a recent overview of self-regulation concepts see Nigg (2017) see also Eisenberg (2017).

the research herein, effortful control and emotion regulation were investigated in separate studies (Studies I and II, respectively).

1.3.2.1 Can Attachment Security Promote Temperamental Effortful Control?

Effortful control

Along with surgency and negative affectivity, effortful control is a main factor in the widely accepted temperament model that was initially described by Rothbart and Derryberry (1981; see also Posner & Rothbart, 2009). Effortful control is the regulatory aspect of temperament and can be defined as "the ability to inhibit a dominant response and/or to activate a subdominant response to plan, and to detect errors" (Rothbart & Bates, 2006, p. 129). As summarized by Eisenberg, Spinrad, and Smith (2004) this capacity is involved in, for example, the awareness of planned behavior, control of thoughts and feelings, conflict resolution, and error correction.

Furthermore, Eisenberg et al. (2014) have pinpointed some important aspects of effortful control. First, the term "effortful" (willful) does not imply that individuals always are aware of their modulation of emotions or behavior. Second, optimal effortful control is not control, per se, but *flexible* responses. For example, when control is not needed, children can also be spontaneous and under-controlled. Consequently, inhibited children may appear regulated but in fact struggle with less flexible willful responses. Third, effortful control is related but not equivalent to the concept of emotion regulation because effortful control can be used for other purposes (e.g., focusing on a task).

Effortful control rapidly advances in children between the ages of 2-7 years (Rothbart, 2011), and at age 4-5, many children are relatively competent at managing impulses (Eisenberg et al., 2014). Even though temperament is considered constitutionally based and relatively stable (Goldsmith et al., 1987), temperament itself develops as shown by a moderate stability (r = .35-.52) during childhood (Roberts & DelVecchio, 2000). Moderate stability is also specifically the case for effortful control (Li-Grining, 2007), but even high stability has been documented (Kochanska & Knaack, 2003).

Because of the confusion of self-regulatory concepts, I emphasize that we followed the work of Rothbart and colleagues (see e.g., Rothbart, Ahadi, Hershey, & Fisher, 2001). Thus, effortful control involved *inhibitory control, attentional focusing, perceptual sensitivity, and low intensity activities,* and was measured with a well-established questionnaire (see p. 48).

The interest in effortful control is related to the many findings that indicate children who score low in this capacity are at risk of externalizing behavior (Bijttebier & Roeyers, 2009; Eisenberg et al., 2004; Eisenberg et al., 2009; Muris & Ollendick, 2005; Olson, Sameroff, Kerr, Lopez, & Wellman, 2005) and Attention Deficit/Hyperactivity Disorder (ADHD) (De Pauw & Mervielde, 2011). Moreover, high effortful control positively predicts emotion regulation (Simonds, Kieras, Rueda, & Rothbart, 2007), social competency (Belsky, Friedman, & Hsieh, 2001; Spinrad et al., 2007), theory of mind (Carlson, Moses, & Breton, 2002; Sabbagh, Xu, Carlson, Moses, & Lee, 2006), moral development (Kochanska, Barry, Jimenez, Hollatz, & Woodard, 2009; Stifter, Cipriano, Conway, & Kelleher, 2009), resiliency (Eisenberg et al., 2004), prosociality (Kanacri, Pastorelli, Eisenberg, Zuffiano, & Caprara, 2013), and academic achievement (Valiente et al., 2013).

Given the substantial evidence of the pivotal role of effortful control in development, as well as its rapid growth and moderate stability, the question arises as to why some children—compared with others—excel in effortful control during the crucial early years for social adjustment and schooling. Because research has more frequently focused on the consequences rather than the predictors of effortful control, individual differences still remain unexplored (Gartstein, Bridgett, Young, Panksepp, & Power, 2013; Kochanska, Murray, & Harlan, 2000). In this thesis, we therefore aim to extend the work on predictors of effortful control.

Notably, low SES has been found to predict poor effortful control (Hackman & Farah, 2009; Zalewski et al., 2012). For example, economically advantaged children have been found to outperform less economically advantaged children on attentional tasks (Mezzacappa, 2004). Although the pathways from SES to effortful control are poorly understood, Zalewski et al. (2012) substantiated a mechanism in which low SES negatively predicted parenting, which in turn affected a child's stress hormones in a way that impeded self-regulation. This mediational understanding is generally supported in studies of how parenting affects a child's stress response (Loman & Gunnar, 2010). Additionally, because of the heritability of effortful control itself (see Lemery-Chalfant, Doelger, & Goldsmith, 2008) and the link between effortful control, education, and jobs, we hoped to rule out a confounding effect of SES by applying this factor in our analyses (Study I).

Effortful control and attachment; possible mechanisms
There are several reasons as to why attachment could affect effortful control. First, poor regulation of stress and emotion has far-reaching effects on inhibition and attention (Pechtel

& Pizzagalli, 2011; Thayer, Hansen, Saus-Rose, & Johnsen, 2009), which are core features of effortful control (Rueda, 2012). Attachment appears to be involved in the regulation of stress (see Kobak, Cassidy, Lyons-Ruth, & Ziv, 2006), as measured using physiological indicators such as cortisol. Children with sensitive caregivers tend to have lower cortisol levels in response to stress compared with children of less sensitive caregivers; thus, attachment may moderate stress reactivity (Bernard & Dozier, 2010).

Moreover, attachment theory purports that early secure attachment fosters children's emotion regulation whereas early insecure attachment more likely leads to emotional dysregulation (Cassidy, 1994). This theoretical link has been buttressed by research (e.g., Moutsiana et al., 2014; Spangler & Zimmermann, 2014; see also Schore 2003a). Although the boundaries between emotions and emotion regulation are debated (see, e.g., Campos, Frankel, & Camras, 2004), secure attachment, compared to insecure attachment, has been found to predict more positive emotions (Sroufe, 2005) and fewer negative emotions, such as fear, anger (Cassidy & Mohr, 2001; Kochanska, 2001; Zimmermann, Maier, Winter, & Grossmann, 2001), and shame (Gross & Hansen, 2000). The possible increased exposure to painful emotions may challenge insecure children's "efforts to control," as they may be overwhelmed by emotions such as fear and shame more frequently. Indeed, effortful control partially depends upon the strength of emotions (Rothbart, Derryberry, & Hershey, 2000), hence secure attachment may ensure the maintenance of effortful capacities.

As indicated above, neurobiological studies have substantiated the role of attachment security on the structural organization of the brain (Bretherton & Munholland, 2016). Of current relevance, Schore (2003a, 2003b) focused upon the connection between the prefrontal cortex and the limbic systems[21]. The prefrontal cortex is significant for mental flexibility, such as attention and inhibition of inexpedient behavior, whereas the limbic system is associated with autobiographic memory and emotional memories (Rolls, 2015). Because effortful control has been physiologically linked to the prefrontal cortex (Posner & Rothbart, 2009), it can be hypothesized that attachment representations and effortful control possibly are related.

Attachment may also indirectly affect the development of effortful control, particularly as children enter the wider school environment. The comparatively advanced social (Groh et al., 2014), emotional (Ontai & Thompson, 2002; Steele et al., 2003), and

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[21] According to Rolls (2015) there is no single limbic system but more so an "emotional limbic system" and a "memory limbic system."

relational competencies (Pallini, Baiocco, Schneider, Madigan, & Atkinson, 2014) of securely attached children may expose them in early childhood to opportunities to further "train" and develop their attentional and inhibitory control. For example, turn-taking during social interactions require the ability to inhibit one's own urges for the benefit of others. Securely attached children easily engage in joint attention, the basis for social interaction, and show more attentive flexibility (Claussen, Mundy, Mallik, & Willoughby, 2002; Pallini & Laghi, 2012). The frequency and quality of such interactions may magnify the effortful control of secure children. In fact, recent work by Stenseng and colleagues has demonstrated that social exclusion and peer rejection in preschool and early school years amplify symptoms of poor self-regulation and ADHD-symptoms over time (Stenseng, Belsky, Skalickà, & Wichstrom, 2015; 2016).

Effortful control and attachment; empirical findings

Thus far, research has focused more on the attachment→emotion regulation link rather than the attachment→effortful control link (Heylen et al., 2017). To our knowledge, no study has longitudinally explored the relation between secure attachment and the development of effortful control in a representative sample—in the perhaps most salient time period—from preschool to school age. Importantly though, attachment security between ages 12-15 months has predicted later task orientation (Vondra, Shaw, Swearingen, Cohen, & Owens, 2001), better continuous task performance scores (Fearon & Belsky, 2004), and better self-regulation in children who carried the short allele of the serotonin transporter gene (*5-HTTLPR*) in the preschool years (Kochanska, Philibert, & Barry, 2009).

Beyond research that has applied measures of attachment, attachment-related *parenting* can arguably shed further light on precursors of effortful control. A growing body of evidence indicates that responsive and sensitive parenting, which also predicts attachment (Boldt, Kochanska, Grekin, & Brock, 2016), may promote effortful control or closely related concepts (see Cipriano & Stifter, 2010; Colman, Hardy, Albert, Raffaelli, & Crockett, 2006; Eisenberg et al., 2005; Graziano, Keane, & Calkins, 2010; Karreman, van Tuijl, van Aken, & Dekovic, 2008; Kim-Spoon, Haskett, Longo, & Nice, 2012; King, Lengua, & Monahan, 2013; Lengua, Honorado, & Bush, 2007; Smith et al., 2012; Valiente et al., 2006; Vazsonyi & Huang, 2010). That said, in a meta-analysis (n = 41) of parenting and self-regulation in early childhood, studies of effortful control were excluded due to their limited number, and no association between parental responsiveness and self-regulation was detected (Karreman, van Tuijl, van Aken, & Dekovic, 2006). Somewhat related is another recent meta-analysis, which

demonstrated that the parenting behaviors that most strongly predict change in externalizing problems are psychological control and harsh control (Pinquart, 2017). Although conceptual confusion makes this research field difficult to review (Zhou et al., 2012), attachment and attachment-related parenting appear likely to influence the development of temperamental effortful control.

However, due to the rapid changes in effortful control during the period from preschool to school (Rothbart, 2011) and the moderate stability of attachment (Pinquart et al., 2013) and effortful control (Li-Grining, 2007), studies that measure attachment during the very first years of life do not necessarily provide information about processes that occur later in childhood. As a result, this thesis intends to take these findings a step further by longitudinally exploring the effect of secure attachment on the development of effortful control across children's transition to school. Beyond controlling for SES, we hypothesized differential effects based on children's *gender*.

1.3.2.1.1 What About Gender?

In investigations of effortful control from infancy to puberty, boys have displayed lower effortful control scores than girls (Else-Quest, 2012; Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006). In fact, the neural underpinnings that may be linked to effortful control (Christ, White, Brunstrom, & Abrams, 2003; Lewis & Todd, 2007; Posner, Rothbart, Sheese, & Tang, 2007; Whittle et al., 2008) seem to mature more slowly[22] in boys (Lenroot et al., 2007; Mutlu et al., 2013). Clinically, boys are overrepresented among children with psychiatric disorders that are characterized by severe problems of inhibition or attention, such as ADHD, even during preschool (Wichstrom et al., 2012), and autism (Werling & Geschwind, 2013).

It is also possible that boys are more dependent on external support to maintain regulation (Weinberg, Tronick, & Cohn, 1999). In fact, the impact of attachment may not be universal. As demonstrated in the study by Kochanska and colleagues, attachment had no effect on the development of self-regulation for children who were homozygous for the long *5-HTTLPR* allele (i.e., *5-HTTLPR* LL). However, among those children who carried the short allele (i.e., *5-HTTLPR* SS, *5-HTTLPR* S/L) attachment security did promote self-regulation (Kochanska, Philibert, et al., 2009). Studies of such interaction effects are generally called for

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[22] Notably, girls' brains do not develop more quickly in general; e.g., the areas of the brain involved in spatial memory have been found to mature earlier in boys than in girls (Anokhin, Lutzenberger, Nikolaev, & Birbaumer, 2000; Hanlon, Thatcher, & Cline, 1999).

in attachment research (Fearon & Belsky, 2016) and in developmental research in general (Bronfenbrenner, 1979; Eisenberg, 2006).

Based on the gender differences in effortful control, as well as in attachment narratives, this led us to hypothesize that attachment security would play a more crucial role in boys' effortful control than in girls'. Although we had few studies to support this idea, there have been indications that boys benefit more from attachment with regard to social competence (Leaper, 2002), attention problems (Fearon & Belsky, 2004), and externalizing problems (Fearon et al., 2010). Thus, in Study I, we investigated the effect of attachment security at 4 years of age on effortful control at 6 years of age while controlling for initial levels of effortful control and SES in addition to testing for moderation by gender.

1.3.2.2 Attachment and Emotion Regulation across the Transition to Middle Childhood

Cultivating emotions that are helpful—and managing emotions that are harmful—is one of the central concerns of the field of emotion regulation (Gross, 2013 p. 359).

Emotion regulation

Emotion regulation is an important aspect of the broader concept of emotional *competence*, which can be defined as follows:

> The ability to purposefully and fully express a variety of emotions, understand the emotions of self and others, and regulate emotional expressiveness and experiences when necessary (Campbell et al., 2016) p. 22).

As with many other regulatory concepts, there is no consensus among scholars regarding the definitions of emotion regulation. Also, and of current importance, emotion regulation in the context of the family may differ from regulation in other social settings (Cole, Martin, & Dennis, 2004a; Thompson, Lewis, & Calkins, 2008). Nevertheless, emotion regulation may be defined as follows, for example:

> Intra- and extra-organismic factors by which emotional arousal is redirected, controlled, modulated, and modified to enable an individual to function adaptively in emotionally arousing situation (Cicchetti, Ganiban, & Barnett, 1991, p.15).

According to Gross (2014, p. 7), emotion regulation can best be understood as "a continuum of emotion regulation possibilities that range from explicit, conscious, effortful, and controlled regulation to implicit, unconscious, effortless, and automatic regulation."

Individuals typically decrease negative emotions (e.g., sadness) and increase positive emotions (e.g., joy) (Gross, 2013).

Notably, emotion regulation is not exclusively a matter of emotional control (see e.g., Eisenberg et al. 2014); tolerating, accepting, and displaying negative emotions are considered fundamental for adapting to the environment (Grolnick, McMenamy & Kurowski, 2006). In this way, whether and how children can show appropriate negative emotions in response to hostility or to tell someone whenever they feel uncomfortable are considered central features of emotion regulation (see Shields & Cicchetti, 1997). With that said, whether negative emotions are adaptive or maladaptive may depend upon the given context (see Dennis, Cole, Wiggins, Cohen, & Zalewski, 2009). The upregulation of *positive* emotions, which typically occurs when children are in play states, is also fundamentally important to emotion regulation (Schore, 2003a).

The study of emotion regulation exploded some 15 years ago (see Gross, 2013 for an illustration), and the pervasive role of emotion regulation in human development has now clearly been demonstrated (Cole, 2014). Emotion regulation has been related to, for example, successful social functioning (Blair et al., 2015), coping styles (Zalewski, Lengua, Wilson, Trancik, & Bazinet, 2011), and social status (English, John, Srivastava, & Gross, 2012). Evidence has also repeatedly indicated that emotion dysregulation contributes to the development of most forms of psychopathology (Cole & Deater-Deckard, 2009), including anxiety (Bosquet & Egeland, 2006), depression (Gotlib & Joormann, 2010), and externalizing disorders (Halligan et al., 2013). Again, understanding the precursors of such regulation is therefore crucial.

The transition from early to middle childhood

Emotion regulation is typically fostered within the context of early parent-child interactions (Sroufe, 1996; Thompson, 2014), and the regulative function of the attachment system has been increasingly emphasized (e.g., Malik, Wells, & Wittkowski, 2015). As discussed by Cassidy (1994; see also Ainsworth et al., 1978/2015), securely attached children tend to have caregivers who, from the early outset, offer comfort and support in times of distress and novelty and who are open to a wide variety of children's emotional expressions. Whereas parents of secure children are attuned to their children's emotional lives and invest in conversations about emotions, parents of insecurely attached children are often dismissive, critical, or even punitive of their children's emotional expressions (Thompson, 2014; Thompson 2016a). For this reason, while secure children learn to understand, accept, and

communicate their emotional states, which integrates both positive and negative emotions, insecure children learn less effective strategies in the attachment relationship, and their internalized representations of their emotional selves may be a hindrance in the longer term.

However, even if emotion regulation may be considered an integral part of attachment (Kerns & Brumariu, 2016; Thompson, 2016a), the empirical evidence is far more limited in the later childhood years than in early childhood (Borelli et al., 2010). As mentioned previously in this text, the middle childhood years, from approximately 6 to 12 years, have generally received limited attention and are hence known as "the forgotten years" (Mah & Ford-Jones, 2012; see also Colle & Del Giudice, 2011).

Importantly, emotion regulation varies and develops throughout the lifespan (Cole, 2014; Gross, 2013). In middle childhood, such regulation becomes more sophisticated and complex, due to, for example, more advanced understanding of others' emotions (Shields & Cicchetti, 1997). Because many cultures offer schooling between ages five to seven (Eccles, 1999), the transition to early middle childhood is often characterized by an extended and advanced social context, involving peer hierarchies, social roles, and cooperation (see e.g., (Colle & Del Giudice, 2011). Indeed, the passage from childcare[23] to school is an important ecological transition (Bronfenbrenner, 1979). Children are henceforth expected to display self-regulation in relation to their classmates, peers, teachers, and surroundings while simultaneously becoming less dependent on being externally regulated by others such that they need to depend on their own regulatory repertoire. These developmental and social changes may be no less profound than changes at earlier or later stages (Eccles, 1999; Mah & Ford-Jones, 2012). Accordingly, it is important to know the factors that promote emotion regulation during the shift to middle childhood.

Although the emerging research has indicated that attachment security promotes emotion regulation in middle childhood (Kerns & Brumariu, 2016), there are several limitations to the research at hand (see Parrigon, Kerns, Abtahi, & Koehn, 2015 for a review). Among these are a lack of longitudinal designs, sample diversity, and involvement of informants of emotion regulation other than child and parent. Additionally, there is paucity regarding the possible role of genetic interaction. Nevertheless, some evidence indicates that greater attachment security in 8- to 12-year olds is associated with, for example, more efficient emotional coping strategies (Contreras, Kerns, Weimer, Gentzler, & Tomich, 2000; Kerns, Abraham, Schlegelmilch, & Morgan, 2007), enhanced emotion identification

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[23] In the current context, Norway, nearly all preschoolers attend childcare (Bjørnestad & Os, 2018).

(Brumariu, Kerns, & Seibert, 2012), increased regulation of threat-induced reactivity (Borelli et al., 2010), and more mature selection of emotion regulation strategies when confronted with hypothetical situations (Colle & Del Giudice, 2011). By contrast, Kim and Page (2013) reported no relation between attachment and emotional regulation in this age group.

Does change in attachment forecast change in emotion regulation?
To extend the literature on this subject, our focus is on the transition to middle childhood with the inclusion of independent measures of attachment and emotion regulation. Moreover, because attachment instability is rarely considered when studying the attachment→emotion regulation link, we investigated the effect of *change* in attachment during the preschool years on *change* in emotion regulation during the early school years. We expected that increased levels of security would forecast increased levels of emotion regulation and that increased levels of insecurity would forecast decreased levels of emotion regulation. Evidently, apart from such an effect, higher levels of attachment security at one point in time could be related to higher levels of emotion regulation at a later point in time. Although the present inquiry primarily focuses on the effect of change, we nevertheless include the effect of higher levels in our analyses.

We could not provide analyses of cross-lagged effects (i.e., the possible effects of emotion regulation on attachment). Additionally, we included a gene by environment (GXE) perspective and questioned the somewhat implicit view that attachment affects all children's emotion regulation equally. Before moving on to the specific GXE model employed in this thesis, I introduce the differential susceptibility framework.

Study II
Model Conceptualization

5-HTTLPR

Attachment security
Change 4-6 years

Emotion regulation
Change 6-8 years
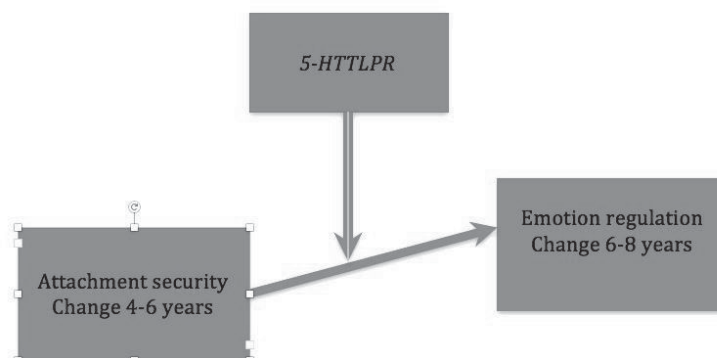
1.3.2.3 Environmental Plasticity: The Case of the Serotonin Transporter

Differential susceptibility vs. diathesis stress

Jay Belsky further built upon Bowlby's[24] evolutionary thinking and suggested that some individuals are more susceptible to environmental influences than others (Belsky, 1997a; 2005; Belsky et al., 2007; Belsky & Pluess, 2009, 2011). Belsky argued that because the future is uncertain, natural selection may have crafted parents to have children who vary in their susceptibility—and to rearing in particular (e.g., Belsky et al., 2007; Belsky & Pluess, 2009). Ultimately, parents' genes more likely pass on if some children are unaffected by the environment and some children can benefit from the environment. According to Belsky and Pluess, some individuals are

> "Fixed strategists" when it comes to making their way in the world, whereas others are "plastic strategists". Or, thinking dimensionally rather than categorically, some individuals are more plastic or malleable and thus shaped by their experiences than others who are less shaped by experience and thus more the way they are because they were born that way rather than made that way (Belsky & Pluess, 2009, p. 20).

Diathesis Stress vs. Differential Susceptibility
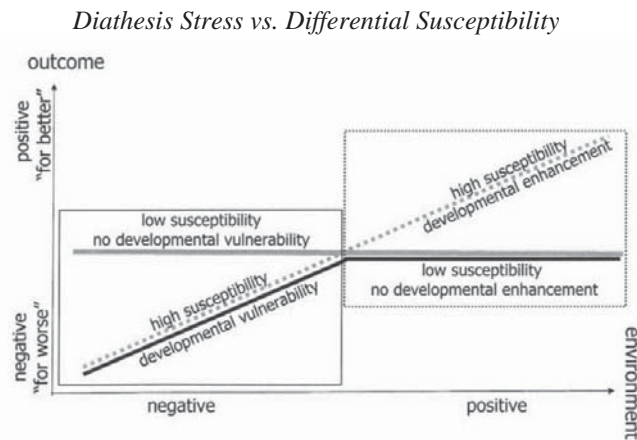
Figure 1. The diathesis–stress/dual risk model (solid black and solid gray lines) and the differential susceptibility model (solid gray and dotted gray lines). The two models are partly overlapping, and selection of a restricted range of environments (i.e., just adversity and the absence of adversity, left-side rectangle) renders the two models indiscernible. In this context, negative outcomes are experienced only by individuals displaying high susceptibility/developmental vulnerability. A focus on positive environments as well as inclusion of the full range of environments reveals the difference between the diathesis–stress and differential susceptibility models. As shown in the right-side rectangle, the differential susceptibility model contends that more susceptible individuals in positive environments will show more favorable outcomes (i.e., developmental enhancement); more susceptible individuals are thus disproportionately influenced by both negative and positive environments. Adapted from "Genetic Vulnerability or Differential Susceptibility in Child Development: The Case of Attachment [Research Review]," by M. Bakermans-Kranenburg and M. H. van IJzendoorn, 2007, *Journal of Child Psychology and Psychiatry, 48*, 1160–1173. Copyright 2007 by Wiley–Blackwell. Adapted with permission.

From Ellis et al., 2011[25]

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[24] Bowlby (1969/1982) used the expression "sensitivity to environment."
[25] With permission from Cambridge University Press. License Number 4227241112714.

Twenty years after the first publications (Belsky, 1997a; 1997b), *the differential susceptibility hypothesis*[26] has been thoroughly studied (e.g. Slagt, Dubas, Dekovic, & van Aken, 2016; van Ijzendoorn, Belsky, & Bakermans-Kranenburg, 2012) and the evidence is substantial, including even experimental designs (van Ijzendoorn & Bakermans-Kranenburg, 2015). The implication of this research is that the traditional diathesis-stress model may only offer a limited understanding of developmental plasticity. Whereas the diathesis-stress thinking stipulates that adverse contextual conditions negatively affect some "vulnerable" individuals more than others, differential susceptibility thinking contends that such putatively vulnerable individuals are also more susceptible to positive experiences than others, which makes them generally more developmentally plastic, "for better and for worse" (Belsky et al., 2007). Interestingly, the groundbreaking and highly cited GXE findings by Caspi, Moffitt, and colleagues (Caspi et al., 2002; Caspi, Sugden, Moffitt, Taylor, & Craig, 2003) were interpreted within the frame of diathesis stress, but in hindsight, these results may in fact rather pertain to the differential susceptibility framework (see Belsky & Pluess, 2009; Sroufe, 2009).

In any case, developmental risk research has typically not been designed to test for differential susceptibility. To demonstrate the benefit of environmental plasticity, one should employ indicators of the environment that range from highly negative to highly positive (e.g., [in]sensitive parenting), and not just the absence of negative conditions (Belsky & Pluess, 2009, 2011, for more details see the figure by Ellis et al., 2011 above). Because attachment reflects, at least in part, the legacy of rearing experience (see Fearon & Belsky, 2016), the differential susceptibility hypothesis led us to think that (changes in) attachment security could predict (changes in) emotion regulation for some children more than for others.

Among the identified markers of differential susceptibility (i.e., primarily negative affectivity [Slagt et al., 2016], physiological reactivity [Boyce & Ellis, 2005], and genetics [van IJzendoorn & Bakermans-Kranenburg, 2015]), we chose to base our research on a genetic marker that has been linked with emotion regulation specifically (Canli & Lesch, 2007; Caspi et al., 2011): the serotonin transporter-linked polymorphic region (*5-HTTLPR*), which is the most studied polymorphism in psychology, psychiatry, and neuroscience (Caspi et al., 2011; Halldorsdottir & Binder, 2017).

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[26] The evolutionary model of *Biological Sensitivity to Context* by Boyce & Ellis (2005) is closely related to the work of Belsky (see Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2011).

The moderating role of 5-HTTLPR

The *SLC6A4* gene codes for the serotonin transporter 5-HTT (Canli & Lesch, 2007). According to Canli and Lesch (2007) and Hariri and Holmes (2006), 5-HTT recycles serotonin from the synaptic cleft to the presynaptic neuron and influences the duration and intensity of serotonin signaling with post-synaptic receptors within the affective corticolimibic circuitry. In this way, 5-HTT is involved in the brain's emotional communication (Canli & Lesch, 2007; Hariri & Holmes, 2006). Of interest to the present work is that individuals vary in terms of how *efficiently SLC6A4* codes for 5-HTT. The *SLC6A4* contains a common polymorphism, *5-HTTLPR*, which is usually reported with two allele[27] variations, a short ("S") and a long ("L") allele, though more variants have been identified (Nakamura, Ueno, Sano, & Tanabe, 2000; Xie et al., 2009).

Notably, the S allele is associated with a reduced coding of 5-HTT. As a result, S carriers have elevated levels of extracellular serotonin, which is thought to lead to heightened emotional reactivity. For example, S carriers evince stronger amygdala reactivity (see (Munafò, Brown, & Hariri, 2008 for a meta-analysis) and cortisol responses to stressors (Gotlib, Joormann, Minor, & Hallmayer, 2008). For example, when exposed to a sad movie, children carrying the S allele showed more regional brain activation than children without this allele (Fortier et al., 2010). Such altered processing of emotional stimuli may also emerge on a behavioral level (Halldorsdottir & Binder, 2017). In fact, meta-analytic evidence documented heightened emotional reactivity among S *homozygotes* in particular (Miller, Wankerl, Stalder, Kirschbaum, & Alexander, 2013). This finding highlights the potential for S homozygotes to develop differently with respect to emotion regulation compared with other children. Moreover, additional meta-analytic work has indicated that the S allele moderates the effect of a variety of environmental exposures, at least in Caucasian children, in a manner consistent with differential-susceptibility thinking (van IJzendoorn et al., 2012). Regarding parameterizing heterozygotes (SL) with S or L homozygotes, the literature is equivocal (see e.g., van IJzendoorn, et al., 2012). Because of this trend, we conducted preliminary analyses to address this issue before testing competing models of GXE.

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[27] "The human genome is composed of 46 chromosomes, which are long sequences of DNA. The DNA sequence is composed of a chain of the nucleotide bases adenine (A), cytosine (C), guanine (G), and thymine (T). An allele is a variant form of a gene in a specific genetic locus on a chromosome. Humans have two alleles at each genetic locus, one from each parent. Each pair of alleles represents the genotype of a specific gene. Genotypes can be either homozygous, with two identical alleles at a particular locus, or heterozygous, with two differing alleles at a locus" (Halldorsdottir & Binder, 2017 p. 214).

Based on the differential susceptibility framework in general and the moderating characteristics of the *5-HTTLPR* in particular, we hypothesized that attachment security, as an environmentally induced regulatory mechanism, is especially important for the development of emotion regulation among the more reactive S carriers. In fact, S carriers have been found to be most affected by their attachment styles with regard to self-regulation in preschool (Kochanska, Philibert, et al., 2009) as well as autonomy, aggression (Zimmermann, Mohr, & Spangler, 2009), stress, and depression (Starr, Hammen, Brennan, & Najman, 2013) in adolescence. Whereas the research by Kochanska, Philibert, et al. (2009) proved consistent with the diathesis-stress model, the works of Starr et al. (2013) and Zimmermann et al. (2009) appear more consistent with differential-susceptibility theorizing.

Notably, two versions of the differential susceptibility framework can be distinguished (Belsky, Pluess, & Widaman, 2013); while the "strong" version stipulates that some individuals are susceptible to environmental influences and others are not, the "weak" version stipulates that some are more susceptible than others. To test for this, we applied the model fitting approach advocated by Widaman et al. (2012) and Belsky et al. (2013) (see p. 52 for details). Now, leaving attachment as a predictor of development, I turn to the issue of predictors of attachment itself.

1.4   Attachment Development and Childcare

Almost all[28] children become attached (Weinfield, Sroufe, Egeland, & Carlson, 2008). Some become more securely attached than others, and attachment security may change over time. The question thus arises: what are the predictors of such change? This thesis also focuses on the role of childcare in attachment development. However, before approaching this topic, a general outline of antecedents of attachment security is provided (for a complete review see Fearon & Belsky, 2016).

1.4.1   Antecedents of Attachment Security

Caregiving and the proximal context

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[28] For children raised in certain institutions, attachments may be incompletely developed or even absent (Zeanah, Berlin, & Boris, 2011).

According to Ainsworth, the mere presence of the parent ensures the establishment of the attachment relationship, but the parent's caregiving behavior predicts the *quality* of this (Ainsworth & Marvin, 1995). With the Maternal Sensitivity Scales, Ainsworth (1969) thoroughly described caregiving behavior related to children's secure base behavior, which is a focus that has remained important ever since and has been repeatedly confirmed (Fearon & Belsky, 2016), even with experimental designs (Bakermans-Kranenburg, van, & Juffer, 2003). However, as shown by the classic meta-analysis by De Wolff and van IJzendoorn (1997), the impact is rather modest (combined effect size of r = .24). The idea that parental sensitivity cannot be the sole predictor of attachment security is further demonstrated by the "transmission gap," i.e., the limited role of parental sensitivity in *mediating* the link between parents' and children's attachment representations (van Ijzendoorn, 1995; Verhage et al., 2016).

Nevertheless, the original Maternal Sensitivity Scales were developed for use with *extended* (>12 hours) observations of parent-child interactions (Ainsworth, 1969). As highlighted by, for example, Biringen, Derscheid, Vliegen, Closson, and Easterbrooks (2014), the association between parental sensitivity and attachment increases with increased lengths of observations. Similarly, when more closely following Ainsworth's methodology, the association between sensitivity and attachment security has been demonstrated to be more substantial (Posada et al., 1999; see also Posada, Kaloustian, Richmond, & Moreno, 2007). For example, Ainsworth recommended various (home) visits in order for the mother to become familiar with being observed (see Posada et al., 2007). Moreover, and as discussed by Oppenheim (2012), Ainsworth's naturalistic work addressed the link between maternal sensitivity and attachment security in a far more general sense than regulation of distress per se (as in the SSP). As such, the sensitivity→security association may involve substantial measurement errors, which may be due to insufficient observations or limited operationalization of attachment behavior or representations. Because the child-parent relationship transcends the attachment system (Sroufe, 2005), naturalistic observations should focus on caregiving behaviors that are relevant for security outcomes (see Posada et al., 2007 for a discussion).

Beyond the focus on parental sensitivity, parental psychological well-being and marital satisfaction are identified as precursors of attachment security (see Fearon & Belsky,

2016), as are parents' mentalization[29] abilities (Fonagy, Steele, Steele, Moran, & Higgitt, 1991; Meins, Fernyhough, Fradley, & Tuckey, 2001; Slade, 2005). Indeed, the issue of mentalization has generated much research and even several clinical applications (Bateman & Fonagy, 2010). There may, of course, also be aspects of the proximal or close environment that not yet have been identified (Fearon & Belsky, 2016), but factors such as presence of the father (Fraley, Roisman, Booth-LaForce, Owen, & Holland, 2013; Vaughn et al., 2016) and parental monitoring (Vaughn et al., 2016) appear to be involved.

Change in attachment security is considered to be "lawful," and it typically stems from profound changes in parental sensitivity and responsiveness that are due to life events (for the better or worse) (Beijersbergen, Juffer, Bakermans-Kranenburg, & van Ijzendoorn, 2012). In a highly-cited paper, Waters, Merrick, Treboux, Crowell, and Albersheim (2000) reported that more than 70% of their sample maintained their original attachment classification over a time span of 20 years. As mentioned before, such high stability was later challenged (Groh et al., 2014), but among those study participants who changed into insecure attachment categories, the majority (78%) had experienced at least one negative life event. These included loss of parent, parental divorce, parental psychiatric disorder, serious illness in the near family, or abuse by a family member (Waters et al., 2000). Such stressors have also been identified by others (e.g., Allen, McElhaney, Kuperminc, & Jodl, 2004; Booth-LaForce et al., 2014).

In their review of predictors of change and stability in developmental periods across the lifespan, McConnell and Moss (2011) concluded that the long-term (in)stability is first and foremost predicted by negative life events. Across infancy, the authors highlighted the following factors:

> Maternal depression, antisocial behavior, maternal employment, childrearing methods, etc. seem to have more of an influence in predicting stability and change in attachment across infancy since they directly impact caregiving behavior. Since the attachment relationship is in the process of formation during infancy, variables that directly alter caregiving behavior have a significant impact on the attachment relationship. Additionally, external factors such as negative life events and factors that operate within the marital relationship such as relationship satisfaction also influence stability and change during this developmental period (McConnell & Moss, 2011, p. 73).

Further on, the impact of predictors somewhat changes over time. As regards early childhood McConnell and Moss emphasized the following:

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[29] See Sharp & Fonagy (2008) for a discussion of related concepts (e.g., *mind-mindedness*, *reflective functioning*), and Koren-Karie, Oppenheim, Dolev, Sher & Etzion-Carasso (2002) for a discussion of the term "*insightfulness*," which builds on attachment theory.

Maternal factors appear to play less of a role in predicting stability and change in attachment. While there are still associations between some caregiving behaviors such as maternal sensitivity and change in attachment classification, factors such as negative life events, marital satisfaction and more than 10 hours of week in child care are just as influential in predicting stability and change in attachment during this period. This makes sense given that developmentally, the preschool child is more capable of interacting with their environment and less restricted to proximity seeking behavior (McConnell & Moss, 2011, p. 73).

Consequently, and not very surprisingly, change in attachment is related to change in the individual's close environment. Moreover, attachment security is less stable in high-risk samples (for a meta-analysis see Fraley, 2002).

Child characteristics

Central in developmental psychology is the view that children contribute to their own development (Sameroff & Chandler, 1975) and to the parent-child interaction in particular (e.g. Biringen et al., 2014). As such, characteristics of the child could themselves have predictive value in the development of attachment security. That said, Sroufe (1985) emphasized that attachment is a relational construct (which reflects the particular history with the attachment figure), not an inherent feature or trait of the child (i.e., temperament). Indeed, that is why we have suggested that attachment could be operationalized as the E (in GXE), at least to a certain extent (Study II). Moreover, the long-standing argument between temperament researchers (e.g., Kagan, 1982) and attachment researchers (e.g., Sroufe, 1985) has shown that attachment security and temperament are only weakly associated ($d = .14$; Groh, Narayan, et al., 2017; see also Vaughn & Shin, 2011). Nevertheless, the role of temperament as a *moderator* of the proximal environment has proven fruitful (see also Section 1.3.2.3). In fact, temperament may explain why the overall effect of parental sensitivity on attachment development remains limited across decades of research (Fearon & Belsky, 2016), with some children being more susceptible to the environment than others. Thus, child characteristics are, in that sense, highly relevant.

A groundbreaking study demonstrated a profound role of genetics in adolescence attachment (Fearon et al., 2014), which, to a more limited degree, has been indicated by others as well (Lee Raby, Cicchetti, Carlson, Egeland, & Andrew Collins, 2013; Fraley et al., 2013) including adult attachment (Brussoni, Jeng, Livesley & Macbeth, 2000). Although it has been claimed that the influence of shared environment on attachment decreases with age (Barbaro et al., 2017), others have claimed that the role of shared environment in attachment beyond childhood is *far* from conclusive (Verhage et al., 2017). Interestingly, though, a few

publications have reported that intrapsychic factors (Allen et al., 2004) and cognitive factors (Stievenart et al., 2014) may predict change. Overall, however, the majority of evidence points to the heavy role of the environment in child attachment (Fearon & Belsky, 2016).

1.4.2   Does Childcare Matter?

Few research questions have caused more controversy in developmental psychology than the role of nonmaternal care (see e.g., Belsky, 2001; 2009; R. Bowlby 2004; Burchinal, Magnuson, Powell, & Hong, 2015; Friedman & Boyle, 2008; Friedman, Melhuish, & Hill, 2010). This long-standing issue (e.g., Belsky & Steinberg, 1978) was especially heated during the mid-1980s. Whereas some researchers contended that as long as quality of care was high, children would benefit from childcare (Phillips, McCartney, Scarr, & Howes, 1987), others raised concerns about lots of time spent in childcare beginning early in life (Belsky, 1986, 1988; Gamble & Zigler, 1986).

Among those who worried about attachment development, some emphasized the mere absence of the mother as a risk factor, while others emphasized that maternal employment affected attachment via the altered quality of parent-child interactions (see Jaeger & Weinraub, 1990 for theoretical models, see also Belsky, 1986). Regardless of these models, research from the 1960s and into the late 1980s yielded mixed evidence of non-maternal effects, which, at any rate, was inconclusive due to considerable methodological limitations (see Howes & Spieker, 2016). Ultimately, the NICHD launched the SECCYD (NICHD Early Child Care Research Network [ECCRN], 2005): the most comprehensive investigation of childcare effects that has ever been undertaken.

NICHD findings

With a large sample (n > 1000) and a stringent design, the groundbreaking "NICHD study" revealed that children who spent on average more than just 10 hours per week in non-familial childcare were more likely to develop insecure attachment to the mother (as seen in the SSP) at 15 months, but only if they also experienced low-sensitivity caregiving (NICHD ECCRN, 1997). Notably, the same dual-risk effect emerged with low-sensitivity caregiving and *quality* of care. However, when these dual risk effects were re-examined at age 36 months (using an age-appropriate modification of the SSP [Cassidy et al., 1992]), only the interaction with *quantity* of care proved significant (NICHD ECCRN, 2001), which is a finding that was bolstered by the Haifa Study of Early Child Care and Infant-Mother Attachment (Sagi, Koren-Karie, Gini, Ziv, & Joels, 2002).

Quality of care may be an important predictor of childcare outcomes depending upon the childcare context studied (Aviezer & Sagi-Schwartz, 2008; Love et al., 2003), and therefore, both quality and quantity of childcare should be considered. Unfortunately, though, one of the limitations of the TESS, and hence this thesis, is the lack of a measure of childcare quality. However, the NICHD Study did not report any evidence of quality-X-quantity interactions or of quality effects accounting for quantity effects when investigating attachment security at 15 months (NICHD ECCRN, 1997) or 36 months (NICHD ECCRN, 2001), nor other developmental outcomes in toddlerhood (NICHD ECCRN, 1998), middle childhood (Belsky et al., 2007), or adolescence (Vandell et al., 2010). We therefore consider our inquiry to be relevant in spite of this limitation.

1.4.2.1 Dual Risk of Low Parental Sensitivity and High Quantity of Care

Notably, none of the studies mentioned above identified *main* effects of quantity of care on attachment, a conclusion that was supported by a meta-analysis published in the same time period as the first NICHD findings (Erel, Oberman, & Yirmiya, 2000). Thus, the results indicated that childcare effects on attachment were to be understood in terms of *dual risk*, that is, adverse effects of childcare on attachment security occur in the context of lots of time in care and limited maternal sensitivity. That said, recent work has shown that main effects cannot be ruled out when the quantity is extreme (> 60/h week) (Hazen et al., 2015) or when attachment behavior is studied on a more detailed level (i.e., attachment subcategories) (Umemura & Jacobvitz, 2014, see also Aviezer & Sagi-Schwartz, 2008). Nevertheless, the repeated findings of dual risk support Belsky's (1986, see also 2001) original risk-factor conclusion that when multiple developmental risks occur (i.e., cumulative risk [Evans, Li, & Whipple, 2013]), they are most likely to be realized in terms of compromising child well-being.

For several reasons, we aim to extend the existing work on dual risk. First, the reported childcare effects on attachment were identified in children between 0-3 years, a time during which attachment-related cognitive resources are restricted (see Ainsworth et al., 1978/2015, p. 198-200 for a discussion) and long hours in childcare are stressful (Drugli et al., 2017; Undheim & Drugli, 2012). As children's intellectual abilities increase, separation from the caregiver becomes less distressing (Ainsworth et al., 1978/2015), which may possibly limit childcare effects to infancy and toddlerhood. On the other hand, long hours in childcare increase the number of situations that activate children's stress and attachment

systems, such as being more tired, feeling sad when excluded by peers, or being physically hurt during play. Physiological stress in the context of childcare seems actually to be more prominent among preschoolers than among infants, and possibly due to more advanced peer interactions (see Vermeer & Groeneveld, 2017 for a review).

Furthmermore, the use of childcare continues to grow in economically advanced countries (UNICEF, 2008; Elborgh-Woytek, 2013). In Norway, children typically start center care around their first birthday, and they remain there for long hours throughout their toddlerhood and preschool years. Notably, the self-reports of wellbeing in childcare of Norwegian children between 4 and 6 years olds is rather moderate, and their parents believe their children thrive more than they do (Bratterud, Sandseter & Seland, 2012). Moreover, a substantial number of Danish children in the same age group reported that their parents are busy and have little time for them (Børnerådet, 2017). These Scandinavian studies indicate that long hours in childcare may challenge the attachment system—even in the context of a quality center care and even among the oldest children. In fact, Bowlby claimed that non-maternal care could affect attachment bonds even for some 5-year olds (Bowlby, 1969/1982; see also R. Bowlby, 2004).

Consequently, no matter what the evidence appears to be regarding childcare and attachment in the very first years of life, one may wonder whether effects prove evident beyond infancy and toddlerhood. This concern is especially important when considering that attachment security, as measured in preschoolers, promotes the development of verbal intelligence (Stievenart et al., 2011), for example, whilst buffering against, for example, externalizing behavior (Roskam, Meunier, & Stievenart, 2011). Because of the instability of attachment, the early childcare→attachment-findings may in fact not be generalizable to the preschool and early school years.

In addition, we do not know whether dual risk can be generalized across methods and contexts. Virtually all prior work that has investigated links between childcare experience and attachment has focused on attachment behavior. In order to ensure the robustness of childcare and attachment findings, research needs to vary across methods as well (Friedman & Boyle, 2008), thus we aim to extend the issue of dual risk to the level of attachment *representations* and in a different context than the US.

The context of a welfare state
Due to substantial variation between sociopolitical contexts, cross-national studies of possible childcare effects on attachment development have been advocated (Aviezer & Sagi-

36

Schwartz, 2008; Love et al., 2003). Even though childcare policies and practices differ in terms of options for family leave, childcare accessibility, affordability (Europea, 2013; Lancker & Ghysels, 2012, 2016), and quality of childcare (Burchinal et al., 2015; Vermeer, van IJzendoorn, Cárcamo, & Harrison, 2016), the majority of childcare→ attachment research has been conducted in the United States (see Howes & Spieker, 2016 for a review).

American parents typically receive limited welfare support involving only 12 weeks of unpaid parental leave, which leads to very early use of childcare (Ruhm, 2011). Moreover, in spite of the actions taken to promote high-quality care for U.S. families at risk, such as the CCDBG law of 2014,[30] there are no federal childcare standards or universal availability of childcare arrangements (Love et al., 2003; Phillips & Lowenstein, 2011). An estimated 11 million U.S. children under the age of five spend an average of 36 hours per week in childcare, and only 10% of such childcare is said to meet the standards that likely lead to positive child outcomes (Childcare Aware of America, 2014, see also (Ruhm, 2011). These features of the U.S. context, which differ from many other industrialized countries (Phillips & Lowenstein, 2011; Ruhm, 2011), may possibly yield different childcare outcomes than, for example, research conducted in a Scandinavian welfare state.

The state of Norway[31] offers substantial welfare arrangements including, for example, 100% paid parental leave for 49 weeks, paid leave when the child is sick, and paid daily breaks for breastfeeding infants (The Norwegian Labour and Welfare Administration, 2017). Moreover, Norwegian childcare is considered to be of high quality (Zachrisson, Dearing, Lekhal, & Toppelberg, 2013), at least at a structural level (Skalickà, Belsky, Stenseng, & Wichstrom, 2015). Childcare centers are also highly accessible (Zachrisson, Dearing, et al., 2013; Zachrisson, Janson, et al., 2013), and family and child factors predict the utilization of childcare only to a very limited extent (Zachrisson, Janson, et al., 2013). From 1 year of age, children have legal right to childcare, and 91% of children aged 1-5 attended childcare during the latest years (Statistics Norway, 2016a). For example, as many as 96.7 percent of 3-5-year-olds, and 80.1 percent of 1-2-year-olds attended childcare in 2014. The majority (94%) of these children have agreed full-time childcare, which corresponds to 41 hours or more per week. However, only one out of five children are actually spending full-time childcare (Statistics Norway, 2016b). What has never been investigated is whether such early, extensive, and continuous care (Belsky & Eggebeen, 1991) affects the development of secure

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[30] U.S. Department of Health & Human Services.
[31] More details about Norway as a state are provided by Zachrisson, Janson, and Nærde (2013).

attachment representations. For this reason, in Study III, we extend work on the determinants of attachment instability by focusing on change in attachment representations across the transition to school and upon the effects of childcare and parental sensitivity.

1.5   Aims of the Thesis

On the whole, attachment, as measured at the level of mental representations across the preschool years and into early middle childhood, has been scarcely studied. This thesis aspires to further extend the vast body of attachment research via the screen-stratified sample of the Trondheim Early Secure Study (TESS). The thesis relies on multi-method, multi-informant TESS data from wave I (T1), II (T2), and III (T3), at which time children were 4, 6, and 8 years of age, respectively.

❖ The aim of Study I is to investigate whether higher attachment security at four years of age could promote temperamental effortful control from 4 to 6 years of age and whether such an effect would prove strongest for boys.

❖ The purpose of Study II is fourfold: first, we investigate the stability and change of attachment security from ages 4 to 6; secondly, we test whether such change could forecast change in emotion regulation from ages 6 to 8; thirdly, we analyze whether this mechanism would prove different according to *5-HTTLPR* polymorphism; and fourthly, we determine whether the results conform to the differential-susceptibility or the diathesis-stress model.

❖ In Study III, we address the issue of precursors of change in attachment representations by asking whether the dual risk of time spent in childcare from 0-4 years of age combined with low-sensitivity parenting would negatively affect attachment development from ages 4 to 6.

2   METHODS

2.1   General overview: the Trondheim Early Secure Study

The participants in Studies I, II, and III were all drawn from the primary sample of the
ongoing Trondheim Early Secure Study (TESS), which was launched in 2007 as a
comprehensive developmental and epidemiological study of children. The TESS is based on
data from a stratified sample of two cohorts of 4-year olds, who were born in 2003 and 2004
in the in the city of Trondheim, Norway (192,847 inhabitants [Statistics Norway, 2017a]) and
who have been followed up biennially since 2007. The work presented herein applies data
from T1, T2, and T3, and the corresponding ages of the children were 4, 6, and 8 years old.

2.1.1   Recruitment

All Norwegian 4-year olds are routinely[32] invited for a thorough health checkup run by a
doctor and a health nurse, which is arranged by the public well-child clinics. For this reason,
to reach out to every family in the respective cohorts of interest, recruitment was arranged via
the well-child clinics in the city of Trondheim (N = 14). All families received a brochure of
the planned study and the Strengths and Difficulties Questionnaire (SDQ; 4-16 version
[Goodman, 1997] [see 2.1.2]), which parents were encouraged to completed before their
scheduled appointment. It should be noted that the brochure contained information that only
one quarter of the 4-year olds would be included in the TESS sample. When meeting at the
well-child clinic, the health nurses gave further information about the TESS and obtained
written consent from those who volunteered to participate.

   As depicted in figure I, attendance at the health check-up was very high (97.2%; n =
3,358). However, children whose parents had insufficient proficiency in Norwegian were not
invited to the study (n = 176), and the health workers missed to ask some families to
participate (n = 166). Therefore, of the invited families (n = 3,456), 3,016 (87.3%) were
finally asked to participate, and 2,477 consented (82.1%).

   Based on a stratification procedure described in the following section, 1,250 of the
2,477 children were drawn to participate, and 997 finally met at T1. Overall, due to the

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[32] These checkups are not mandatory by law, but over time, a practice has developed in which most
parents adhere to these health controls as if they were obligatory.

characteristics of this recruitment procedure, the TESS sample is considered to be a community sample (Wichstrøm et al., 2012).

2.1.2   Screening and Stratification

Beyond this thesis, the general aims of the TESS included a focus on the prevalence of psychiatric disorders in preschoolers. To increase sample variability and thus statistical power, children were 1) screened for emotional problems, conduct problems, hyperactivity or inattention, peer-relationship problems, and psychosocial problems with the SDQ; 2) stratified into the study on the basis of their SDQ scores; and 3) oversampled, in the case when their SDQ problem scores were high.

The SDQ (a = 0.74) is a 31-item measurement of mental health problems in children from 4 to 18 years of age and meets the screening criteria for this age group very well (Sveen, Berg-Nielsen, Lydersen, & Wichstrom, 2013). Due to the findings that SDQ scores are substantially lower among children from Scandinavian samples compared to, for example, the United Kingdom or United States (see Sveen et al., 2013), the regular cut-offs were lowered to reflect the context of the current sample. As shown in figure II (appendix), the SDQ scores were divided into four strata: 0-4 (44.2% of the population), 5-8 (29.5% of the population), 9-11 (18.5% of the population), and 12-40 (7.8% of the population). In the next step, children with higher scores on the SDQ were *oversampled*: Using a random number generator, 38.1%, 49.1%, 71.4%, and 89.2% of children in Strata 1, 2, 3, and 4, respectively, were drawn to participate in TESS. This stratification procedure was taking into account when analyzing the data.

With respect to attrition during the recruiting phase, meaning the 253 children who did not participate at T1, the dropout rate was not related to the four SDQ strata (x^2 = 5.70, degrees of freedom [df] = 3, NS) or genders (x^2 = 0.23, df = 1, NS). Attrition beyond recruitment is outlined in Section 2.1.4.

2.1.3   The Participants

The final sample of 997 children (M_{age} = 4.5, standard deviation [SD] = .25) attended assessment at the university, and they were accompanied by one caregiver, the vast majority of whom were mothers (Fathers, T1: 15.3% [n = 130]; T2: 18.2% [n = 136]). Practically all caregivers (99.5%) were the child's biological parent (M_{age} = 35.1, SD = 5.0). For a summary of sample characteristic at T1, see Study I, Table 1.

The children were followed up two (T2) and four (T3) years later: 795 children participated at T2, when children had begun the first grade (M_{age} = 6.7 years, SD = .17), and 699 children participated at T3 when they were in the third grade (M_{age} = 8.8 years, SD = .24). Almost as many girls (49.5%, 51.3%) as boys (50.5%, 48.7%) participated at T2 and T3, respectively.

With consent from the parents, a child's primary teacher completed a questionnaire concerning the child's emotion regulation at T2 and T3 (there were approximately three children from each class participating in TESS, but some classes, and even schools, had only one participating child). Children in Norway start at school the year they become 6 years old, and the teachers who responded had known the child for an average of 6 months at T2 and 2.5 years at T3. The response rate was 99.1% at T2 and 86.1% at T3. Most teachers were female (84.6%, n = 666, at T2 and 77.7%, n = 470, at T3).

2.1.4   Attrition

As all three studies in this thesis involve longitudinal data, tests of systematic missing data were required. Attrition analyses were conducted for each study based on the variables included in the given study, as well as key demographic characteristics including gender and SES. No systematic missing data was detected in Studies I and III, but male gender and poor language comprehension bordered on significance (p = .055 and p = .064, respectively) in Study III.

In Study II, children's verbal comprehension predicted attrition from T1 to T2 (odds ratio [OR] = .99, 95%; confidence interval [CI] = .99-.99) and from T2 to T3 (OR =.99, 95% CI = .98-.99). Emotion regulation at T1 predicted attrition from T2 to T3 (OR = .51, 95% CI = .34-.76). However, when analyzing the total explained variance in attrition from T2 to T3, emotion regulation was no longer significant (OR = .68, 95% CI=.44-.1.06) and the combined effect of predictors of attrition was modest (Cox & Snell R^2 = .018, Nagelkerke R^2 = .039). The effect of predictors from T1 to T2 was also modest (Cox & Snell R^2 = .005, Nagelkerke R^2 = .009).

Notably, the sample size varied across variables and studies and also due to the software applied (SPSS for Study I vs. Mplus for Studies II-III), which manage missing data differently: whereas a complete case analysis was applied in SPSS, the Mplus handles missingness according to a full information maximum likelihood procedure that uses all available data, provided cases have values for the outcome. The sample size was 903 in Study I, 678 in Study II, and 921 in Study III. With respect to Study II, we only included the

children who were successfully genotyped (n = 678); however, the children genotyped did not diverge from those not genotyped on study variables except for verbal comprehension (*OR* = .99, *CI* = .98-.99).

2.1.5 Ethics

In Norway, research that relates to the Health Research Act[33] of 2009 must be approved by the Regional Committee for Medical and Health Research Ethics (REK) in the given region. The REKs are founded on the Norwegian law, research ethics, and international conventions such as the Declaration of Helsinki[34]. Before 2009, the law also required a separate approval from the Norwegian Data Protection Authority (NDPA), but from 2009 onwards, the REK became responsible for the judgment of data protection as well. As such, the launching of TESS in 2007 (T1) was approved by REK in Mid-Norway and the NDPA, and changes in focus and measures at T2 and T3 were approved by REK in Mid-Norway. See appendix for the consent forms that were signed by the parents.

Notably, Norwegian parents decide whether their child(ren) below the age of 16 should participate in research or not. However, according to the Children Act[35] (§ 33), the child's personal opinion should increasingly be taken into account as the child becomes older. Beyond the parent's responsibility, the research workers who met with the TESS children would pay attention to the child's motivation and comfort so as to not force the child to participate in the various tests and observations. Research ethics were discussed at the research group's regular meeting (every second week), and the research group also assured they comply with the Child Welfare Act[36].

In accordance with REK, the families received no compensation for participation as such. However, at each study wave, the parent received a gift card of the value of NOK 300, the child received small gifts (e.g., jump rope, pencil sharpener), and one of the families won a "travel lottery" for a value of NOK 40,000. If the family had moved from Trondheim (T2 and T3), travel expenses were refunded.

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[33] https://lovdata.no/dokument/NL/lov/2008-06-20-44
[34] https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/
[35] https://lovdata.no/dokument/NL/lov/1981-04-08-7#KAPITTEL_6
[36] https://www.regjeringen.no/en/dokumenter/the-child-welfare-act/id448398/

2.2 Measures

Please note that a summary of all measures is provided in Table B (see appendix). Due to the issue of copyrights, questionnaires, manuals, or other original material could not be included in the appendix. Thus, only the consent forms are attached.

2.2.1 Observational Measures

As detailed below, measures of attachment and parental sensitivity were observational. The research workers who arranged the observations had substantial experience with children (e.g., as public nurses or childcare teachers), and at least a bachelor's degree within a relevant discipline. Similarly, those who coded the observations had at least a bachelor's degree within a relevant discipline, and they were all certified for research-related coding. Blind coding was ensured (e.g., coders could not code both attachment and parent-child interaction of the same child, and research workers who also were coders would not code their own videos).

Research workers and coders attended meetings and boost sessions to ensure that protocols and manuals were followed properly. An experienced psychology professor with a specialization in clinical psychology led this work together with a specialized clinical psychologist.

Attachment representations (ages 4 and 6)

The children's attachment representations were assessed at T1 and T2 using the Manchester Child Attachment Story Task (MCAST), which is suitable for children ages 4-8[37] (Green et al., 2000). As regards story-completion techniques in general, some longitudinal studies have demonstrated that attachment measured with these methods can be predicted by early attachment in infancy as measured with the SSP (see Yuval-Adler & Oppenheim, 2014, for a review).

As regards the MCAST, and as summarized by Jin, Chung, and Hazen (2018) and Wan, Danquah, and Mahama (2017), among others, the psychometric properties of the MCAST have proven satisfactory across several contexts (e.g., Australia [Pasalich, Dadds,

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[37] In TESS (T1), mean age of the children was 53.0 months (range 46.3-63.0, *SD* = 2.1) (Wichstrøm et al., 2012). We consulted Jonathan Green who recommended MCAST for our sample but emphasized judgment of the child's maturity via the neutral "breakfast vignette." As such, some children were excluded (some were also excluded because of other reasons, including reluctance or tiredness). As outlined in the MCAST guide: "Children should be encouraged to play until it is clear if they really do not have the motivation/capacity to engage in the play task. If they clear do not the interview cannot proceed" (Green, Stanley, Goldwyn & Smith, 2008, p. 5).

Hawes, & Brennan, 2012]; Ghana, [Wan et al., 2017]; Italy [Barone et al., 2009]; Korea [Jin et al., 2018]; Norway [Hygen, Guzey, Belsky, Berg-Nielsen, & Wichstrøm, 2014], and the UK [Green et al., 2000]) as well as sample characteristics (e.g., community sample [Hygen et al., 2014]; sample involving ethnic minorities [Futh et al., 2008], and clinical sample [Pasalich et al., 2012]). The MCAST has displayed internal consistency and short-term stability, and it has correlated in anticipated ways with other key attachment measurements (Barone et al., 2009; Green et al., 2000). For example, insecure attachment has been cross-sectionally associated with higher levels of callous-unemotional traits (Pasalich et al., 2012), and secure attachment has been associated with higher levels of emotional competence (Colle & Del Giudice, 2011). Additionally, attachment disorganization has longitudinally predicted higher aggression and decreased self-oriented social skills (Hygen et al., 2014).
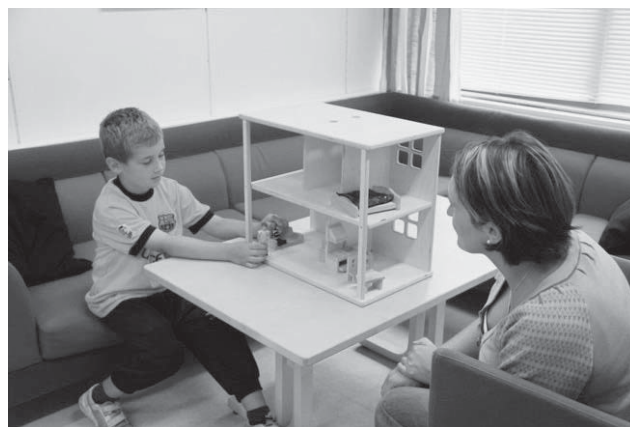
As described by Wan et al. (2017), the MCAST is set up as a doll play completion task that aims to capture attachment representations through the story stems and narratives. The picture[38] above shows the doll house used in the TESS. Initially, the child is shown a non-attachment-related vignette that is used to determine the testability of the child (i.e., a breakfast vignette). If the child is capable of this kind of play and storytelling, the vignette is followed by four attachment-related stories that the child is supposed to complete. The administrator establishes a story that includes a child doll and a mommy or daddy doll (depending on the gender of the parent that accompanied the child to the clinic). The family's ethnicity is also considered. Importantly, to avoid over identification, the child's identification

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[38] The persons depicted here are not study participants. Photo: private.

with the doll figures is emphasized but made *implicit* (e.g., "So this is the [name of child] doll and this is the mommy/daddy doll").

The MCAST stories begin with everyday neutral events followed by a sudden and distressing event: the child 1) is alone when waking up from a nightmare in the middle of the night, 2) hurts a knee while biking (close to their home), with pain and bleeding, 3) experiences acute abdominal pain when watching TV alone in the living room (with parent present in the kitchen nearby), and 4) loses sight of the parent while at a large shopping mall. This format is designed to activate the child's attachment system and, accordingly, attachment-related behaviors and thoughts, which resemble those used in the SSP and the "five adjective questions" in the AAI. After presenting the story, the administrator asks, "What happens next?" to facilitate the child's completion of the narrative. The child is then asked about the feelings experienced by the child doll and the parent doll.

The entire MCAST procedure was videotaped, and reliable coders were blind to any information regarding the child and family and coded each attachment vignette according to the MCAST coding manual (Green, Stanley, Goldwyn & Smith, 2008). Different teams coded T1 and T2, and all coders were certified in collaboration with the MCAST founders at the University of Manchester, UK. A random 10% of the MCAST videos were re-coded by blinded coders. As regards coders' agreement of security ratings, the *ICC* reliability (see e.g., Janson & Olsson, 2004) across multiple pairs of coders was .81 at T1 and .86 at T2. The respective *ICC* of attachment disorganization was .73 and .75. The categorical measure of secure attachment (B), which was applied in a set of secondary analyses (Study I), had an inter-rater reliability of $k = .77$.

Importantly, to increase statistical power, and to take into account variation across the MCAST vignettes, we chose a continuous approach for analyzing attachment security. Without violating the manual's principles, the TESS study (see (Hygen, Guzey, Belsky, Berg-Nielsen, & Wichstrom, 2014) has developed a transparent and analytic procedure, which considers that children's strategies may vary within and across vignettes: the primary categorization (A, B, C, and D) of each vignette is coded as 1 (present) or 0 (absent), and if present, secondary classifications are given a score of 0.5. The total attachment scores are computed by averaging the primary and secondary scores across the four-story completion vignettes. Consequently, a child who attained a primary classification of B on three of the total of four vignettes in the MCAST and a secondary classification of B on one vignette would be given a B score of .875 ([1 + 1 + 1 + 0.5] divided by four vignettes to attain a mean score). Accordingly, the highest B-mean score attainable was 1.0. Conversely, a score of 0

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would result if the child exhibited insecure or disorganized attachment at all four vignettes. Also, in terms of change in attachment (Studies II-III), a child could change from, for example, fully insecure (B = -1) to fully secure (B=1) attachment, or display no change at all (B = 0).

Parental sensitivity (T1)

Parental sensitivity was measured with the Emotional Availability Scales (EAS 4th Ed. Biringen, 2008) at T1. The EAS was developed to judge the quality of parent-child interactions. It is based on four parental scales: sensitivity, structuring, non-intrusiveness, and non-hostility, and two child scales: responsiveness and involvement. All six dimensions have a dyadic focus, meaning the parent cannot "look good" without considering the child's behavior in the interaction and vice versa (Biringen, 2000) p. 105). The psychometrics of the EAS are considered to be acceptable (Biringen et al., 2014).

Similar to the majority of EAS studies (see Biringen et al., 2014), this thesis only applied the sensitivity scale ($a = 0.82$), which, overall, emphasizes an emotional connection between the parent and the child (Biringen, 2008). In addition to genuine, spontaneous, and congruent parental affect, as well as the child's enjoyment of the interaction, this scale also involves the more classic aspects of sensitivity (see Ainsworth et al., 1978/2015) such as parental perception of, and responsiveness to, the child's signals and communications (for more details of the EAS, see Biringen et al., 2014; Saunders, Kraus, Barone, & Biringen, 2015).

The scoring of the EAS was based on 30-minute videotaped sessions of parent-child interactions at the university lab. The parent and child were left alone in a suitable and comfortable room with toys. The rooms had one-way mirrors such that the administrator could ensure that the dyads followed an instruction (simply by knocking on the window whenever the procedure should move on). The instruction was set out to ensure that all dyads were challenged in similar ways: The dyads were successively told that 1) they should engage in free play, 2) the child should guide the play, 3) the parent should lead the play, and 4) the parent should tell the child to clean up the toys independently.

Certified and blinded professionals coded the interactions according to the EAS manual. The sensitivity scale is from 7-29 (low to high), hence the reversed scale implies insensitivity (Biringen, 2008). A random 10% of the video clips were re-coded by blinded raters (ICC = 0.71). All coders were certified in collaboration with the founder of the EAS, Zeynep Biringen, at Colorado State University.

2.2.2 Questionnaires

For the sake of clarity, the SDQ (see 2.2.1) was applied *prior* to T1 (in the recruiting phase). The SDQ was otherwise not used in this work.

Temperamental effortful control (ages 4 and 6)

The widely used Children's Behavior Questionnaire (CBQ) (Rothbart et al., 2001) was applied to measure effortful control at T1 and T2. The CBQ is based on the reactive and self-regulative model of temperament (Rothbart & Derryberry, 1981), which involves the broad factors of negative affectivity, surgency, and effortful control. The present study applied the Norwegian versions of the CBQ for children ages 3-7, which were completed by the parents.

The standard version (195 items) of the CBQ was applied at T1, and the short version (94 items) was applied at T2. In accordance with the developers of the CBQ (Putnam & Rothbart, 2006; Rothbart et al., 2001), effortful control was based on the scales of attentional control (14/6 items), inhibitory control (13/6 items), low-intensity pleasure (13/8 items), and perceptual sensitivity (12/6 items). Both the standard and short version of effortful control yielded suitable reliability (a = 0.84 [T1], 0.75 [T2]).

Emotion regulation (ages 6 and 8)

Children's emotion regulation was measured with the Emotion Regulation Checklist (ERC) (Shields & Cicchetti, 1997) completed by teachers at T2 and T3. The ERC was translated to Norwegian and translated back to English, and this version was accepted by the founders of the ERC.

The ERC is based on Q-sort methodology and is designed to assess adults' perceptions of children's typical methods of managing their emotions. It is applicable for parents, teachers, and other adults who interact with children in the ages from 6 to 12. The ERC is widely used, and its reliability is supported (Curtis & Cicchetti, 2007; see also Molina et al., 2014; Campbell et al., 2016).

The ERC consists of 24 items on which the informants are asked to judge how characteristic each item is of a particular child on a Likert scale ranging from 1 (almost always) to 4 (never) (Shields & Cicchetti, 1997). The items are organized into two subscales where one is negatively weighted and the other is positively weighted: a) Lability/Negativity and b) Emotion Regulation. This research only involved the latter scale: Emotion Regulation (α = .78 [T2, T3]), which comprises eight items that describe situationally appropriate affective displays, empathy, and emotional self-awareness (e.g., "can say when s/he is feeling

sad, angry or mad, fearful or afraid," "seems sad or listless," "displays appropriate negative emotions in response to hostile, aggressive or intrusive acts by peers"). Notably, the exclusion of the Lability/Negativity scale was chosen in order avoid an outcome that too closely resembled the temperament trait "negative affectivity," which is suggested to be a susceptibly factor itself (Belsky et al., 2007; Ellis et al., 2011) and therefore would interfere with the focus of differential susceptibility (Study II).

2.2.3   Tests/Other

Language comprehension (age 4)
The children's receptive language ability was measured at T1 using the Norwegian version of the Peabody Picture Vocabulary Test (PPVT-III; Dunn & Dunn, 1997) (a = .98). The PPVT is a classic test of receptive vocabulary that can be used across ages (from 2.5 to 90+ years) and displays very strong psychometrics (e.g., Castellino, Tooze, Flowers, & Parsons, 2011). The child is shown four pictures and must select the one that matches the word orally presented by the examiner. The procedure takes approximately 10-15 minutes. Before the PPVT was applied in the TESS, a pilot study of 17 4-year olds was conducted with the Norwegian translation, and a few adjustments were made to ensure increased complexity during the test.

5-HTTLPR Genotyping and Distribution
At T2, spit samples were collected from those children (n = 716) whose parents had approved their child's participation in the genetic part of the TESS (see appendix). The spit samples were carried out using 2 ml of saliva applying the Oragene DNA/saliva kit (DNA Genotek, Ottawa, Ontario) and stored according to specific instructions to await the genotyping procedure.

As reported by the external laboratory that performed the genotyping (and as reported in Stenseng et al., 2017), DNA was later extracted and stored according to the manufacturer's protocol. Polymerase chain reaction (PCR) of the serotonin-transporter-linked polymorphic region (*5-HTTLPR*) was conducted with the Ampli Taq ® 360 DNA polymerase kit (Applied Biosystems, Massachusetts, USA). The amplification reactions were performed in a total volume of 25 μl containing 10-100 ng genomic DNA, 1.25 units of AmpliTaq 360 DNA Polymerase, 0.75 mM MgCl2, 16% (v/v) 360 GC Enhancer, 0.5 mM dNTP, and 0.3 μM of each primer. The *5-HTTLPR* marker was genotyped by size separation of the PCR product on the ABI 3730 DNA Analyzer (Applied Biosystems) and sized utilizing the GeneScan 600 LIZ

Size Standard (Applied Biosystems) and the ABI PRISM Gene Mapper ® software, version 4.0 (Applied Biosystems). The *5-HTTLPR* genotype frequencies were consistent with the Hardy-Weinberg equilibrium[39] ($\chi^2 = 2.77$, p = .10).

In total, 678 spit samples were successfully genotyped for *5-HTTLPR*: 18.4% (n = 125) of the children were identified as the SS genotype, 51.5% (n = 349) were identified as the SL genotype, and 30.1% (n = 204) were identified as the LL genotype.

Demographics

Parental socioeconomic status (T1)

Socioeconomic status (SES) was measured as the highest parental occupation in the family household (at T1), as coded according to the International Classifications of Occupations (International Labour Office, 1990). Professionals and leaders were grouped together as having "high" SESs, whereas farmers, fishermen, skilled, and unskilled workers were grouped as having "low" SESs.

Quantity of childcare (Prior to T1)

At T1, the parents filled in a questionnaire regarding the average number of hours per day and days per week their children were in childcare when they were at the ages of 6-12 months, 1-2 years, 2-3 years, 3-4 years, and 4-5 years. Prior work measuring quantity of childcare prospectively and retrospectively at the age of 5 years indicates that such retrospective reports are reasonably accurate (Vandell & Corasaniti, 1990). Quantity of care was computed as accumulated hours in childcare from 6 months to T1 (25th, 50th, and 75th percentiles = 3,948, 5,640, and 6,815 hours, respectively).

Gender

Child gender is specified in the tables (Study I, III).

2.3   Statistical Analyses

In line with the longitudinal design of this work, all analyses were based on regression models. Unfortunately, none of these studies involved paths that included more than two time

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[39] According to the Hardy-Weinberg principle a genetic variation in a population will remain constant from one generation to the next in the absence of other evolutionary influence (e.g. Oxlade, 2007).

points (attachment and effortful control was not measured at T3 and emotion regulation was not measured at T1), which excluded the possibility of ordinary growth modeling.

Notably, due to the stratification procedure (prior to T1), those children who were oversampled at the outset had equally *less* impact when estimating the coefficients—and vice versa. Thus, the regression coefficients reported in our work are estimations for the sample population, not the stratified sample itself.

2.3.1 Study I

In this study, we employed the Complex Samples General Linear Model (CSGLM) procedure in the SPSS software (version 19.00). First, all factors (i.e. effortful control [T1, T2], secure attachment, verbal comprehension, SES [and gender]) were standardized to z-scores. Secondly, to investigate the main and interactive effects of children's attachment on the development of effortful control, the factors were entered into the CSGLM in the following order: 1) the main effect of each factor unadjusted for all of the other factors; 2) the main effect of each factor adjusted for effortful control at T1 and gender; 3) all of the factors adjusted for all of the other factors; and 4) the interaction between secure attachment and gender. To correct for multiple testing, we applied the sequential Šidák correction[40] (Šidák, 1967).

To estimate the population coefficients, inverse probability weighting including the Horvitz–Thompson estimator (Horvitz & Thompson, 1952) was applied. This is the standard procedure to obtain unbiased estimates for the population from which the weighted samples are drawn. Consequently, all parameters were weighted with the inverse of the drawing probability for each participant i.e., children who scored low on the SDQ were "weighted up," and those who scored high were "weighted down".

2.3.2 Study II

Descriptive and regression analyses
In this study, we run all analyses in Mplus version 7.31 (Muthén & Muthén, 1998-2012). The effect of the development of attachment security on the development of emotion regulation was investigated via regression analyses within a structural equation framework. The level

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[40] The Šidák is known as a slightly less stringent correction than the more familiar Bonferroni correction.

(i.e., intercept, set at age 6) and change in emotion regulation from 6 to 8 years of age were regressed on the intercept (set at age 4), and change in attachment security from age 4 to 6. Additionally, change in attachment and change in emotion regulation were regressed on their respective intercepts, and verbal comprehension was adjusted for. Missing data were handled through a Full Information Maximum Likelihood procedure (see e.g., Enders, 2001). Due to the aforementioned lack of a third measurement point for attachment and emotion regulation, we sat the error terms to zero, which practically implies difference scores. Furthermore, by adjusting for intercepts in all analyses, regression to the mean was taken into account.

Again, due to stratification, all analyses were performed with weights proportional to the number of children in a specific stratum divided by the number of participants in that stratum; this strategy yielded corrected population estimates. A robust maximum likelihood estimator was applied, which also provided robust standard errors; notably, this approach is robust to moderate deviations from normality.

Testing for differential susceptibility

Because of our expectation that attachment development would have a stronger impact for the short-allele carriers and due to our focus on changes in attachment forecasting changes in emotion regulation, we used a *modified* version of Widaman and colleagues' (Belsky, Pluess, & Widaman, 2013; Widaman et al., 2012) competitive model-fitting approach for testing differential-susceptibility vs. diathesis stress:

First, the Widaman approach concerns whether the crossover point of the regression slopes among more and less susceptible individuals deviates significantly from the minimum and maximum observed values of the exposure. Thus, one does not test whether an interaction exists at the very outset. To ensure that we indeed had a GXE interaction (*5-HTTLPR*-X-attachment), we examined whether the effect of intercept and change in attachment on intercept and change in emotion regulation differed across the three allelic groups (SS, SL, and LL). This examination was conducted via a multi-group analysis, in which the model fit when fixing the regression coefficient as equal in two allelic groups was compared with a model with a freely estimated coefficient. The resulting difference in model fit was tested with a Wald test with 1 df. Because the literature is equivocal regarding the placement of the SL group (van Ijzendoorn et al., 2012), we examined whether the prospective effects differed between the SS and SL carriers, as well as between the SL and LL carriers.

Second, Widaman (2012) describes a procedure that test whether the crossover point differs from 0, which is appropriate if the lines cross near the y-axis. However, in our case,

that would imply testing for differences in emotion regulation when children mostly change and become more insecurely attached. The slopes may, however, also cross near the other end of the attachment spectrum (which runs from 0 to 1 in the present case), that is, when children predominantly become more securely attached over time. Therefore, we needed to test whether the crossover point was different from 1 (moving from insecure to fully securely). Also note that, similar to our analyses of main effects of attachment, baseline attachment was also controlled in the GXE analyses.

2.3.3   Study III

The analyses in Study III was quite similar to those run in Study II including identical procedures to account for stratification, missing and deviations from normality. All analyses were run in Mplus version 7.21 and started with descriptive and correlation analyses with all study variables (attachment security at T1 and T2, accumulated hours in childcare from 0-4 years of age, parental (in)sensitivity at T1, child language comprehension at T1, parental SES and child gender). In order to investigate the effect of quantity of care and parental (in)sensitivity on change in attachment, we thereafter conducted regression analyses within a structural equation framework (similar to Study II). The initial level and change in attachment representations from 4 to 6 years of age were regressed on centered hours in childcare from 0-4 years (divided by 1000), centered parental sensitivity (reversed) at T1, and the interaction of hours in childcare and parental sensitivity (reversed), while adjusting for SES and child language at T1 and gender.

3 RESULTS

This chapter summarizes the main findings from study I-III. Detailed results, tables and figures are provided in the studies/papers. Please note that Study II was published with additional (online) tables. These can be inspected in the appendix (S1-S3). Noteworthy here is that attachment security measured in these studies refers to the degree of attachment security and is measured at the level of representations (IWMs). However, a secondary analysis with a *categorical* variable of security (B) was run in Study I, and a secondary analysis with continuously measured *disorganized* attachment (D) was run in Study II (see below as well as in the papers). These secondary analyses were a result of the review processes with the journals that published the papers.

3.1 Study I

The aim of this study was to test 1) whether children's attachment security at four years of age could predict temperamental effortful control at six years of age—while controlling for initial levels of effortful control as well as gender, language comprehension and SES, and 2), whether this effect the effect would prove stronger with boys than with girls (i.e., an interaction effect).

Our preliminary analyses showed substantial stability of effortful control ($r = .62$) from ages 4-6, and an increase in effortful control across this period from preschool to school. Notably, girls scored higher on effortful control than boys at both time points, and the boys' effortful control scores at 6 years of age ($M = 4.98$, $SD = 0.52$) resembled the girls' effortful control scores at 4 years of age ($M = 4.92$, $SD = 0.40$).

On this background, a series of regression analyzes confirmed a weak positive main effect of attachment security on effortful control ($\beta = .07$; $p = .019$), and an interaction effect of attachment and gender in predicting effortful control ($\beta = 14$, $p = .014$). Secure attachment promoted boys' effortful control scores only[41] ($\beta = .15$, $p = .005$) [girls: $\beta = .01$, $p = .76$]).

Regarding the debates of categorical vs. continuous distribution of attachment, we further ran secondary analyses with attachment security as a *categorical* variable ($k = .77$). Now, the main effect of attachment remained significant ($\beta = .07$, $p = .03$), but gender as a

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[41] For the sake of order, the regression confidents of boys and girls were significantly different from each other (z=2.11; p=0.03).

moderator did not prove significant (β = -.09, p = .16). When analyzing boys alone the effect of categorical secure attachment was significant only as a trend[42] (β = .19, p = .09).

3.2   Study II

This study had more scopes than the previous study and the results were somewhat more complex. We investigated: a) the stability and change in secure attachment representations from ages 4-6, b) whether the development of attachment from ages 4-6 forecasted the development of emotion regulation from ages 6-8, and c) whether the latter prediction would be moderated by the *5-HTTLPR* polymorphism, and finally d) whether such a moderation statistically would form a pattern of diathesis-stress or (weak or strong) differential susceptibility.

a) Secure attachment representations were modestly stable (r = .28) from ages 4-6 and levels of security increased somewhat with age (mean growth per year (M_{growth}) = 0.08, 95% CI = 0.06-0.09, p = <0.001). To some extent, increased levels also pertained for emotion regulation from ages 6-8 (M_{growth} = 0.02, 95% CI = 0.00-0.05, p = 0.02) and the stability of emotion regulation was moderate of size (r = .43).

Notably, there were no differences in the levels of attachment security towards mothers vs. fathers at T1 [Mothers (M = 0.51, SD = 0.33), Fathers (M = 0.49, SD = 0.32) (t(804)= -0.64, p = 0.526)] or T2 [Mothers (M = 0.52, SD = 0.33), Fathers (M = 0.49, SD = 0.34) (t(653) = -0.93, p = 0.353)].

b) Higher level of attachment security at 4 years of age predicted a higher level of emotion regulation at 6 years of age as well as increased emotion regulation from the ages of 6 to 8. Moreover, children who evinced further increases in security from 4 to 6 years of age also evinced greater emotion regulation at age 6 and greater increases in emotion regulation from ages 6 to 8. Thus, there was an effect of change in attachment even when the intercept of attachment was controlled. Of note is that we also detected a genetic main effect: *5-HTTLPR* S homozygotes evinced decreased emotion regulation from ages 6-8 years compared with LL carriers (β =-0.10, p = 0.035).

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[42] Evidently, such framing of non-significant findings are not without controversies (Wood, Freemantle, King, & Nazareth, 2014). Nevertheless, we here demonstrated that results differ across dimensional and categorical approaches.

c) *5-HTTLPR* did not moderate the effect of age-4 level and ages 4-to-6 changes in attachment on the *level* of emotion regulation at age 6. However, the effect of change in attachment from ages 4 to 6 years on change in emotion regulation from ages 6 to 8 years did prove to be genetically moderated, in that the effect in question was strongest for the S homozygotes ($\beta = 0.63$, $p = 0.001$) and significantly different from that of the SL group (Wald $= 16.36$, $p = 0.001$) and LL group (Wald $= 5.33$, $p = 0.021$). Because the latter two groups did not differ from one another regarding this effect on change in emotion regulation, they were merged in the subsequent analysis.

d) Changes in attachment theoretically ranged from -1 (being fully secure at age 4 and becoming fully insecure at age 6), to 1 (being fully insecure at age 4 and becoming fully secure at age 6). Thus, a score of 0 indicates *no change* in attachment security over time. Because such scoring revealed that some children obtained scores of either -1 or 1, the crossover point central to distinguishing the two models of interaction should be significantly different from these maximum and minimum observed values to conform to differential susceptibility.

As depicted in Study II, the results from the modified Widaman et al. (2012) method provided support for the differential susceptibility model. Not only did the crossover point for the simple slopes of the two allelic groups — S homozygotes and L carriers — fall quite close to 0, but the 95% CI included neither the minimum observed value (i.e., -1) nor the maximum observed value (i.e., 1) (C = 0.29, 95% CI = -0.02-0.59).

Based on Belsky et al. (2013) we further investigated whether this finding pertained to weak or strong differential susceptibility: A strong model, in which the effect of change in attachment on later emotion regulation was fixed at zero for the L carriers, was compared with a weak model, in which the effect was freely estimated. By using Satorra and Bentler's (2001) procedure the difference in model fit proved significantly better when the estimates were freed ($\Delta X^2 = 6.05$, df $= 1$, $p = 0.01$), which supported weak differential susceptibility. However, the effect among L carriers (the combined SL/LL group) was modest ($\beta = 0.13$, $p = 0.01$) compared with the stronger effect among S homozygotes.

Secondary analyses and supplementary material

During the review process with Study II we were encouraged to run secondary analyses to further check our results by including parent reports of child emotion regulation and also focusing on disorganized attachment (see appendix for the respective supplementary tables).

Parent-reported emotion regulation as outcome with attachment security as predictor

The analyses were rerun with the parent-reported ERC (a = .65). The correlations between parent and teacher reports were only modest (r = .12 to .22); hence, similarity in the findings between teacher and parent ratings could not be expected. There were no main effects of attachment on parent-reported emotion regulation. However, findings resembling those obtained with teacher reports were found with respect to our GXE analyses: Increased attachment security predicted increased emotion regulation at 6 years of age for S homozygotes, and this result was significantly different from that of the LL group (Wald = 5.34, p = 0.021). Also, there was a tendency for S homozygotes to have a steeper increase than the SL group (Wald = 3.0, p = 0.084). Moreover, increased attachment security predicted increased emotion regulation from ages 6-8 for the S homozygotes, and this increase was significantly stronger than in the LL group (Wald = 4.30, p = 0.038). In sum, we concluded that the analyses with parent-reported emotion regulation replicated some of the teacher-generated data but were insufficient to conduct the original analyses of differential susceptibility vs. diathesis-stress.

Teacher-reported emotion regulation as outcome with attachment disorganization as predictor

To be noted is that our main findings pertained to the degree of attachment security. However, because children were categorized not only on the 'opposite' of security, that is on organized insecure attachment strategies (A and C), but also on disorganization (D), it could be that low security scores, and thus our findings, did not merely reflect insecurity but rather *disorganization*. As such, we further tested whether the effect of security would remain if we adjusted for disorganization (ICC = .73 [T1], ICC=.75 [T2]). The disorganization variable was scored similarly to attachment security, and these variables proved, not surprisingly given their partially ipsative relationship, to be highly and negatively correlated[43] (r= -.68 at T1, r = -.62 at T2).

The effects of disorganization on emotion regulation were first investigated alone. Higher disorganization at 4 years decreased emotion regulation at 6 years (β = -.32, p < .001) and from 6 to 8 years of age (β = -.21, p = .002). Furthermore, increased disorganization from 4 to 6 years of age predicted decreased emotion regulation at 6 years (β = -.23, p = .001).

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[43] Multicollinearity diagnostics revealed acceptable values (Variance Inflation Factors [VIF]) < 1.9).

However, the effect of increased disorganization on emotion regulation from 6 to 8 years of age did not turn out significant (β = -.12, *p* = 0.091). When all analyses from which these results emerged were rerun *controlling for attachment security*, all effects of disorganization were reduced to insignificance. These results dissuaded us from addressing the GXE issue using disorganization as the E variable.

In conclusion, the secondary analyses provided some additional, although not identical, evidence that attachment is related to future emotion regulation and that attachment disorganization does not add predictive power over and above attachment security.

3.3   Study III

The aim of this study was basically to replicate the NICHD findings of a dual risk of high quantity of care and low parental sensitivity in predicting attachment insecurity. First of all, our results showed that higher parental sensitivity was associated with greater attachment security at T2 but did not reach significance at T1 (*r* = .07, *p* = .064). Notably, parental sensitivity was negatively skewed (-.91, *SE* = .08); that is, most parents scored moderate to high on parental sensitivity, and none scored at the very lowest values. As regards distribution of childcare, 57.9% of the children spent more than the mean number of hours (5,243) in childcare from ages 0-5 (25% percentile = 3,948 hours, 50% percentile = 5,640 hours, and 75% percentile = 6,815 hours).

The regression results showed that lower parental sensitivity modestly predicted decreased attachment security over time (β = -.08, *p* = .015). While there was no significant relation between quantity of care and security, (β = -.03, *p* = .459) the interaction of quantity of care and parental sensitivity significantly predicted security (β = -.10, *p* = .006). Also, girls exhibited increased security in comparison to boys (β = 0.21, *p* = <.001) but SES and language comprehension did not explain any change in security.

Evidently, continuous x continuous interactions are not informative per se, hence secondary analyses were necessary in order to gain insight into the interaction effect. Because of the skewed sensitivity scale in this low-risk sample, and recommendations of applying meaningful values of the moderator (Cohen, Cohen, West & Aiken, 2003, see also Aiken & West, 1991), we chose to run multi-group analyses based on a cut-off point for low parental sensitivity. Thus, instead of using a simple slopes approach with plus/minus 1 SD (by default), we ensured that "low sensitivity" more likely reflected suboptimal sensitivity by calculating a cut-off point based on the scoring details provided in the EAS-manual (Biringen,

2008). This yielded a maximum EA-sensitivity score of 20.5, which, for the sake of order, was somewhat lower than below 1 *SD* (22.13).

While adjusting for all study variables, a multi-group analysis was then run with children of low sensitive (n = 75) vs. sensitive (n = 762) parents (84 cases became missing in this secondary analysis). When parents were low in sensitivity, more quantity of care predicted greater decrease in attachment security (β = -0.33, *p*= .009), but this same association proved insignificant in the sensitive subgroup (β = -.004, *p*= .917), i.e. for the majority of the sample. In order to visualize these results, we thereafter used the recommended procedure for plotting interaction effects with covariates in the context of growth modeling, which is provided by the Mplus's website.

Now, using Excel, the estimates from the multi-group analysis were plotted along with the mean levels of all study parameters, which produced a graphic interaction (Figure 1, Study III). For the sake of order, the (visual) trend of a curvilinear slope of the non-low-sensitivity subgroup proved insignificant (*p* = .097).

4 DISCUSSION

4.1 Summary of Findings

The overall aim of this thesis is to investigate parent-child attachment relationships across preschool to school age by studying attachment at the level of mental representations (IWMs). All analyses are based on the comprehensive dataset from an early phase of the Trondheim Early Secure Study (n = 997).

First, we investigated the effect of attachment security on the development of effortful control from ages 4-6 while including the perspective of child gender (Study I). Secondly, we studied the effect of change in attachment security from ages 4-6 on change in emotion regulation from ages 6-8 with the application of a GXE perspective, and we also addressed the question of stability and change in attachment itself (Study II). Thereafter, we continued on to study attachment security as an outcome by examining the role of childcare in the development of attachment security (Study III). Visualizations of the main results of this thesis are provided in the appendix (figure III, see also figure IV), and the findings can be summarized as follows:

- From preschool to school age, children's attachment representations were only modestly stable, increased attachment security across this period was the developing norm, and girls displayed more secure representations than boys did. The levels of attachment security did not differ by parental gender.
- In the context of low parental sensitivity (approximately 10% of the sample), children who spent higher amounts of time in childcare during their first four years of life showed decreased attachment security across their transition to school—beyond the effect of low parental sensitivity itself.
- Attachment security promoted self-regulatory capacities both in terms of temperamental effortful control and emotion regulation, but the effects differed with child characteristics:
    - Attachment security only promoted effortful control for boys.
    - While attachment security predicted increased emotion regulation for all children, the effect was much stronger for the presumably more reactive children: the *5-HTTLPR* homozygotes (18% of the sample).

- Change in attachment security forecasted change in emotion regulation in a "for better or worse" manner; children who were S homozygotes displayed the highest increase in emotion regulation when becoming more secure, but they also exhibited the highest decrease in emotion regulation when becoming less secure.
- Disorganized attachment, which was highly negatively correlated with attachment security, did not add any value to attachment (in)security in predicting the development of emotion regulation.

Beyond the focus of attachment, our study shows two additional results:

- Substantial rank-order stability but also normative increases in effortful control across the preschool years. Girls'[44] scores were higher than those of boys.
- A modest (genetic) main effect of the *5-HTTLPR* in predicting the development of emotion regulation from ages 6-8 years.

4.1.1   General Discussion

<div align="center">

Everything develops (Sroufe, 2009)

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Everything develops indeed. In this study, we have demonstrated that attachment representations have a rather dynamic quality during the late preschool years. When developing more secure representations of the parent, children's emotion regulation seems to prosper. Similarly, when such representations became less secure, they forecasted less adaptive emotion regulation. Because emotion regulation was measured through the context of peers, our findings further reinforce the claim that attachment has a particular function in organizing self-regulating behavior across contexts (Sroufe & Waters, 1977; Sroufe, 2016).

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[44] Not reported in any of our studies is that girls showed somewhat higher emotion regulation as well (ages 6 and 8, reported by both parents and teachers). There was no gender difference in language comprehension (age 4). Notably, based on their meta-analysis of verbal abilities, Hyde and Linn (1988) concluded that gender differences only slightly favored girls (mean effect size = .11). Recently, Toivainen, Papageorgiou, Tosto, and Kovas (2017) demonstrated how boys catch up with girls' verbal and non-verbal abilities between 4 and 7 years of age. Although the effects were limited, girls outperformed boys during very early childhood, boys outperformed girls in late middle childhood, and there were no differences in early middle childhood and early adolescence (Toivainen et al., 2017).

Moreover, this finding demonstrates *developmental validity*, which refers to when "change produced in the person's conceptions and/or activities carries over to settings and other times" (Bronfenbrenner, 1979, p. 35). Thus, the claim that attachment is an overrated phenomenon (Meins, 2017) is challenged by our results.

However, attachment security was a stronger predictor for some children's development than for others. In our low-risk sample, and in the context of ongoing[45] parent-child relationships, attachment security operated in a differentiated manner based on gender and genetic reactivity. As such, attachment effects may have been misspecified in previous attachment research (see also Groh et al., 2017).

Whereas girls did not benefit from secure attachment in their development of effortful control, boys' effortful control was facilitated by secure attachment. Similarly, change in attachment security strongly affected change in emotion regulation for the *5-HTTLPR* S homozygotes, but this effect was far less applicable to the *5-HTTLPR* L carriers. Moreover, and in accordance with the differential susceptibility hypothesis (Belsky, 1997), being an S homozygote was not only a matter of risk: when they became increasingly secure, these children showed the highest increase in emotion regulation of all children. For this reason, when conceptualizing attachment security as an environmental factor (E), attachment operated in a "for better and for worse" manner (Belsky et al., 2007) depending on characteristics of the child. It should be mentioned, however, that attachment may be less of an E than expected (Barbaro et al., 2017; Fearon et al., 2014); genetic factors have been reported with regard to *adolescents'* attachments, but not younger children's attachment, as in the current work (Bokhorst et al., 2003; Verhage et al., 2017); Fearon & Belsky, 2016).

Across our studies (I-III), most effects were modest in size. Notably, the effect of attachment on effortful control was weak (the main effect was $\beta = .07$, and the effect for boys was $\beta = .14$). This finding in contrast to the strong effect of change in attachment on change in emotion regulation for the *5-HTTLPR* S homozygotes ($\beta = .63$). Because the scopes, moderators, age span, and other factors differed across studies (I-II), making a comparison is somewhat problematic. Nevertheless, it could be argued that secure attachment representations seem a stronger predictor of regulation in the "emotional" domain than in the "cognitive/executive" domain (for an illustration, see Campbell et al., 2016). It should also be noted that attachment becomes increasingly difficult to measure with age (Marvin et al., 2016), thus measurement errors may hide the true scope of the effect. Yet again, such errors

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[45] After all, attachment theory emphasized the impact of loss or maternal deprivation.

likely do not explain the *relative* discrepancy between the coefficients of effortful control and emotion regulation.

The somewhat more limited effect of attachment on effortful control can also reflect the idea that emotions clearly are embedded in the attachment system and effortful control is less so. Arguably, when considering the developmental models by Main et al. (2005), our study of effortful control (Study I) was *somewhat* closer to a "pure prediction" (an outcome that does not reflect attachment) and the study of emotion regulation (Study II) seems *somewhat* closer to "functional equivalence" (an outcome that strongly mirrors attachment). Although pure prediction perhaps is the most interesting (Main et al., 2005), such research hypotheses may also approach the risk of trying to "explain everything" (see Sroufe, 2016).

With that said, effortful control is undoubtedly involved in the regulation of emotions (Eisenberg et al., 2014). It is possible that if we had measured effortful control in emotion-laden situations, the attachment→effortful control linkage may have proven stronger. However, the stability of effortful control ($r = .62$) was higher than the stability of emotion regulation ($r = .43$), and the latter was even measured in a later developmental phase. This finding implies that there was less variance that required explanation in the cognitive/executive domain than in the emotional domain. Kochanska and Knaack (2003) have compared the stability of effortful control to the stability of IQ, yet they identified higher stability of effortful control than we did ($r = .82$).

Because of the pivotal role of self-regulation in development (Phillips & Shonkoff, 2000), and because attachment security promoted self-regulation, the predictive ability of change in attachment becomes an important question. In Study III, we demonstrated that the dual risk of high quantity of childcare and low parental sensitivity decreased attachment security as children transitioned from childcare to school. Consequently, the NICHD findings of such cumulative risk in very young children (NICHD, 1997, 2001; Sagi et al., 2002) appear to extend far beyond toddlerhood.

In sum, change in attachment security was the rule more than the exception, attachment effects did not operate across the board, and the cumulative risk of childcare and parental insensitivity in attachment development extended to the start of school. To our knowledge, these findings have not previously been reported nor as prospectively studied in a low-risk and relatively large representative cohort sample of children ages 4-8 years. The more detailed discussion below may further illuminate the possible added value of these findings.

Against this backdrop, the order of the discussion is as follows: change and stability in attachment (Study II) (see 4.2); the role of childcare in attachment development (Study III) (see 4.3), the impact of attachment on emotion regulation (Study II) (see 4.4.1) and effortful control (Study I) (see 4.4.2), and finally an overall discussion of scientific challenges across the studies (I-III) (see 4.5).

4.2 Becoming Secure

4.2.1 The Plasticity of Attachment Representations During Preschool to School Age

Stability and change

When the TESS was launched, no comprehensive study of the stability of attachment representations across preschool to school age was available except for the short-term longitudinal work by Green et al. (2000) with a limited follow-up sample (n = 33). Now, our finding of modest stability ($r = .28$) is close to identical ($r = .32$) with the work by Stievenart et al. (2014) but contrasts the high stability (76%) reported by Green et al. (2000). More specifically, we replicated Stievenart's work with a community sample (the sample in Stievenart's study was a mix of referred and non-referred children), by providing estimates for the population, and across methods, by applying the Manchester Child Attachment Story Task (MCAST) instead of the more familiar Attachment Story Completion Task[46]. The latter point may also be regarded as a further validation of the MCAST (see e.g., Jin et al. 2018). Consequently, taken together, our findings have added value in further demonstrating the plastic nature of attachment representations during the transition to school age.

Although it is indeed possible that the more comprehensive studies are closer to the "true" stability, we cannot dismiss that large-scale studies are more prone to measurement error as regards observational measures. After all, with a smaller sample, there is a higher likelihood of coding synchronization (see Thompson, 2008 for a discussion of assessments in large-scales studies). Interestingly, the Green et al. (2000) study involved the founders of the MCAST, and the studies of other attachment experts with small samples have documented high stability (> 70%, with behavioral measures) across even long spans of time (e.g., Waters et al., 2000). However, smaller samples provide less variability, and hence more stability, by default. In fact, the body of "change and stability" attachment research has now provided

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[46] Also known as the MacArthur Story Stem Battery (MSSB).

mixed results for decades (see McConnell & Moss, 2011; Stievenart et al., 2014), and meta-analytic evidence points to moderate stability in general (Fraley, 2002; Pinquart et al., 2013). Crucially, the most comprehensive study to date (Groh et al., 2014), which included a larger sample size than the aforementioned meta-analyses, documented an overall *weak* stability in attachment ($r = .12$). For this reason, even if we studied change continuously at the level of representation and in a low-risk sample, which is associated with higher stability (Fraley, 2002), the true stability during preschool is unlikely to be very high.

Progress towards more secure attachment representations?

Beyond change in attachment security, we also identified *increased levels* of security. In this way, there was normative progress towards more secure attachment representations, which may not be surprising with regard to the significant socio-cognitive changes that take place during this time span across preschool to school (e.g., theory of mind advancement [Curenton, 2011; Astington & Claire Hughes, 2013]). In fact, the trend of increased security has been indicated by others, to some extent, in studies of attachment development among younger children (see Solomon & George, 2008) as well as in a risk sample (Vondra et al., 2001). Moreover, this trend corresponds with longitudinal (Stievenart et al., 2014) and cross-sectional (Gloger-Tippelt & Kappler, 2016) findings of increased security and decreased disorganization with age in older children. Apart from increased levels of attachment security, we also demonstrated increased levels of effortful control (Study I) and, to some degree, also of emotion regulation (Study II). Thus, overall, the progression towards security relates to a general developmental trend across preschool to school.

Bowlby (1969/1982) postulated that the goal-corrected partnership (from ages 3-4) is the very latest stage of the attachment ontogenesis and that changes afterwards are rather quantitative in nature. The increased security perhaps shows how children gradually influence their parent (their secure base) by more clearly negotiating different needs and plans. Of interest here is Marvin's (1977; see also Marvin et al., 2016) discussion of how the relationship gradually emerges:

> By 4 years the child has developed the skills most basic to this new relationship, and that at this point he can apply these skills in relatively simple and familiar contexts. Then, over the next few years, the skills, and the relationship, become increasingly extended, consolidated, and mature (Marvin, 1977, p. 55).

However, we cannot rule out that increased security in ages 4-6 also relates to issues of validity and confounding factors. Although our work focused on attachment security (B) and not the complete ABCD pattern, some secondary analyses were conducted with attachment disorganization (D) (Study II), and D was found to be strongly negatively associated with attachment security ($r = -.68$)[47]. As such, increased levels of attachment security increased the probability of decreased levels of disorganization by default because, in total, the A, B, C, and D categories were ipsative.

Historically, the D group was first "unclassified" (Ainsworth et al. 1978; Waters, Bretherton & Vaughn, 2015). In a recent paper, Reisz, Duschinsky, and Siegel (2017) discussed Bowlby's unpublished texts on disorganization (made available via the John Bowlby Archive). It turns out that Bowlby did not agree with Main and Solomon's *categorization* of disorganized behavior (Reisz et al., 2017). In fact, Bowlby abstained from operationalizing disorganization, and he suggested that Main and Solomon should have rather called the behavior a *status*, not a *pattern* (Reisz et al., p. 6). However, disorganized behavior was not prevalent among Ainsworth and colleagues' small sample. Disorganized attachment behaviors (e.g., fear of caregiver, freezing [Main & Solomon, 1990; see also Granqvist et al., 2017]) are frequent in high-risk samples (Waters et al., 2015). In the case of severe maltreatment, the rates of disorganized attachment come close to 90% (Cicchetti et al., 2006; see also Zeanah et al., 2011). Indeed, disorganized attachment is of high clinical significance (Lyons-Ruth & Jacobvits, 2016; Granquist et al., 2017) and predicts, for example, externalizing (Fearon et al., 2010; Madigan et al., 2016) and internalizing behavior (Madigan et al., 2016).

Nevertheless, the understanding of disorganized attachment is not very straightforward (Granqvist et al., 2017). For example, although the present work took secondary attachment classifications into account, such secondary classifications are rarely reported. When van IJzendoorn and colleagues (1999), as a part of their meta-analytic work, contacted authors for more detailed attachment scores, they found that in 20 out of 25 samples (n = 1,219), D was combined with organized (ABC) attachment. In 14% of the cases, disorganization was combined with a secondary secure pattern (i.e., a D/B combination) (van IJzendoorn et al., 1999).

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[47] For the sake of order, the categorical measures were also negatively correlated (-.48** [T1]; -.42** [T2]).

A relevant speculation may suppose that disorganization, as measured at the level of representations among preschoolers, involves rather different aspects of development. Some children may be immature, others may indeed be traumatized or neglected, others again may be both. In fact, disorganization is even associated with being *male* (see further discussion below). Apart from such speculations, we found that disorganized attachment had *no added value* to (the degree of) attachment security in explaining the development of emotion regulation (Study II).

At any rate, in this age group, confounding developmental variables should be considered (Green et al., 2000). For instance, the assessment of IWMs can be confounded by cognition and language (Solomon & George, 2016; McElwain, et al. 2008). Of note in this regard is also the finding that reasoning IQ influenced the development of secure representations (Stievenart et al., 2011). Unfortunately, though, the TESS did not provide a measure of IQ before T2. Nonetheless, we can shed some further light onto Stievenart's (2014) finding that the gender effect in attachment narratives (i.e., girls' higher security) disappeared when language abilities were controlled. Because of their referred sample, Stievenart et al. recommended their study be replicated with a sample of normally developing children. Also, in a comprehensive review of attachment research, Fearon et al. (2016) recommended further investigation of a possible spurious effect of attachment representations due to language abilities. In our work, language comprehension was only weakly correlated with attachment security at T1 and T2 and did *not* predict change in attachment in the multivariate analysis (see Table 2, Study III). As footnoted on p. 60 in this thesis, gender differences in language abilities are very limited (Hyde & Linn, 1988) and seem to disappear during the preschool years (Toivanen et al, 2017). Even though we only adjusted for language comprehension (not language production), girls' narrative production seemed to relate to factors other than language per se.

4.2.2   Gender Differences

Boys' and girls' narratives
As expected, girls evinced more secure representations (Study I, III). In fact, gender was the strongest predictor of increased change in attachment of all of the variables in our study (β = .21, see Table 2, Study III). Previous research has demonstrated that girls' attachment narratives are more secure, coherent, and organized than those of boys, even across cultures (Pierrehumbert et al., 2009). In a study (n = 69) by George and Solomon (2016), the

correlation between attachment representations and gender was 0.28, which is nearly identical with our study (see Table 2, Study I). George and Solomon reported that boys amounted to 74% of the disorganized-caregiving group and 100% of the disorganized-punitive group. Moreover, mothers were rated as more helpless with boys than with girls. Before this publication, Gloger-Tippelt and Kappler (2016) applied a pooled analysis (> 20 samples [n = 887]) and reported that among 4-8 year olds, girls were 1.8 times more likely than boys to present secure attachment narratives and 0.4 times less likely to present disorganized narratives. As regards MCAST in specific, the issue of gender differences is mixed, such that some studies have identified differences (Del Giudice, 2008) and others not (Jin et al., 2018).

Notably, with regard to children's narrative capacities (as in the MCAST), girls' narratives are *generally* more complex than those of boys. Girls elaborate more, and they construct more emotionally expressive narratives (von Klitzing et al., 2000; Fivush & Zaman; 2015). Furthermore, children *co-construct* their narratives with their parents, and mothers and fathers may contribute to different aspects of the emotional narrative (Oppenheim, Emde, & Wamboldt, 1996). Girls' narratives reflect their mothers' communication styles, and fathers' communications are less elaborate and expressive than those of mothers, yet more so with daughters than with sons (Fivush & Zaman, 2015). It is possible that girls seek and prefer the more mentalizing and emotional conversations with their mothers (Fivush & Zaman, 2015), which, from an evolutionary perspective, would prime girls for skills that become useful in their future motherhood (see (Bjorklund & Ellis, 2014). On the other hand, observed gender differences could be due to gender *identity* (self-perceived gender) rather than *categorical* gender (i.e., sex) (Grysman & Fivush, 2016).

In addition to immaturity, it could be the case that some of the more "disorganized" elements measured in the MCAST relate to spontaneous play-fighting that normatively are less displayed among girls (see also Toth et al., 2013). However, boys' behavior should also not be underestimated. In fact, there have been indications that boys may react differently to parenting than girls. David and Lyons-Ruth (2005) reported that boys more often than girls displayed insecure and disorganized behavior when maternal behavior was frightening.

Boys' and girls' socioemotional development and the emerging relationship
Further on, when inspecting our results as a whole (Study I-III), gender differences were detected across all of our three developmental outcomes (i.e., emotion regulation, effortful control and attachment itself; see figure IV, appendix). Only language comprehension did not differ by gender. Thus, even if gender differences should not be overstated (see Hyde, 2005

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for a critical discussion), socioemotional gender differences may be more than artifacts. Longitudinal brain research has demonstrated that gender moderates children's brain development trajectories[48] (e.g., girls cerebral volume peaks at age 10 and boys cerebral volume peaks at age 14; Lenroot et al., 2007) and that females' social brain matures earlier than males' (Mutlu et al., 2013; see also McCarthy, 2015 for a general discussion of brain gender differences). In Study I, we demonstrated that boys' effortful control at 6 years of age was comparable to girls' levels at 4 years of age. We also showed that this gender difference was still present at 6 years of age and that only boys' effortful control benefited from attachment security. These findings may further support the notion that developmental pathways differ across gender and that attachment therefore may be a stronger force for the self-regulation of boys than for girls during the preschool years (the latter finding also implies that attachment security, as measured with the MCAST, has predictive validity for boys; see also Section 4.4.2).

Conceivably, what could be suggested is that the *emerging relationship* (see Marvin, 1977) manifests earlier among girls than among boys. In other words, the ontogenesis of attachment (see Bowlby, 1969/1982) may differ by gender. When taking into account that the capacity for theory of mind (Adenzato et al., 2017; Baron-Cohen, 2010) and tender-mindedness (see (Hyde, 2014; Weisberg, DeYoung, & Hirsh, 2011) seems to be higher among females, such that girls may more easily negotiate and advance goal-corrected partnerships with their parents. Arguably, this could explain, at least to some extent, the typical lack of gender differences when (more straightforwardly) measuring attachment at the level of behavior and the evident gender differences, which now are increasingly reported (see Toth et al., 2013), when moving to the level of representation.

4.2.3 The Role of Parental Gender

Parental gender and parental sensitivity

As regards the development of attachment security, high parental[49] sensitivity predicted increased security across preschool to school age, but the effect was weak (β = -.08) and the cross-sectional coefficient at T1 did not reach significance (Study III). It should be noted,

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[48] Trajectories are long-term pathways of development. Developmental transitions are embedded in such trajectories and evolve over shorter time spans (Caspi & Roberts, 2001, p. 54). As such, this thesis focuses on transitions more than trajectories.
[49] Please note that the role of single parenting or same-sex couple parenting was not addressed in our work.

however, that the sensitivity scale was skewed. It yielded somewhat less variation than expected, and the inter-rater reliability was sub-optimal, which further may have caused misspecified coefficients. With that said, the effects of (maternal) sensitivity are generally small to modest in size (Fearon & Belsky, 2016), and beyond very early childhood, sensitivity becomes a somewhat weaker predictor of attachment security (McConnell & Moss, 2011).

It is noteworthy that 15% (T1) to 18% (T2; attachment was not measured at T3) of the parents in our sample were fathers, and *paternal sensitivity* usually predicts less variance in children's attachment than mothers' sensitivity does (for meta-analyses, see De Wolff & van Ijzendoorn, 1997; Lucassen et al., 2011). Moreover, because children seem to report greater safehaven caregiving from mothers and greater secure base caregiving from fathers (Kerns, Mathews, Koehn, Williams, & Siener-Ciesla, 2015), and the MCAST focuses on safe haven (typically "comfort") more than secure base (typically "support"), this distinction may have further weakened the sensitivity effect on attachment.

Notably, we did not investigate if the (measured) paternal attachment representations were independent of the (unmeasured) maternal attachment representations. The concordance of maternal and paternal attachment is not a clear-cut case (Boldt, Kochanska, Grekin & Brock (2016; Sroufe, 2016). The now-dated meta-analysis by Fox, Kimmerly, and Shafer (1991, see also Howes & Spieker, 2016) discerned a modest concordance. Recent work by Di Folco et al. (2017), who administered the MCAST to 6-year olds, demonstrated that 58% of their sample (n = 117) were securely attached to both parents and that maternal and paternal attachment representations were highly correlated ($r = .55$).

More importantly, Di Folco and colleagues also administered the Secure Base Script Test (Psouni & Apetroaia, 2014) to a subsample one year later. The Secure Base Script Test does not differentiate between maternal and paternal attachment, but it measures *general* scripted secure base and safe haven knowledge (Psouni & Apetroaia, 2014). Di Folco et al. (2017) demonstrated that paternal attachment, as measured with the MCAST, converged with the Secure Base Script Test, but the same pattern did not yield the same results for *maternal* attachment. Di Folco et al. launched several explanations of this latter finding, of which some are related to features of the MCAST already discussed above. Crucially, however, they suggested that paternal representations possibly reflect a more *generalized* representation of self and others, whereas maternal representations reflect the very particular relationship with the mother. Di Falco et al. (2017) concluded that this finding may limit the value of the MCAST as a measure of paternal attachment.

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When and how different attachment strategies to different attachment figures are organized with integrated representations of self and others (as measured with the AAI) is among the most significant puzzles in attachment theory (see e.g., Boldt et al., 2016). As measured among infants, attachments to mothers and fathers are independent factors (Sroufe, 1985; Main & Weston, 1981; see also Bretherton, 2010), and in accordance with, for example, Waters, Bretherton, and Vaughn (2015, see also Sroufe, 1985; 2005), we treated attachment as a relationship and not a trait of the child. However, it is still debated whether attachment is unique to the relationship or a quality of the child, or perhaps, over the course of development, it may change from relationship-specific to being descriptive of the individual (Boldt et al., 2016).

In that sense, we *may* have tapped into the developmental issue of the timing of more integrated attachment representations, which develop from early middle childhood (Dykas, Woodhouse, Cassidy, & Waters, 2006; Psouni & Apetroaia, 2014). For this reason, not only may paternal attachment confound our findings, but our operationalization of attachment as E (in GXE) could here involve the specific maternal representations as well as the more general attachment style in progress (i.e., attachment becoming more trait-like).

On the whole, then, our results should be interpreted in light of the fact that all statistical analyses (Study I-III) were run without accounting for parental gender. With an overall focus on interaction effects, this was primarily an issue of statistical power.

Family equality?

Nevertheless, as shown in Study II, there were no differences in the levels of attachment security with mothers vs. fathers neither at T1 nor at T2. Thus, the children in our study did not portray more secure maternal attachment than paternal attachment, which is in accordance with Di Folco et al. (2017), who also included a continuous security approach. In the aftermath (not reported in any study), I also tested whether parental sensitivity (measured at T1) differed by parental gender. There was a small yet significant effect: fathers were coded as *slightly* less sensitive than the mothers (Fathers [M = 24.49, SD = 3.21], Mothers [M = 25.32, SD = 2.97]; t[844] = -2.9, p = 0.006), which is a finding that, for example, could be due to actual less sensitive father-child interactions or the fact that all EAS coders were female.

Because the current research was situated in a relatively egalitarian context where almost as many women as men work (Statistics Norway, 2017), parental gender may be less likely to confound the results (compared to, for example, a patriarchal society [see Dette-

Hagenmeyer et al., 2014]). Indeed, so-called "maternal gatekeeping,"[50] which could interfere with the father-child attachment relationship, is by definition less likely to take place within more modern families. In fact, by virtue of accompanying their young child to the clinical assessments in the TESS, the TESS fathers showed involvement in their children's daily lives. What we cannot answer is whether these fathers were representative of Norwegian fathers' daily involvement. Of note here is a study by Costigan and Cox (2001; see also Lucassen et al., 2011), who identified that fathers who attend "family research" tend towards higher family involvement and more positive functioning (e.g., better quality of marriage), and involved fathers are more likely to have securely attached children (Brown, Mangelsdorf & Neff, 2012). With that said, recall that we oversampled children at risk based on their SDQ scores.

4.3   Does Quantity of Childcare Compromise Attachment Development?

4.3.1   Replication and Extension of the NICHD Study

As the use of non-parental care rose in the industrialized world, so did concerns and debates about children's attachment relationships. To add to the literature on determinants of change in attachment, we therefore built upon the thinking that children's development most often is comprised in the context of multiple rather than single risk factors (i.e., cumulative risk; Evans et al., 2013; Belsky, 1986), and the NICHD findings that the dual risk of much time in childcare and low parental sensitivity predicted decreased attachment security (NICHD ECCRN, 1997, 2001; see also Sagi et al., 2002).

As far as I know, our results are the first to demonstrate that such dual risk, earlier identified in the USA (NICHD ECCRN, 1997, 2001) and Israel (Sagi et al., 2002), extends a) beyond infancy and toddlerhood, b) to measured attachment *representations* (IWMs), and c) to the context of a Scandinavian welfare state. Additionally, we controlled for SES. Thus, along these lines, dual risk appears to be a robust risk factor that cuts across age, context, and method[51]. Recall, however, that we analyzed *continuous* change in attachment security, an approach that may identify effects that otherwise are hidden with pure categorical approaches

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[50] "Maternal gatekeeping is conceptualized within the framework of the social construction of gender and is defined as having three dimensions: mothers' reluctance to relinquish responsibility over family matters by setting rigid standards, external validation of a mothering identity, and differentiated conceptions of family roles" (Allen & Hawkins, 1999, p. 199; see also Di Falco et al., 2017).
[51] For the sake of order, sample sizes were not too different across contexts: US = 1,281; Israel = 758; Norway = 921.

(Futh et al., 2008). Dual risk may thus not produce insecure attachment representations but rather less secure representations. Nevertheless, those children who were relatively insecure at the outset may have further progressed into more consolidated insecure representations.

Ultimately, knowledge of determinants of change in attachment is important due to the central role of attachment in children's development (Sroufe, 2016), social development and externalizing problems in particular (see Groh, Fearon, et al., 2017). Because findings from infancy and toddlerhood may not be generalizable to a later time in development, the present finding of the role of dual risk throughout the preschool years represents added value. Indeed, preschoolers' secure attachment representations buffer against externalizing behavior (Roskam et al., 2011) and promote the development of emotion regulation (Study II). Deteriorating security due to this dual risk may hence have a cascading effect on socioemotional problems.

As Study III showed, childcare in and of itself did not compromise attachment development. In fact, negative main effects of childcare quantity on attachment security have more recently been reported only when the quantity of childcare is extreme, such as more than 60 hours per week (Hazen et al., 2015), or when attachment sub-categories are studied (Umemura & Jacobvitz, 2014). By contrast, *positive* changes in attachment security were identified among Mapuche infants in Chile who attended full-time childcare (Cárcamo et al., 2016). Due to Cárcamo and colleagues' lack of focus on the quantity of care, as well as the very different characteristics of the Chilean sample (e.g., in terms of poverty, single parenthood, children's ages, etc.), comparison of findings may not be a straightforward matter. Indeed, contextual factors have been emphasized by many researchers (e.g., Aviezer & Sagi-Schwartz, 2008; Love et al., 2003; Vermeer et al., 2016).

Quality of childcare
Following up on the NICHD childcare→attachment findings (1997, 2001), Sagi et al. (2002) reported a main effect of center-based care in their study of Israeli infants, which they interpreted to be a result of very poor quality caused by a high infant-caregiver ratio and insufficient training of staff. In fact, Sagi and colleagues concluded that the infant-adult ratio, *not the amount of care*, was the more robust predictor of infants' attachment, independent of mothers' caregiving. Moreover, in a successive publication by Love et al. (2003), combined results from studies across three contexts (Australia, Israel, and US) indicated that quality of care may moderate the effect of quantity of care depending upon the given context. Consequently, even if the NICHD study was launched to answer the childcare controversy,

Love and colleagues questioned the NICHD findings' generalizability across contexts. As such, we cannot rule out that quality of care possibly could account for our dual risk finding.

The present issue of dual risk was, however, not a focus in the Love et al. (2003) study, and analyses of three-ways interactions were not reported (i.e., maternal sensitivity-quantity-quality). Furthermore, there was a lack of evidence of quality-quantity interactions or quality effects that accounted for quantity effects when investigating attachment security and other developmental outcomes in the NICHD study (NICHD ECCRN, 1997; 1998; 2001; Belsky et al., 2007; Vandell et al., 2010). Having said that, recent work (based on > 7,000 observations) has shown that quality of care is generally higher in Australia and New Zealand, and that quality in the US is higher than in Europe, South America, and Asia (Vermeer et al., 2016).

Interestingly, "the better provision of Norway's children in early years education and care study" (*Gode barnehager for barn i Norge* [GoBaN[52]]) has now published their very first findings: Eliassen, Zachrisson, and Melhuish (2018), have demonstrated that, irrespective of SES, the quality of Norwegian childcare does not predict cognitive development. However, Bjørnestad and Os (2018) reported that the general quality of Norwegian childcare is lower than expected. Because the TESS children attended childcare in an earlier phase of the Norwegian childcare expansion[53], findings from the GoBaN may not be directly comparable to the TESS. In fact, we cannot rule out that quality even could have been worse for the TESS children. However, teacher-child relationships were not investigated, and the mediocre quality rather related to issues such as insufficient hygiene and safety procedures Bjørnestad and Os (2018).

4.3.1.1 Possible Explanations of Cumulative/Dual Risk

This research has brought up the question of why high quantity of care and parental insensitivity would pose a cumulative risk to attachment development. Theoretically, childcare is supposed to affect attachment development either because of the separation itself

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[52]GoBaN is the first major study in Norway to focus specifically on the quality and effectiveness of ECEC http://www.hioa.no/Forskning-og-utvikling/Hva-forsker-HiOA-paa/FoU-ved-LUI/Better-Provision-for-Norway-s-children-in-ECEC

[53]As outlined by e.g., Solheim (2013), from 2005 onwards, it became a political goal to provide childcare for all children from their first birthday. This goal was formalized by law in 2009 and followed up with state subsidies to ensure a maximum monthly childcare fee of 2,330 NOK (approximately $300).

or because parents who work behave differently towards their children (see Jaeger & Weinraub, 1990). Moreover, childcare centers are arenas in which attachment behaviors and needs are evoked, but typically without the presence of the (likely) preferred attachment figures (i.e., the parent).

Many Norwegian children spend longer hours per week in childcare than their parents typically are "allowed" to work (41 vs. 37.5 hours, respectively), and they thrive somewhat less in childcare than their parents assume (Bratterud et al., 2012). In addition, a substantial amount of (Danish) preschoolers reported that their parents have little time for them (Børnerådet, 2017). With accumulated hours in care, Norwegian toddlers show substantial tiredness (Undheim & Drugli, 2012). In fact, a toddler's cortisol is higher in childcare than at home, especially among those who spend more than 7 hours per day in childcare (Drugli et al., 2017; Vermeer & Groeneveld, 2017). Of note is that Drugli et al.'s (2017) finding was not moderated by quality of care or child or family characteristics. In spite all of this, we did not detect a main effect of quantity of childcare on the development of preschoolers' attachment representations (Study III). The question thus arises of how we can understand that long hours in childcare amplify the negative effect of low parental sensitivity, or vice versa, that low parental sensitivity transforms childcare into a negative factor.

Based on the pioneering work of Ainsworth, Oppenheim and Koren-Karie (2013) emphasized that (observable) parental sensitivity behavior builds on the parents' capacity for *insightfulness* (or mentalizing). For this reason, the less sensitive parents may relate to their children's childcare experiences and emotional well-being to a lesser degree. As measured in Study III, parental sensitivity involves, for example, shared affect, amount and enjoyment of interaction, and acceptance of the child (Biringen et al., 2014; Saunders et al., 2015). Consequently, insensitive parents may further share less positive affect and enjoyment when first together with the child. Eventually, what may be at stake here is the child's view of the caregiver as an available source of stress reduction, which is the core of the attachment system (see Schore, 2000).

Previous results derived from the TESS have shown that accumulated time in childcare predicts greater childcare-teacher-child conflict (i.e., a main effect of quantity of care) (Solheim et al., 2013), and children with less sensitive parents are more likely to engage in sub-optimal interactions with childcare teachers and peers (see Biringen et al., 2014). Taking into account that children's sociable systems (Bowlby, 1969/1982) are most activated when the attachment system is de-activated (Cassidy, 2016), children with less sensitive parents, who spend long hours in childcare, and who possibly are in conflict with the

caregivers there may experience that their attachment systems become overloaded. Arguably, these factors do not promote representations of the parent as a secure base.

Interestingly, compared to children with sensitive parents, children with less sensitive parents displayed *increased* attachment security when quantity of care was at a minimum (Figure 2, Study III). Thus, for some children the mere presence of the parent during daytime should perhaps not be underestimated. This result could potentially relate to indications that mothers with lower education (and often lower income) have the greatest difficulties in balancing work and caregiving (Bianchi, 2011; Hsin & Felfe, 2014). According to Hsin and Felfe (2014, p. 1885), less-educated women who work full time spend 16 fewer hours per week exhibiting caregiving behaviors. Although we controlled for SES in Study III, we did not, for example, involve the issue of single parenting. Indeed, the consequences of less sensitive caregiving may be amplified if the family experiences more stress and the parent-child dyad has little time to repair the relationship[54] (see Tronick & Beeghly, 2011). After all, this is now a discussion of low sensitivity in the context of a low-risk sample as opposed to extreme insensitivity, as more often seen in high-risk samples (see Out, Bakermans-Kranenburg, & Van Ijzendoorn, 2009 for a discussion).

As long as the parent is sensitive to the child's attachment needs, the potential strain of long hours seems to be no threat to the developing IWMs. Again, robust relationships between children and caregivers are considered to be a matter of continuous reparation of "interactive errors" that takes place within the dyad (see e.g., Tronick & Beeghly, 2011). Of interest here is the finding that working mothers who worry about their children's welfare when separated attempt to compensate for time spent apart (Booth, Clarke-Stewart, Vandell, McCartney, & Owen, 2002). As such, the predictable routine of being separated and reunited with a caring parent, and meanwhile spending the day in a supportive environment, may build clear representations of the parent as available and helpful, at least if the child's stress tolerance is not overloaded; cognitive functioning has been found to be optimal at moderate levels of cortisol (activation) (see Suor, Sturge-Apple, Davies, Cicchetti, & Manning, 2015).

Overall, the current findings somewhat support Bowlby's (1973; see also R. Bowlby 2004) notion that prolonged separation from the caregiver may affect attachment relationships even in the late preschool years, but only in the context of cumulative risk.

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[54] In my original work, before the submission of Paper III, I had also identified an interaction effect of quantity of care and *externalizing* problems. Thus, in *addition* to the finding of quantity of care and parental (in)sensitivity, children with externalizing problems increased their attachment security when childcare was at a *minimum* and vice versa. Crucially, externalizing problems did not confound the effect of quantity of care and parental (in)sensitivity (Study III).

4.3.2   The Continuous Expansion of Childcare

The effect of childcare on attachment security has been a delicate research topic for about six decades. In the end, attachment is a multi-determinant outcome (Thompson, 2008; Vaughn et al., 2016), and family influences are generally and consistently stronger and more pervasive than childcare effects (Solheim, 2013; Phillips & Lowenstein, 2011), which generally are modest in size (Thompson, 2008). Nevertheless, the use of childcare is expanding, which, for a variety of reasons, is a desired policy (Europea, 2013) and pertains to the needs of the increasing female labor force, in addition to benefitting the reduction of poverty and gender and social inequality (Elborgh-Woytek, 2013). If the EU states fulfill the Barcelona Objectives (Europea, 2013), 90% of European children between 3 years and school age will have future access to childcare.

Notably, though, spending long hours in childcare appears to be the developing norm (UNICEF, 2008), and our findings indicate that high quantity of care, perhaps depending upon culture, context (Cárcamo et al., 2016), or quality of care (Aviezer & Sagi-Schwartz, 2008), might be demanding even for the *oldest* children whose parents are less attuned to their needs. The fact that the vast majority of the parents in the current sample provided sensitive caregiving, and that the strain of long hours seemed to be nonthreatening to most preschoolers' attachments, should be interpreted in the context of a generous welfare state, which likely promotes the well-being of parents and children. Thus, possibly, cumulative or dual risk can affect more children in less family-friendly contexts or high-risk samples. Also, we cannot rule out that higher quality of care can *reduce* such cumulative risk.

Our findings imply that increased time in childcare is not conducive to improving attachment relationships. Because Norwegian childcare generally does not benefit children's development (Solheim et al., 2013), childcare should not—by default—be considered an intervention in and of itself; perhaps we still need to "*cherish the parents*" (Bowlby, 1951, p. 84). Already in the 1950s, Bowlby had highlighted the paradox that mothers and families are more left to themselves in modernized countries than in less developed countries. With regard to the possible strain of balancing work and caregiving (Bianchi, 2011; Hsin & Felfe, 2014), some parents and families may indeed need more support in their daily struggles. Preferably, attachment interventions should include a focus on parenting as well as relationships with childcare teachers and peers (see e.g., Solheim et. al., 2013; Stenseng et al., 2016).

A secure relationship with a childcare teacher can reduce stress in children who are separated from their parents (R. Bowlby, 2007), and the quality of adult-child interactions in childcare settings is important for children's development in general (Phillips & Lowenstein,

2011). However, as shown in a meta-analysis (Ahnert, Pinquart, & Lamb, 2006), the likelihood of being securely attached to a childcare teacher sank from 1977 to 2005, and compared to girls, boys were less likely to develop secure attachments to childcare teachers (Ahnert et al., 2006; see also Fearon & Belsky, 2016). In the Haifa study (Sagi et al., 2002), boys appeared to be more vulnerable to center care, unstable care, and high infant-caregiver ratios (see Howes & Spieker, 2016 for a summary). Thus, we cannot rule out that childcare is more challenging to boys' than to girls' attachment development (Study III).

Lastly, there are indications that children with multiple risks (e.g., poor parenting and externalizing problems) do not benefit from the same protective factors as children with lower risk (see Sabol & Pianta, 2012). Interestingly, however, highly reactive children have been found to display the lowest behavioral problem scores of all when the quality of care is high (Pluess & Belsky, 2009).

4.4 Attachment Security and the Development of Self-Regulation

4.4.1 The Development of Attachment Influenced the Development of Emotion Regulation

Although the role of attachment in emotion regulation has been highly elaborated (e.g., Cassidy, 1994; Fonagy et al., 2004; Schore, 2000; Shaver & Mikulincer, 2014), the evidence beyond the very early childhood years is more modest and methodologically limited (Parrigon et al., 2015). Therefore, we aimed to extend the literature by studying the attachment→emotion regulation link as measured in a cohort sample from the ages of 4-8 and by taking change in attachment security into account (Study II).

Change predicting change

Beyond indicating that attachment and emotion regulation continued to develop over a two-year period, we demonstrated that change in attachment representations across preschool age forecasted change in emotion regulation across early school age. As far as I know, this finding has not previously been offered. However, our findings are in accordance with studies that have demonstrated associations with attachment and more competent emotional coping strategies (Colle & Del Giudice, 2011; Contreras et al., 2000; Kerns et al., 2007), enhanced emotion identification (Brumariu et al., 2012), and increased regulation of threat-induced reactivity (Borelli et al., 2010) in middle childhood. Notably, though, Kim and Paige (2013)

did not detect any relation between self-reported attachment security and parent-reported emotion regulation in a risk sample (n = 74).

Conceptually, our findings illustrate that development is ongoing and that even later measured attachment—beyond toddlerhood and at the level of representation—organizes subsequent behavior (Sroufe & Waters, 1977); when security increased, regulatory capacities increased, and when security decreased, regulation decreased as well.

Attachment security may operate directly on a child's regulatory development or indirectly through the socialization process (Cassidy, 1994; Sroufe, 1996; Thompson, 2014). According to van IJzendoorn and Bakermans-Kranenburg (2004; 2012), attachment security can be viewed as a buffer against stress or as a moderator of physiological reactivity. Consider in this regard the fMRI finding by Moutsiana et al. (2014) that secure attachment in infancy predicted neural responding during regulation of emotions 20 years later. In fact, the more securely attached individuals showed a different neural pattern when trying to up-regulate positive emotions. This finding is in accordance with Biringen's emphasis on positive affect in the dyadic attachment relationship (Biringen, 2008). Thus, a highly secure individual has not only learned that negative emotions can and will be resolved, but also how to seek and upregulate positive emotions. Indeed, "Attachment is not just the reestablishment of security after a dysregulated experience and a stressful negative state, it is also the interactive amplification of positive affects, as in play states" (Schore, 2003a, p. 143-144).

By contrast, insecure children have typically experienced that they are left alone with difficult emotions to manage, hence experiencing emotions in social settings may be a challenge in and of itself. After all, these children's IWMs are hypothesized to display less confidence in self and/or others—especially with regard to managing emotions (Bowlby, 1969/1982; Sroufe, 2005). The teacher reports of emotion regulation applied here included items such as "can say when s/he is feeling sad, angry or mad, fearful or afraid" and "displays appropriate negative emotions in response to hostile, aggressive, or intrusive acts by peers."

Thus, when considering that emotion regulation was measured in the context of peers, our findings further buttress the claim that attachment provides a foundation for children's entrée into the peer group (e.g., Sroufe, 2005; 2016). Indeed, a meta-analysis has provided evidence for a substantial role (d = .39) of early attachment in social competence (Groh et al., 2014). Unfortunately, though, a meta-analysis involving emotion regulation per se, has, to the best of my knowledge, not yet been conducted. Again, the confusion of self-regulatory concepts (Nigg, 2017; Zhou et al., 2012) may complicate such analyses.

Organized insecure attachment and disorganized attachment

Furthermore, because children in the TESS were rated on organized insecure attachment strategies (A and C) as well as disorganization (D) (Main & Solomon, 1990), we checked whether low security scores reflected insecurity (i.e., high levels of A and C) or disorganization (high levels of D). By adjusting for disorganized attachment, we extend the literature by demonstrating that the driving force of the attachment→emotion regulation link was attachment insecurity more than attachment disorganization (Table S3, appendix).

Meta-analytic work has documented mixed evidence of the predictive role of attachment disorganization in psychopathology. Whereas Groh et al. (2012) found that disorganization only pertained to increased risk of externalizing disorders, not internalizing disorders (see also Groh et al., 2017), Madigan et al. (2016) reported that disorganization was associated with externalizing as well as internalizing disorders. Importantly, these meta-analyses were based on different age spans (Groh et al. studied 0-3 years; Madigan et al. studied 3-18 years) and methods (Groh et al. used behavioral measures; Madigan et al. used representational and questionnaire measures). Nevertheless, because emotion regulation is involved in developmental psychopathology (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Cole & Deater-Deckard, 2009), our findings that disorganization predicts emotion regulation, but not when controlling for attachment insecurity, seem to add value.

However, even though we used a representational measure among 4-6 year olds, our findings are more similar to the work by Groh et al. than the work by Madigan et al. In fact, Groh and colleagues reported that insecure (avoidant) attachment, not disorganized attachment, was associated with internalizing disorders. This result parallels our finding that insecurity, rather than disorganization, had predictive value. Another issue here is that we employed a continuous approach, which, again, may reveal results that remain hidden with categorical approaches.

Main effects and mixed findings

Even though our findings further highlight the impact of attachment security (B) on the development of emotion regulation (with effect sizes in the range (β = .19-.27), the results are only valid for teacher-reported emotion regulation. When rerunning the analyses with parent-reported emotion regulation, there were no main effects of attachment security (B), neither intercept nor change, on parent-reported emotion regulation, neither intercept nor change. The null finding mentioned above by Kim and Paige (2013) was also based on parent-reported emotion regulation; in fact, it was the identical measure that was applied here. Notably,

though, the parent-reported measure displayed inferior reliability in our study. The correlations between parent and teacher reports were modest, which, is common (De Los Reyes & Kazdin, 2005) and related to factors such as parent psychopathology (Carneiro et al., 2017) and teacher-student conflicts (Berg-Nielsen, Solheim, Belsky, & Wichstrom, 2012). In addition, we excluded the ERC Lability/Negativity scale as an outcome (due to our focus on environmental plasticity, as described earlier). Thus, our results only pertain to the scale of emotion regulation.

In sum, attachment representations promoted the development of emotion regulation, and the driving force appeared to be insecurity more than disorganization. However, beyond the main effects, attachment appeared to be more important to some children's development of emotion regulation than to others. By applying a GXE design, the added value of Study II also involves the *differential effects* of attachment.

4.4.1.1 The Significance of Attachment Security for the More Reactive Children

Based on the increased evidence that environmental effects are moderated by child characteristics in terms of temperamental negative affectivity (Slagt et al., 2016) and genotypes (van Ijzendoorn & Bakermans-Kranenburg, 2015), we investigated whether the effect of changes in attachment security on changes in emotion regulation would vary as a function of child genotype. We relied on the most-studied polymorphism, the serotonin-related *5-HTTLPR* polymorphism, which has been linked to emotional reactivity (see (Halldorsdottir & Binder, 2017) and identified as a genetic moderator, even in experimental work (Belsky et al., 2013; Belsky & van IJzendoorn, 2015; van IJzendoorn & Bakermans-Kranenburg, 2015).

Recall that heightened emotional reactivity is displayed among S *homozygotes* in particular (Miller et al., 2013). As such, there was reason to suspect that these children would be more dependent upon secure attachment representations than children who (presumably) were less reactive. As hypothesized, compared to their peers, the more reactive children benefited more from being securely attached. Change in attachment security (from ages 4-6) was a remarkably stronger predictor of change in emotion regulation (from ages 6-8) for the *5-HTTLPR* S homozygotes ($\beta = .63$, $p = .001$) than for SL and LL carriers ($\beta = .06$, $p = .32$; $\beta = .25$, $p = .006$, respectively). In addition, there was even a main effect of the *5-HTTLPR* polymorphism: compared to L homozygotes, S homozygotes evinced decreased emotion regulation from 6 to 8 years of age (0.10, $p = .035$; see Table 2, Study II). Thus, not only did

attachment differently affect different genotypes, but independent of attachment, the S homozygotes did not display the same normative increase in emotion regulation as did their peers.

Again, these findings were based on teacher-reports of emotion regulation. Even if no main effects with parent reports were identified, increased attachment security promoted emotion regulation at 6 years of age for the SS group (Table S1, appendix). This result is significantly different from that of the LL group ($W = 5.34$, $p = 0.021$), and there was a tendency for the SS group to have a steeper increase than the SL group ($W = 3.0$, $p = 0.084$). Secondly, increased attachment security predicted increased emotion regulation from 6 to 8 years of age for the SS group, and this increase was significantly stronger than in the LL group ($W = 4.30$, $p = 0.038$).

Moreover, the effect of attachment at 4 years of age only attained significance when parents reported child emotion regulation. Given that previous studies have reported attachment-X-*5-HTTLPR* effects in preschoolers (Kochanska, Philibert, et al., 2009) and adolescents (Zimmermann, Mohr & Spangler, 2009; Starr, Hammen, Brennan, & Najman, 2013), the somewhat mixed GXE results at 6 years of age may be methodological rather than substantial. However, it may also be that newly learned emotion regulation is partly specific to relationships; first, it is shown towards parents who offer the context of secure attachment, and only later generalized to other relationships, such as those with teachers and peers.

Taking into account that we also discerned a main effect of the SS genotype on change in emotion regulation from ages 6-8, we cannot exclude that processes occur beyond the preschool years in which the *5-HTTLPR* polymorphism comes into play as a more potent moderator and predictor. Possibly, the first year in Norwegian schools is somewhat less demanding and more similar to childcare than the second year in school. Therefore, compared to their peers, the more reactive children may experience the shift from first to second grade as more challenging.

Even if individual differences in brain development related to emotion regulation are far from identified (Johnstone & Walter, 2014), it has been well documented that as children grow older, they use increasingly more cognitive emotion-regulation strategies (Perlman & Pelphrey, 2010). This was illustrated with a sample of children ages 5-11 years old, in which the older children were reported to use the more dorsal "cognitive" areas of the anterior cingulate cortex[55], whereas the younger children engaged the more ventral "emotional" areas

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[55] A specialized prefrontal region implicated in emotion regulation. See also 1.2.2.1

(Perlman & Pelphrey, 2010). As such, from ages 6-8, we may tap into the shift in prefrontal activation in which the more reactive S homozygotes possibly lag behind their less reactive peers, while at the same time, they profit from the more secure representations in times of distress. Indeed, throughout the lifespan, social experiences influence the development of brain areas involved in self-regulation (see Kolb et al., 2012 for a review). However, such development does not seem to be linear or easy to predict (Ahmed, Bittencourt-Hewitt, & Sebastian, 2015). This idea was illustrated earlier in this discussion, and in the context of age, gender, and language development (Toivainen et al., 2017, p. 60).

Overall, the secondary analyses with parent-reported emotion regulation, as well as analyses of disorganization, replicated some of the teacher-generated data, but we regard these results as insufficient for testing differential susceptibility vs. diathesis stress. Thus, the further discussion is based on teacher reports of emotion regulation.

For better and for worse; differential susceptibility

Whether individuals are vulnerable (as in diathesis stress) or plastic (as in differential susceptibility) has been an increasing focus in developmental psychology and psychopathology. For this reason, we aimed to contribute to the literature by longitudinally demonstrating whether S homozygotes not only display poor emotion regulation development in the context of decreased attachment security, but also whether these children, in the context of increased security, not only become as regulated as their peers but even "outperform" their peers' development. By applying Widaman et al.'s (2012) test for diathesis stress ("worse") vs. differential susceptibly ("better and worse"), we statistically demonstrated that our findings support the differential susceptibility model. Consequently, as depicted in figure 1 (see Study II), S homozygotes' environmental plasticity was not only a matter of risk but also of *potential*; when becoming more secure, these children's emotion regulation flourished most of all.

However, even the L carriers' development of emotion regulation was predicted by attachment (in)security. For this reason, we further clarified whether we had identified weak or strong differential susceptibility by following a statistical model fitting procedure (see Belsky et al. (2013). The results supported *weak* differential susceptibility, but, again, the effect among L carriers (the combined SL/LL group) was modest ($\beta = 0.13$, $p = 0.01$) compared to the stronger effect among SS carriers (Table 3, Study II). As such, we identified a *weak* weak form of differential susceptibility. When considering the limited prevalence of *5-HTTLPR SS* homozygotes in the current sample (SS = 18.4%), changes in attachment seemed

to exert a strong impact on only a minority of the children. For the majority of the children, this impact was somewhat more limited.

This finding further sustains the concept of differential susceptibility (Belsky, 1997a; Belsky et al., 2007; Belsky & Pluess, 2009) in general. More specifically, this finding is also in accordance with meta-analytic evidence that indicates the following ideas: the moderation effects of *5-HTTLPR* of diverse environmental factors prove more consistent with differential susceptibility than diathesis stress (van Ijzendoorn et al., 2012; van Ijzendoorn & Bakermans-Kranenburg, 2015), emotional reactivity is especially linked to individuals who are homozygous for the S allele (Miller et al., 2013), and attachment interventions are more effective for S carriers (Morgan et al., 2017).

Differential susceptibility and ecological transitions

Our focus on development across the late preschool years to the early school years was not only a choice based on the limited available research, but also because of the profound ecological transitions that are involved across this developmental age. Because development does not take place in a vacuum (Bronfenbrenner, 1979), the finding that changes in attachment from ages 4-6 predicted changes in emotion regulation from ages 6-8 should be interpreted in the developmental setting of the child. At 6 years of age, (Norwegian) children typically end childcare and start school that, evidently, represents a change of context and possibly also role transitions, which is one form of ecological transition (Bronfenbrenner, 1979, p. 103). As the children enter school, they are expected to become "students," and thus the demand for discipline, independency, and smooth interactions with peers increases.

However, as we have seen, the effect of changes in attachment—which supposedly reflects a change in the proximal environment—did not operate universally but in a "for better and for worse" manner. Moreover, in accordance with the transactional[56] view on development (Sameroff & Chandler, 1975; Sameroff, 2009), Caspi and Roberts (2001) emphasized that individuals not only are formed by life-course transitions, but individuals typically react and respond to these changes with their personal characteristics. Arguably, therefore, the malleable children may not only be most affected by the quality of the proximal

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[56] "In the transactional model, development of any process in the individual is influenced by interplay with processes in the individual's context over time. The development of the child is a product of the continuous dynamic interactions of the child and the experience provided by his or her social settings. What is core to the transactional model is the analytic emphasis placed on the bidirectional, interdependent effects of the child and environment" (Sameroff, 2009, p. 6).

environment, but also to ecological transitions in and by themselves (e.g., having a sibling, experiencing parental divorce, moving to a different neighborhood). For this reason, the effect of change in attachment may have been amplified by the fact that emotion regulation was studied across one of the most significant transitions in children lives, starting school, and because increased emotion competency is a bare necessity in the context of schooling. As such, one may wonder whether environmental plasticity is more strongly depicted across major life transitions. To my knowledge, however, no qualitative or quantitative reviews have addressed such a possibility. Interestingly, a common issue in GXE research is that some genetic effects only can be seen at certain ages (Davies & Cicchetti, 2014; Liu, Maity, Lin, Wright, & Christiani, 2012).

4.4.1.1.1 The Pitfalls of GXE Research

The present work applied the candidate gene approach to GXE (cGXE; Duncan, Pollastri, & Smoller, 2014), which is associated with many challenges. In fact, the critiques of cGXE research are quite substantial (e.g., Dick et al., 2015; Duncan & Keller, 2011; Duncan et al., 2014; Halldorsdottir & Binder, 2017; Salvatore & Dick, 2015, see also Rutter & Dodge, 2011) and highlighted here in the main discussion, with a focus on "the choice of G and E."

Operationalization of G

The cGXE is common among psychological scientists but controversial among geneticists (Duncan et al., 2014). In fact, the basis for those candidate genes that social scientists typically rely on no longer reflects the state of the art in genetics (Dick et al., 2015). Whereas cGXE has relied on neurobiological information related to, for example, pharmacotherapies (Duncan et al., 2014), the genome-wide association study (GWAS) approach has demonstrated that amongst genetic risk variants identified thus far, the vast majority of variants do not relate to the protein coding portions of genes, which most often have been the hypothesized regions for genetic candidates (Duncan et al., 2014). With that said, GWAS studies do not include environmental factors, and geneticists typically focus on the identification of risk variants for diagnoses (e.g., schizophrenia or diabetes) in adults and not the broader specter of normative development (e.g., variation in emotion regulation) during childhood. Thus, comparison of GWAS and GXE does not appear to be straightforward.

As outlined by Dick et al. (2015), it may be appropriate to apply a cGXE approach if the choice of G is based on a variant that has a known function. However, such functions are

difficult to identify, and studies often differ in regard to how to assign a risk allele. With smaller samples, such as ours, homozygotes of the risk allele are often combined with heterozygotes in order to increase statistical power. However, such collapsing of alleles is conceptually problematic (see Dick et al., 2015 for a discussion). For this reason, even though we grouped *5-HTTLPR* SL with *5-HTTLPR* LL based on a statistic test, hence avoiding arbitrary merging of allelic groups, the problem of placing the heterozygotes remains. Recall, however, that the GXE analyses were conducted with three separate groups (SS, SL, and LL). It was only when conducting the test of differential susceptibly vs. diathesis stress that SL and LL were collapsed.

Further on, we applied *5-HTTLPR* because of the increasing evidence of its role in emotional reactivity (Canli & Lesch, 2007; Caspi et al., 2011; Halldorsdottir & Binder, 2017). Again, S carriers evince, for example, stronger amygdala reactivity (Hariri et al., 2005; Munafò et al., 2008) and cortisol responses to stressors (Gotlib et al., 2008), which may explain why we detected a main effect of *5-HTTLPR*. Consequently, even if the role of *5-HTTLPR* in *diagnoses* (e.g., depression, anxiety) is unclear (Culverhouse et al., 2017; Halldorsdottir & Binder, 2017), and much remains to be learned about the serotonergic system (Canli & Lesch, 2007), there are sound reasons to believe that *5-HTTLPR* somehow is involved in the "emotional brain" (for a review, see Caspi et al., 2011).

It is noteworthy that most research does not take into account that the 5-HTT gene has other variations than L and S alleles (Kenna et al., 2012; Kuzelova, Ptacek, & Macek, 2010). For example, and paradoxically, the L_G allele closely resembles the S allele functionality (Kuzelova et al., 2010). As a result, studies like ours, which only divide between S/L and L/L genotypes may, in fact, underestimate the effect of *5-HTTLPR* (Kuzelova et al., 2010). Moreover, conflicting results may not necessarily point to 5-*HTTLPR* as a poor choice of G, but rather they may indicate poor operationalization of E and outcomes (Caspi et al., 2011; Halldorsdottir & Binder, 2017).

Operationalization of E
In order to advance the GXE field, measures of the environment should be reliable and theoretically plausible (Dick et al., 2015). Moreover, too much variability of the operationalization of E causes challenges for future meta-analytic work. Also, a Type II error may arise when E is poorly assessed (Rutter & Dodge, 2011; Monroe & Reid, 2008). Even if we identified a GXE finding with our operationalization of E (i.e., change in attachment) our study may still be regarded a somewhat limited test of environmental effects. As mentioned

earlier in this thesis, in spite of limited evidence in childhood (Verhage et al., 2017), child factors in attachment security cannot be ruled out (Barbaro et al., 2017). As such, our choice of E may have indexed other aspects than environmental risk or benefit, per se. In fact, it might be argued that the measured change in attachment partially reflects the child's sensitivity to environmental inputs in such a way that children who exhibit more change in attachment might do so because they are more susceptible to the environment for better and for worse. As a result, the interpretations of our results may be challenged because both change in attachment and genotype might reflect, in part, children's susceptibility to the environment.

Having said that, others have applied attachment as E in very early childhood (Kochanska, Philibert, et al., 2009; Li et al., 2016), late preschool years (Hygen et al., 2014), and adolescence (Starr et al., 2013; Zimmermann, Mohr, & Spangler, 2009). At any rate, the work reported herein did not aim to focus on GXE in itself, but rather to investigate whether attachment is equally important to all children's emotional development. Also, in order to test for differential susceptibility, we ensured that E was scaled from very negative to very positive. In fact, the mere lack of a negative environment (e.g., lack of negative life events) may not be equal to the presence of a positive environment (e.g., highly sensitive parents) (see Belsky & Pluess, 2009 for a discussion). Therefore, one could argue that attachment was a somewhat unorthodox operationalization of E but a relevant operationalization for tests of differential susceptibility vs. diathesis stress.

4.4.2 Attachment Promoted Effortful Control—in Boys

In Study I, we provided the first longitudinal investigation of the attachment representations→effortful control link during the late preschool years. Despite substantial continuity in effortful control from ages 4-6, attachment security at 4 years of age predicted effortful control at 6 years of age—even when initial effortful control, gender, SES, and language comprehension at T1 were controlled.

Our findings complemented three previous studies, which have demonstrated that attachment relates to self-regulatory capacities in very early childhood (Fearon & Belsky, 2004; Kochanska, Barry, et al., 2009; Vondra et al., 2001). The outcomes of these previous studies varied from restricted aspects of effortful control (Fearon & Belsky, 2004) to regulation in a more general sense (Vondra et al., 2001). Thus, we extended the role of attachment beyond infancy and toddlerhood to the level of representation and by studying the

term "effortful control" in particular. Beyond the publication of Study I, a recent study on predictors of academic achievement has now demonstrated that effortful control mediates the effect of attachment from toddlerhood to adolescence (Dindo et al., 2017). As such, even long-term effects of attachment on effortful control have been identified, which further supports the value of our own findings. Importantly, however, in our study, attachment security only predicted increased effortful control among boys.

The role of age and gender

As outlined in Study I, the attachment→effortful control linkage revealed no attachment effects on girls (*girls,* β = .01, *p* = .76; *boys,* β = .15, *p* = .005). Although we hypothesized an effect of gender, we did not expect that girls' effortful control would be independent of attachment security. Notably, our results show an increase in effortful control from ages 4-6, and that boys' effortful control at 6 years of age resembled girls' levels at 4 years of age. This latter finding is reflected by meta-analytic evidence that girls display higher effortful control than boys (Else-Quest, 2012; Else-Quest et al., 2006). In fact, this gender gap seems to widen from infancy through middle childhood and narrows before puberty (Else-Quest, 2012). This observation may potentially be due to the aforementioned slower maturity of the neural underpinnings of effortful control in boys (Lenroot et al., 2007; Mutlu et al., 2013). Relatedly, boys are overrepresented in some of the most profound diagnoses with impaired inhibition or attention, such as ADHD and autism (Wichstrøm et al., 2012; Werling & Geschwind, 2013). Arguably, therefore, at least within certain timeframes, boys may be more dependent upon external emotion regulation and secure attachment representations than girls. In fact, Weinberg et al. (1999) reported that infant boys were more dependent on their mothers to maintain regulation than infant girls. Also, there are some indications that boys can be more vulnerable to, or react differently to, sub-optimal parenting (see David & Lyons-Ruth, 2005; Out, Bakermans-Kranenburg, & Van Ijzendoorn, 2009; Rothbaum & Weisz, 1994).

Furthermore, boys are generally more surgent (extroverted) than girls (Else-Quest, 2012). As such, there is "more to regulate." Also, the free play of boys is less regulated and occurs farther away from adults compared with that of girls (Fabes, Martin, & Hanish, 2003). Thus, again, the regulatory function of secure attachment may be more important to boys than to girls, who are somewhat less surgent, can be regulated by nearby adults, and participate in play that is more orderly. Notably, Fearon and Belsky (2004) reported that secure attachment buffered against lower continuous task performances among preschool-aged boys. There is

also some evidence that attachment may be a stronger predictor for the social development (Leaper, 2002) and behavioral problems (Fearon et al., 2010) of boys than for girls.

A developmental shift?

Another finding that indirectly may shed light onto gender differences have emanated from research by Espy and colleagues that was recently published as an SRCD[57] Monograph (Nelson et al., 2016). Here, a *developmental shift* in executive control was revealed in typically developing children (n = 388). Whereas executive control (e.g., inhibition, flexible shifting) and foundational cognitive abilities (e.g., motor speed, language abilities, visual/spatial perception) were inseparable at ages 3 and 3.75, these two factors uniquely contributed to executive tasks performance at age 4.5 and 5.25. Because the constructs of executive control and effortful control overlap in terms of attention and inhibition (Clark et al., 2016), the age of 4 to 5 years hence represents a particularly important developmental time to study and understand children's developing capacities for executive/effortful control (Nelson et al., 2016). Thus, not only does effortful control rapidly develop from preschool to school years (Eisenberg et al, 2014; Rothbart, 2011), but there may be a *qualitative shift* in effortful control between ages 3-5 (Nelson et al., 2016).

Now, if gender is thought of as a proxy for age or maturity, we may have studied boys in a highly relevant time span, yet studied girls in a less potent time span (see also 4.5.4). After all, if girls, to some extent, have an effortful control "advantage," they may be somewhat less dependent on their attachment style. Consider, in this regard, that whereas children with poor self-regulation adjust better in the context of high quality parenting, the absence of such parenting is less of a threat to children who already have adequate self-regulation (see Bates, Schermerhorn, & Petersen, 2012). Another finding that can support this line of thinking is from a study by Spruijt, Dekker, Ziermans, and Swaab (2018): In a sample of 4-8 year olds, supportive and less intrusive behavior as well as parents' question style impacted children's effortful control. Parents who asked more open-ended (and not too few or too many) questions had children who displayed better inhibitory and attentional control. However, this finding was *moderated by age*; the parental effects only impacted the youngest part of the sample, which again supports the idea that gender may be a proxy for age or maturity.

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[57] Society for Research in Child Development.

Lastly, it cannot be discounted that effortful control may enhance secure representations. Unfortunately, however, we did not map any cross-lagged effects. Nonetheless, by controlling for initial levels of effortful control, we identified a unique contribution of secure attachment representations on effortful control, and a recent randomized control study has shown that attachment-based interventions can increase executive functions among toddlers (Lind, Raby, Caron & Roben, 2017). Such experimental evidence strengthens our own findings.

4.5   Scientific Considerations

4.5.1   Correlations vs. Causations

Admittedly, none of our studies can answer questions of *causality*. Although the TESS has a longitudinal design, our research was based on correlational studies. As is the case for developmental research in general, any relevant unmeasured time-variant factor (e.g., peer-relations) or time-invariant factor (e.g., genetics) may have confounded our results. Notably, more stringent statistical models could have controlled for such confounders. For example, dynamic panel models, which adjust for time-invariant unmeasured confounders (e.g., genetics, item overlap across questionnaires), have now been applied to developmental research (see Klein, Bergmann, & White, 2017; Wichstrøm, Belsky, & Steinsbekk, 2017). However, the measures available for the present work (e.g., MCAST, CBQ, EAS), were only measured twice, and at least three measurement points are required in order to apply dynamic panel models (Bollen & Brand, 2010). As a result, we could use neither ordinary growth modeling nor dynamic panel models (or similar methods), and the issue of causality could not be addressed in our work. However, longitudinal designs and independent measures are less likely to lead to spurious effects. In particular, the change within change methodology in Study II reduces the possibility of time-invariant factors (i.e., factors that affect the outcome to the same extent at different time-points) influencing the results, as they cannot explain changes over time.

4.5.2   Attrition and Generalizability

The next question to address is if the results reported herein can be generalized to the population. Although there was some attrition from recruitment to T1 and between time points (figure I), no systematic missing was revealed in Study I or III, and the combined effect of predictors of attrition in Study II was weak. The TESS studies have generally reported limited selective attrition (Hygen et al., 2015; Skalickà, Belsky, Stenseng, & Wichstrom,

2015; Stenseng et al., 2016; Wichstrom, Belsky, & Berg-Nielsen, 2013; Wichstrom, Belsky, Jozefiak, Sourander, & Berg-Nielsen, 2014). Factors such as gender, social skills, behavioral functioning, parental mental health, and SES did not predict attrition (Hygen et al., 2015; Skalickà et al., 2015; Stenseng et al., 2016; Wichstrøm, Belsky, & Berg-Nielsen, 2013). Moreover, and similar to Study II, when factors have predicted attrition in the TESS (e.g., teacher-rated social competence) the (combined) effect has been very limited (Reinfjell, Karstad, Berg-Nielsen, Luby, & Wichstrom, 2016).

Still, we had no information concerning those families who, at the very outset, 1) did not show up at the health checkup for 4-year olds (2.7% of the cohorts), 2) the families with insufficient proficiency in Norwegian (n = 176), 3) those families that the health workers did not invite (n = 166), and 4) those who declined to participate before the sample was drawn (n = 503). This lack of information poses hypothetical limitations to the representativity of the TESS sample (when stratification is adjusted). For example, families with insufficient proficiency in Norwegian may have represented a lower SES group than the final sample studied in the TESS.

Of note is, however, that adjusted for stratification, the TESS study sample (at T1) was compared to the register information from Statistics Norway on all parents of 4-year olds in 2007 and 2008 in the city of Trondheim (Wichstrøm et al., 2012). The only parameter that somewhat deviated was the rate of divorced parents, which was *higher* in the TESS sample than in the population (7.6% and 2.1%, respectively) (see Wichstrøm et al., 2012 for more details).

Attrition and generalizability was investigated in another Norwegian population-based longitudinal study: the TOPP study, which was initiated in 1993. Here, the total dropout rate was higher than in the TESS (56% and 30%, respectively). However, as documented via a Monte Carlo simulation[58], the attrition rate did not affect the estimates between variables (Gustavson, von Soest, Karevold, & Roysamb, 2012). Thus, Gustavson and colleagues (2012) concluded that longitudinal studies of risk and protective factors are informative even when attrition is substantial.

Overall, the TESS sample appears to be representative of the population in Trondheim and Norway, hence the findings are generalizable to our given context. However, if the original 2003 and 2004 Trondheim cohorts posited more risk than we were able to detect, the

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[58] Data simulation that uses random samples from a known population (see Mooney, 1997).

results reported herein (which took stratification into account) could, possibly, be somewhat underestimated.

4.5.3 P-values and Effect Sizes

The present research consistently applied a significance level of 0.05, which is common yet arbitrary and problematic in and of itself (Ellis, 2009; (Ziliak & McCloskey, 2008). Whereas a more stringent significance level reduces the chance of Type I errors, which, again, is recommended by geneticists (Duncan et al., 2014), approaches that are too conservative may cause Type II errors. Evidently, this is a "Catch 22" and a trade-off between the risk of two unwanted outcomes (Field, 2009).

Because there is a vast problem with low reproducibility of results in psychology, and because reproducibility increases with stricter significance levels (Aarts et al., 2015), it could be argued that we should have applied a level of, for example, 0.01 or 0.001. On the other hand, as long as effect sizes and confidence intervals are reported, the p-value is not the sole indicator of the "significance" of the results (Card, 2017; Durlak, 2009; Ziliak & McCloskey, 2008). Admittedly, larger samples increase the likelihood of significant results (Ellis, 2009), and the TESS sample is on the larger side. For this reason, in order to accommodate the increasing demands of reports of other indicators, such as confidence intervals (Card, 2017; Durlak, 2009), and make our research more transparent, we provided effect sizes (regression and correlation coefficients) and confidence intervals across all studies. In that sense, the research community can independently determine the overall nature of our results.

At the end of the day, interpretation of statistical results requires qualitative evaluation. According to Durlak (2009, see also Ellis, 2009), judgment of effect sizes as suggested by Cohen (1988; 1992) was a *rule of thumb* and not to be applied mechanically. Whether effects are small, medium, or large also depends on the context (Durlak, (2009). Durlak (2009) argued that the following factors may be taken into account in order to evaluate effect sizes: *i*) the quality of the research, *ii*) the comparability of outcomes (comparing "apples to apples") and judgment of confidence intervals (how precise are the estimates?), and *iii*) practical value. If we apply these principles to the current research, here illustrated by Study II (attachment→ emotion regulation), we *i*) provided data from a thoroughly designed study, and although *ii*) comparisons were hindered by the lack of similar studies, the confidence interval for change in attachment on change in emotion regulation (B = .20, 95%, CI = .08-.31) was fairly narrow; *iii*) the findings also imply that fostering attachment security

may promote emotion regulation, which, in turn may decrease the risk of psychopathology (Cole & Deater-Deckard, 2009).

4.5.4   Did We Study Development?

As Bergman and Cairns wrote, "Longitudinal data are the life-blood of developmental research" (2000, p. 448). However, development is a complex phenomenon (Sroufe, 2009), which has been compared to a web of pathways (Meins, 2017). Even though longitudinal designs are warranted when investigating such pathways, they may not always be the best option for the story of more intricate developmental processes. In fact, most research only provides a snapshot of these processes (Flynn, Pine & Lewis, 2006), and the current study is included in the range of this tradition.

Some scholars have argued for a *microgenetic* approach to the study of development (see Siegler & Svetina, 2002), which would be to recruit children who are on the verge of a developmental change (e.g., achievement of more advanced problem-solving skills), and expose the children to situations in which such capacities are trained, thereby studying the processes as they take place. Although the microgenetic approach promotes in-depth knowledge of developmental processes that lead to change, such studies are often conducted in the context of normative cognitive development (see Siegler & Svetina, 2002) and have less value when it comes to issues of long-term stability and change. Nevertheless, this approach is a reminder of the significance of thorough and repeated assessments.

The lack of more than two measurement points not only poses limits to statistical approaches but also impedes investigations of developmental *transactions*. As indicated by Sameroff (2009, p. 13), two measurement points cannot shed light on development as transactions between the child and its environment over time (Sameroff & Chandler, 1975; Sameroff, 2009). Also, as discussed in Study II, insufficient measurement points create limitations with regard to the temporal ordering of change. Thus, for example, the possibility that emotion regulation might influence attachment could not be addressed in this study.

Furthermore, the two-year lag was a rather default procedure, which, amongst other factors, related to project economy and practicalities and not necessarily theories of development. This is often a limitation of developmental research (see Bergman & Cairns, 2000). For example, yet hypothetically, with regard to Study I, it can be argued that girls' effortful control, compared to boys' effortful control, reached the "ceiling" at T2. After all, young girls are more self-regulated than young boys in the first place (Else-Quest et al.,

2012), and the most significant development of effortful control may have been "taken out" between the ages of 3-5 (see Eisenberg et al., 2014 for a discussion).

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4.5.5 Strengths and Challenges with Observational Measures

Our work involved observational measures of the concepts of IWMs and parental sensitivity, which, arguably, are difficult concepts to operationalize. The strength of our approach relates to the fact that our measures were built upon a rich history in developmental psychology (the MCAST builds on the SSP, and AAI and the EAS build upon work by Ainsworth and others). However, there are several challenges to the observed measures.

As discussed by Thompson (2008), measurement of key constructs is often not optimized in large-scale research project (e.g., NICHD). Indeed, the TESS could not prioritize, for example, longer and repeated observations in naturalistic settings or measuring attachment to both parents. Also, the psychometrical indexes of coders agreement varied from $ICC = .71$ (EAS sensitivity at T1) to $ICC = .86$ (MCAST continuous B at T2), but continuous measures of MCAST A and C were lower and even critical (A = .71 [T1]; A = .72 [T2]; C = .70 [T1]; C= .52 [T2]).

In spite of the evidence that attachment security at the behavioral level predicts attachment security at the representational level, Bretherton (2005) has advocated for somewhat cautious comparison of attachment across the SSP and story-completion techniques. After all, the child's fantasies, defenses, and construction of realities make the latter more complex to interpret. Therefore, training and expertise are warranted in order to generate valid data (Brownell, Lemerise, Pelphrey & Roisman, 2015). Yet, even expert coders may display somewhat non-optimal inter-rater reliability. In an attachment study by Zeanah, Smyke, Koga, and Carlson (2005), which involved two other well-known experts E. Carlson and A. Sroufe, the interrater reliability of SSP was reported to be adequate ($k = .78$) and was almost identical to our k with categorical B at T1 (.77); the authors wrote that "differences were resolved by conferencing" (Zeanah et al., 2005, p. 1018). In another study, which involved coding of family interactions, the authors reported that when coder agreement was below a cutoff point, a third coder would score the session and the most experienced coders would code the difficult cases (Kerns, Tomich, Aspelmeier, & Contreras, 2000). These examples illustrate that inter-rater reliability can be more or less reconciled before the raw data are applied in analyses, which in turn complicates comparison of research, also because

researchers' approaches to inter-rater reliability are not always transparently reported. In the TESS, independent coding was done before the reliability was calculated.

The continuous attachment scores applied in this work rested on the categorical MCAST coding system. This hybrid approach may be regarded as a limitation. However, it is also a transparent method that takes into account that some children operate with more or less secure representations within the same assessment (as well across time). As Bowlby put it, children learn that the caregiver is "available—occasionally, frequently, or most of the time" (Bowlby, 1973, p. 237). Also, our hybrid approach was rather straightforward and is therefore possible to be replicated by others who apply the MCAST. Yet again, comparison of research may be impeded when methods become too varied (Radke-Yarrow, 2000).

It should be noted that less is known about the MCAST as a measure of father-child relationships (Goldwyn et al., 2000). Thus, based on our discussion above on paternal vs. maternal attachment (see also Di Folco et al., 2017), our results are somewhat uncertain when it comes to the representativity of paternal attachment. Even if children's levels of attachment security did not differ across parental gender, such levels do not disclose any matters of functionality.

> Although 12 hours in certainly not necessary to get a good estimate of mother-infant dyad's typical behavior, 10-15 minutes is most unlikely to be enough[59] (E. Waters).

According to Biringen (2008), judgment of parental sensitivity is challenging and considered to be the most complex of the parental behaviors that constitute parental emotional availability. Whereas Ainsworth and colleagues spent more than 70 hours per family (n = 26) when studying parent-child interaction in the Baltimore Study, we spent approximately 30 minutes on such observations (n = 921). In fact, the association between EAS sensitivity and attachment security is reported to be stronger when observations are longer (Biringen et al., 2014). To some extent, this may explain the weak sensitivity-attachment associations in our work. It can also be argued that it is quite fascinating that even shorter observations of parent-child dyads can produce results as reported herein. After all, parental sensitivity turned out to be involved in cumulative risk in reducing attachment security (Study III).

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[59] See http://www.psychology.sunysb.edu/attachment/measures/content/ainsworth_scales.html

4.5.6 Stringent Methodology Among Geneticists

Differential susceptibility has not been established with stricter methods used by geneticists involving very different threshold of significance (Duncan et al., 2014). Therefore, not only may our choice of G and E be problematic, but also the identification of differential susceptibility per se. In fact, data simulations have shown that with smaller sample sizes, and in the context of Type I error, differential susceptibility, which statistically is known as a cross-over/disordinal interaction, is more likely to be demonstrated than is diathesis stress, which statistically is known as an ordinal interaction (Dick et al., 2015; Roisman et al., 2012).

Also, many studies have concluded on cross-over/disordinal interaction (differential susceptibility) on the basis of *visual inspections* of interactions, which is problematic because a visual plot may not be statistically distinguishable from an ordinal interaction (diathesis stress; see Roisman et al., 2012 for a discussion). As such, our statistical test of cross-over/disordinal vs. ordinal interaction somewhat strengthens the current findings. However, we only applied the Widaman approach for such testing (Widaman et al., 2012; Belsky et al., 2013) and hence cannot rule out that a different result would emerge with alternative tests (see Del Giudice, 2017; Roisman et al., 2012; see also Belsky et al., 2015).

Overall, the present finding that the impact of changes in attachment on changes in emotion regulation was a) moderated by *5-HTTLPR* genotype and was b) in terms of a (weak) cross-over/disordinal interaction could be a Type I error; this idea cannot be ruled out. Another possibility is that our findings reflect an association between some unmeasured genetics related to the *5-HTTLPR* and (even an) unmeasured environmental factor related to attachment security.

It should also be noted that we did not include any demographic variables (e.g. gender, SES) in this Study II. We hence do not know whether inclusion of demographics could have produced different results. For example, a recent study has demonstrated that genetics can interact with gender and age (Sannino et al., 2017). Because of the aforementioned association with attachment and gender, there could even be a three-way-interaction of attachement-X-*5-HTTLPR*-X-gender in predicting emotion regulation. Nevertheless, and as summarized below, the following factors may strengthen the value of our findings:

- The study was longitudinal and involved a change→change design, which, although it increases the measurement error, has the benefit of reducing time-invariant confounding factors. To my knowledge, such a design has rarely been applied in

cGXE work. Also, when testing for GXE, the initial level or baseline of attachment (i.e., E, the predictor) was controlled.

- The sample was moderately large (n = 678), stringently recruited, and consisted of children of the same age; it also included equally many boys as girls and was homogenous in terms of Caucasian ethnicity (the S-allele tends to serve as a plasticity marker in Caucasian samples; van Ijzendoorn, Belsky, & Bakermans-Kranenburg, 2012).

- G (*5-HTTLPR*), E (change in attachment), and outcome (teacher-reported emotion regulation) were independent measures. Thus, shared informant bias was reduced, which is especially important when testing differential susceptibility, as a self-reported assessment of E could involve heritable response biases.

- E was operationalized in such a way that it supposedly reflected change to a very positive environment (high attachment security) or change to a very negative environment (high attachment *in*security).

- The choice of G (*5-HTTLPR*) was due to its link to emotional reactivity.

- The grouping of heterozygotes (*5-HTTLPR* SL) with a homozygous group (*5-HTTLPR* LL) was based on a statistical test.

- In terms of differential susceptibility, the conclusions on disordinal vs. ordinal interaction, and weak vs. strong disordinal interaction were based on statistical tests (not visual inspection).

Apart from what has already been discussed, the specific limitations of each study are provided in Study I-III.

4.6   Implications and Proposals for Future Research

"The principal main effects are likely to be interactions"
One overall message from this thesis is that attachment effects may apply in a more differentiated manner than what often is considered. Here, we demonstrated that effects can vary from *none* (attachment security on girls' effortful control) to *strong* (change in attachment security on change in emotion regulation for the *5-HTTLPR* genotypes). Attachment effects on children's socioemotional development should hence be regarded on the basis of, for example, child characteristics, while taking the specific outcome into

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consideration. With that said, the child's experience of being attached should be valued in and of itself.

Fostering security

Attachment is not static, and attachment security at an earlier point in time is no guarantee for better adaptation at a later point in time. If attachment security declines, this may forecast declined emotion regulation as well. Efforts to foster secure attachment relationships should thus not be restricted to the very first years of life, as increasing security across the transition to school or preventing its decline clearly seems to have prospective benefits. The focus on security is relevant given that insecurity, rather than disorganization, emerged as a significant predictor of emotion regulation.

Environmental plasticity

Whether and how attachment affects a child, and whether and how the child would benefit from interventions, may depend on the degree of environmental plasticity of the child, but possibly also upon the parent's plasticity (see Hartman & Belsky, 2016). Importantly, high reactivity (e.g., negative affectivity) should not be considered solely as a risk, as it also may keep a promise for change. At any rate, the present GXE findings should be not only be replicated but also tested via randomized control trials. A proposal for future studies is to include a measure of adult differential susceptibility as well (see Aron & Aron, 1997; Hartman & Belsky, 2016).

Even if it is too early to conclude whether interventions should be carried out in specific ways for specific children and families, future studies should keep investigating what works for whom (see e.g., Morgan et al., 2017).

Attachment in context

The finding that cumulative risk (insensitive parenting and long hours in childcare) may undermine attachment development throughout the preschool years is notable. Apart from increasing parental sensitivity, which is common in attachment interventions (see e.g., Cassibba, Castoro, Costantino, Sette, & Van Ijzendoorn, 2015; Hoffman, Marvin, Cooper, & Powell, 2006), the amount of time children are separated from their caregivers should perhaps also be targeted. At the end of the day, however, this issue is not just a matter of personal choice (Belsky, 2009; Phillips & Shonkoff, 2000). Nevertheless, perhaps parents should be

informed that with long hours in childcare, sensitive caregiving becomes even more important in order for children to develop trustful relationships.

Relatedly, a recent U.S. social policy report published by the SRCD highlighted that parenting is "the most emotionally powerful, demanding, and consequential task of adult life. Long before modern societies emerged, extended family and community members shared the task of parenting. Today, without such a network of experience and support, it is a task for which we are often poorly prepared" (Teti et al., 2017, p. 3). The present study sample was one of low risk (e.g., sensitive caregiving appeared to be the norm and SES played a minor role). In the future to come, where Norwegian welfare arrangements could be put in play due to, for example, lowered gross national income in combination with increased expenses (see NOU 2016: 3), we should carefully consider what structures uphold low risk in our society. The reason for this consideration is that not only may higher risk increase attachment insecurity and disorganization, but such attachments in combination with other risk factors may be a whole different story than attachment insecurity in the context of low risk.

Dysregulated boys or overregulated childhood?

Although not a main focus of this study, boys' socioemotional development appeared to lag behind girls'. This should not be regarded "inferior development," but perhaps a reflection of what is considered adaptive in our time. After all, in a society where nearly all children, from very early on, attend highly organized arenas (childcare center, school), with high demands on self-regulatory capacities and advanced socio-cognitive understanding, some children may be more fit to adapt than others. Possibly, our gender-related findings may shed further light on the ongoing debates of quantity of childcare (e.g., Drugli et al., 2017), school start, and drop out (Stoltenberg, 2017) here in Norway.

Future research

As I started out on this journey, I aimed for findings that could add something new to the literature. Now that this journey comes to an end, I find myself just as occupied with the issue of scientific replication and publication bias (see e.g., Card, 2017; Duncan, Engel, Claessens, & Dowsett, 2014). Future research should combine the factors that lead to trustworthy findings. For example, longitudinal studies that have measured attachment on several occasions may now rerun their analyses with stricter statistical models in order to address questions of causality. Also, one should strive for a balance between large samples and thorough methods. The recruitment method and large sample applied herein could be used in

order to select subsamples for more thorough and naturalistic investigations, which could include, for example, studies of paternal attachment and attachment in intact and non-intact families. In addition, the role of gender in the development of attachment representations should be given further attention. According to one of the pioneers of attachment research, Everett Waters (2015[60]), "the most important attachment studies have not yet been conducted."

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[60] E. Waters at SRCD Biennal Meeting. Part of the conversation is available here: https://www.youtube.com/watch?v=bhOeoUs6dwg. See also Waters, Petters, and Facompre (2015).

4.7   Conclusions

The overarching research questions (page 3) are answered as follows:

I.   During the ecological transition from preschool to school, children's attachment representations, which at both times were more secure among girls, a) became more secure and b) were characterized by instability. Because of this finding, the late preschool years may represent a developmental period when attachment security can be strengthened or weakened. Programs and interventions to foster attachment security should therefore not be limited to the very youngest children.

II.   Overall, attachment security in preschool and early school age years promoted self-regulation, but the effects did not apply universally: a) higher security predicted increased effortful control for boys only, and b) increased attachment security forecasted increased emotion regulation for all children, yet significantly stronger for the presumably more reactive children (*5-HTTLPR* SS genotypes, 18% of the sample).

III. The cumulative risk of low-sensitive parental caregiving in combination with high quantity of childcare negatively interfered with attachment development. Promoting parents' sensitive caregiving could possibly foster security among these children.

Afterthought

"Norway tops the global happiness rankings for 2017 in the World Happiness Report."

At the end of the day, the families recruited from the peaceful city of Trondheim generally displayed low risk. This reality contrasts the starting point of attachment theory, which built upon two world wars, adversity, and despair. Now, worldwide, 28 million children have recently fled their homes because of conflict and war (Unicef, 2016). Who are their attachment figures and where can they be found?

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STUDY/PAPER I

STUDY/PAPER II

Change in Attachment Predicts Change in Emotion Regulation Particularly Among *5-HTTLPR* Short-Allele Homozygotes

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In view of the theory that the attachment relationship provides a foundation for the development of emotion regulation, here, we evaluated (a) whether change in attachment security from 4 to 6 years predicts change in emotion regulation from 6 to 8 years and (b) whether *5-HTTLPR* moderates this relation in a Norwegian community sample ($n = 678$, 99.7% Caucasian). Attachment was measured with the Manchester Child Attachment Story Task, and teachers completed the Emotion Regulation Checklist. Attachment security was modestly stable, with children becoming more secure over time. Regression analyses revealed that increased attachment security from 4 to 6 forecasted increases in emotion regulation from 6 to 8 and decreased attachment security forecasted decreases in emotion regulation. This effect was strongest among the *5-HTTLPR* short-allele homozygotes and, according to competitive model fitting, in a differential-susceptibility manner.

Keywords: 5-HTTLPR, attachment, differential susceptibility, emotion regulation, serotonin transporter gene

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A child's attachment to parents has been regarded as a foundation on which emotion regulation develops. Indeed, attachment has been described in terms of dyadic regulation of emotion (Sroufe, 1996) and as a regulation theory (Schore, 2001). As a result, attachment is presumed to have wide-ranging, even if indirect, developmental consequences. After all, emotion regulation has been shown to play a pervasive role in human development (Cole, 2014), including social functioning (e.g., Blair et al., 2015; English, John, Srivastava, & Gross, 2012) and psychopathology (e.g., Bosquet & Egeland, 2006; Halligan et al., 2013). However, beyond the infancy and early childhood years, there has been limited investigation of associations linking attachment and emotion regulation (Borelli et al., 2010; Kim & Page, 2013). This is a notable lacuna, in that research on younger children (e.g., Kochanska, Philibert, & Barry, 2009; Vondra, Shaw, Swearingen, Cohen, & Owens, 2001) may not generalize to older children or across developmental periods. This is no doubt due, at least in part, to the well-known fact that development continues well beyond the early childhood years.

Thus, the work presented herein seeks to extend research on an important ecological transition (Bronfenbrenner, 1979), the shift from day care to school, while examining links between attachment and emotion regulation. Given the evidence that environmental effects, including attachment effects, may vary as a function of children's genetic make-up, we further evaluate the possibility that links between (change in) attachment and (change in) emotion regulation may be genetically moderated by a widely studied polymorphism that has been repeatedly found to operate in such a manner; namely, the serotonin-transporter gene, *5-HTTLPR*. Indeed, in exploring this issue, we competitively evaluate diathesis-stress and differential-

susceptibility models of Gene × Environment (GXE) interactions, conceptualizing attachment as a reflection of exposure to quality of the rearing environment.

Emotion Regulation and the Forgotten Years

Emotion regulation is an important component of emotional competence (Saarni, 1999) and can be defined

> as the ability to respond to the ongoing demands of experience with the range of emotions in a manner that is socially tolerable and sufficiently flexible to permit spontaneous reactions as well as the ability to delay spontaneous reactions as needed. (Cole, Michel, & Teti, 1994, p. 76)

Although a conceptual consensus on emotion regulation is still lacking (Cole, 2014), there is broad agreement that regulatory abilities emerge as a result of socioemotional exchanges within the family, particularly between parents and children (Thompson, 2014). If these parent–child transactions are problematic, children may develop less efficient regulatory capacities or even emotion dysregulation (Cole et al., 1994). This is shown by, for example, strikingly low emotional intensity or avoidance of certain emotions, both of which can adversely affect children's social relations (Cole et al., 1994).

Emotion regulation develops throughout the life span (Cole, 2014). In middle childhood, these capacities become more complex as evidenced by increased emotional understanding as well as the integrative processing of complex cues regarding others' emotions (Shields & Cicchetti, 1997). Furthermore, due to the demands of schooling, middle childhood is a period of exposure to new social roles and peer hierarchies (see, e.g., Colle & Del Giudice, 2011). Children are now expected to display self-regulation in relation to their classmates, peers, teachers, and surroundings while becoming less dependent upon external regulators. In fact, the developmental and social changes—and challenges—that take place in middle childhood may be no less profound than those that characterize earlier developmental epochs (Eccles, 1999; Mah & Ford-Jones, 2012).

Despite these observations, most emotion regulation research conducted by developmentalists has focused on children prior to school entry (Adrian, Zeman, & Veits, 2011). It is not surprising, then, that middle childhood, extending from approximately 6 to 12 years of age, has been described as "the forgotten years" (Mah & Ford-Jones, 2012). Thus, we focus on changes in attachment and emotion regulation across the transition to early middle childhood.

Attachment and Emotion Regulation

Building upon Bowlby's (1969) hypothesis that attachment experiences organize the child's ability to cope with future internal and external demands, attachment researchers (e.g., Sroufe, 1996) emphasize that *secure attachment* (Ainsworth, Blehar, Waters, & Wall, 1978) promotes emotion regulation. According to Thompson (2014, 2016) and Cassidy (1994), securely attached children tend to have parents who are sensitive to their children's experience of uncertainty and distress and who are open and responsive to a wide variety of children's emotions. Thus, in arousing situations, secure children experience parents as sources of comfort and support, which reduces emotional tension. As a result, these children de-

velop skills and confidence in managing their own emotions (Sroufe, Egeland, Carlson, & Collins, 2005). At a representational level, security-inducing care gradually promotes an internal working model (IWM; see Bretherton, Ridgeway, & Cassidy, 1990), reflecting positive beliefs of self and others, including the beliefs that one is worthy of being cared for and that significant others represent a safe haven whenever the attachment system is activated.

In contrast, insecure children's experiences are marked by episodes of emotional distress that are poorly handled by caregivers. The resulting IWMs may include inefficient scripts for expressing and/or managing diverse emotions in the longer term, placing these children at risk of becoming emotionally dysregulated (see Schore, 2003). Consider evidence that compared to securely attached children, insecure children demonstrate increased anger and fear and decreased joy during the first 3 years of life (Kochanska, 2001).

The attachment–emotional regulation dynamic is further intensified by the fact that overwhelming emotions typically arise in the context of attachment relationships (Cassidy, 2016). For example, a child who has been left reluctantly by the attachment figure may become angry or sad. This particular attachment figure is also the one to offer support at parting and upon reunion and, in that sense, is the source of both distress and regulatory scaffolding, thereby promoting the child's self-regulation. In fact, such situations were the starting point for Bowlby's attachment theory (see Ainsworth et al., 1978; Ainsworth, Blehar, Waters, & Wall, 2015).

Although the links between attachment and emotion regulation during middle childhood have not been entirely ignored by developmentalists, the available work is limited (see Parrigon, Kerns, Abtahi, & Koehn, 2015 for a review) by a lack of longitudinal designs, sample diversity, and informants other than children and parents regarding children's emotion regulation. Nevertheless, available evidence indicates that greater attachment security in 8- to 12-year-olds is associated, contemporaneously, with more competent emotional coping strategies (Contreras, Kerns, Weimer, Gentzler, & Tomich, 2000; Kerns, Abraham, Schlegelmilch, & Morgan, 2007), enhanced emotion identification (Brumariu, Kerns, & Seibert, 2012), increased regulation of threat-induced reactivity (Borelli et al., 2010), and more mature selection of emotion regulation strategies when confronted with hypothetical challenges (Colle & Del Giudice, 2011). However, we would be remiss not to acknowledge that Kim and Page (2013) failed to detect links between attachment and emotional regulation in this age group. The work reported herein seeks to build upon and extend prior work by employing a longitudinal design, studying a large representative Norwegian community sample, and relying on teacher reports of emotion regulation.

This study is informed by an organizational view of the role of attachment in development (Sroufe, 2005, 2016; Sroufe & Waters, 1977), and thus by the way that individual patterns of early behavior organize subsequent patterns of adaptation. This process operates across contexts (Sroufe, 2016) and especially with regard to the effect of attachment on self-management or self-regulation (Sroufe, 2016; Sroufe et al., 2005). Despite the crucial factor of timing, early childhood experiences sometimes have greater impact on later development than more recent experiences (Sroufe, 2013). In line with this idea is thorough methodological evidence that maternal sensitivity in the first years predicts social competence as late as 15 years of age (Fraley, Roisman, & Haltigan,

2013). Such results provide a basis for hypothesizing that earlier measured attachment should predict later measured emotion regulation. Given the long-term and sometimes slow-to-see effects of attachment on development (Sroufe, 2016), we hypothesize that the level and change in attachment security from 4 to 6 years of age will organize and influence the subsequent level and change in capacities for emotion regulation from 6 to 8 years of age. The measurement schedule of the longitudinal study on which this report is based does not afford reciprocal evaluation of the effects of emotion regulation on attachment, and it allows us to consider attachment only at ages 4 and 6 and emotion regulation at ages 6 and 8.

Change and Stability in Attachment Representations

Our effort to determine whether change in attachment predicts future change in emotion regulation is based on the view, articulated previously, that development continues beyond the preschool years. Indeed, we conceptualize the growth of security and insecurity from 4 to 6 as part of an ongoing developmental trajectory, which leads us to predict that change in attachment over this period should contribute the developmental trajectory of emotion regulation.

The importance of conducting longitudinal inquiries, particularly those focused on change in attachment, is underscored by the fact that attachment security may not be as stable as long presumed, which should not be entirely surprising. After all, Bowlby (1969) acknowledged that attachment-shaped internal-working models could change, even if this was less likely the older children became. As it turns out, meta-analyses indicate that attachment security is, at best, moderately stable over time (Fraley, 2002; Pinquart, Feussner, & Ahnert, 2013). A comprehensive study recently documented weak long-term stability when investigating stability from the first 3 years of life to late adolescence (Groh et al., 2014). Stability is enhanced, however, with assessment intervals less than 2 years, equal methods, and measurement beyond infancy and at the representational level (Pinquart et al., 2013). Furthermore, in line with Bowlby's hypothesis of increasingly stable IWMs, stability coefficients are more substantial beyond the age of 6 (Pinquart et al., 2013).

Whether stability or instability best characterizes consistency in attachment over time, it is no doubt the case that some insecure individuals become more secure over time and that some secure individuals become more insecure over time. Such patterns of change in attachment have been related, for example, to altered caregiving behavior, negative life events, and parental marital satisfaction (see McConnell & Moss, 2011 for a review). Arguably, a child who becomes more secure over time, perhaps even changing from insecure to secure, would be expected to evince positive growth in other domains of development as well, possibly even more so than a child who remains consistently secure over time. This reasoning leads us to hypothesize that increasing security across the transition to school will forecast increased levels of emotion regulation and that increasing levels of insecurity will forecast decreased levels of emotion regulation.

Given our focus on the predictive power of change in attachment security, we are positioned to also examine the stability of attachment. Here, we extend such work by measuring attachment at the representational level, relying on the Manchester Child

Attachment Story Task (MCAST; Green, Stanley, Smith, & Goldwyn, 2000). To our knowledge, only two investigations to date have examined stability at the representational level. First, using the Attachment Story Completion Task (Bretherton et al., 1990), Stievenart, Roskam, Meunier, and Van de Moortele (2014) chronicled modest stability over a 2-year period (i.e., $r = .32$, intraclass correlation coefficient [ICC] $= 38\%$) among 3- to 8-year-olds ($n = 358$). Green et al. (2000), in contrast, documented substantial stability (i.e., 76.5%) in attachment representations across a 6-month interval in a sample of 5- to 7-year olds ($n = 33$ at follow-up) using the MCAST. The latter finding needs to be interpreted in the context of a high base rate of security as well as wide confidence intervals given the limited sample size. Thus, we will investigate stability and change in secure attachment representations in children from age 4–6 years in a representative community sample; The Trondheim Early Secure Study (TESS).

Gene-by-Attachment Interaction

Even if earlier attachment influences later emotion regulation, there is reason to believe that effects of attachment, like a variety of environmental exposures and developmental experiences, could prove more operative in the case of some and less influential in the case of others (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011). This raises the possibility that presumed effects of attachment may vary across children, including perhaps as a function of their genetic make-up. Indeed, to the extent that attachment reflects, at least in part, the legacy of rearing experience (see Fearon & Belsky, 2016, for an updated review), the study of Attachment × Gene interaction can be conceptualized, as it has been, as relevant to the broader investigation of GXE interactions. Thus, in addition to evaluating prospective linkages between changes in attachment security and emotion regulation, we address the question of whether such associations vary as a function of children's genotypes. Here, we focus on the *5-HTTLPR*-polymorphic region given its particular role in emotion regulation (Canli & Lesch, 2007) as well as prior work showing that this polymorphism interacts with a variety of developmental experiences and environmental exposures (Canli & Lesch, 2007; van IJzendoorn, Belsky, & Bakermans-Kranenburg, 2012), including attachment disorganization (Kochanska et al., 2009) and maternal unresponsiveness (Davies & Cicchetti, 2014).

Whereas the traditional diathesis-stress thinking stipulates that adverse contextual conditions will negatively affect more "vulnerable" individuals than others, differential susceptibility thinking contends that such putatively vulnerable individuals are also more susceptible to supportive or positive experiences than others, making them generally more developmentally plastic, "for better and for worse" (Belsky et al., 2007; Belsky & Pluess, 2009, 2013; Ellis et al., 2011). Two versions of the differential susceptibility framework can be distinguished (Belsky, Pluess, & Widaman, 2013); while the "strong" version stipulates that some individuals are susceptible to environmental influences and others are not, the "weak" version stipulates that some are more susceptible than others.

Given the presumption that attachment security is, at least in part, a reflection of rearing experience, such as parental sensitivity (Fearon & Belsky, 2016), we hypothesize that change in attach-

ment security will predict changes in emotion regulation for some children more than others. What remains unclear, however, is whether the genetic moderation of the effect of change in attachment security that we anticipate will better fit the weak or strong diathesis-stress or differential-susceptibility models of the GXE interaction. As a result, we employ a model fitting approach that competitively evaluates the fit of these alternative conceptual frameworks (Belsky et al., 2013; Widaman et al., 2012). Notably, such evaluation of vulnerability versus susceptibility models is not merely of theoretical interest. After all, support for differential susceptibility would imply that those most vulnerable to adversity might be most likely to benefit from interventions—to promote the development of secure attachment in the first place and/or to foster security given an insecure base.

The Moderating Role of 5-HTTLPR

To date, some of the most promising work suggesting that the effects of attachment may be genetically moderated comes from GXE research on the serotonin transporter 5-HTT, which is encoded by the *SLC6A4* gene (Canli & Lesch, 2007). As reviewed by Canli and Lesch (2007) and Hariri and Holmes (2006), 5-HTT recycles serotonin from the synaptic cleft to the presynaptic neuron and influences the duration and intensity of serotonin signaling with postsynaptic receptors within the affective corticolimbic circuitry. Thus, 5-HTT is involved in the brain's emotional communication (Canli & Lesch, 2007; Hariri & Holmes, 2006).

Of importance to the current study is that humans vary in the efficiency of how *SLC6A4* codes for 5-HTT. *SLC6A4* contains a common polymorphism, *5-HTTLPR*, which is usually reported with two allele variations: a short ("S") and a long ("L") allele. Notably, the S allele is associated with reduced transcription of the 5-HTT-gene promoter (Lesch et al., 1996). As a result, S carriers have elevated levels of extracellular serotonin, which is thought to lead to heightened emotional reactivity. For example, S carriers evince stronger amygdala reactivity (see Munafò, Brown, & Hariri, 2008 for a meta-analysis) and cortisol responses to stressors (Gotlib, Joormann, Minor, & Hallmayer, 2008).

Meta-analytic evidence also documents heightened emotional reactivity among S *homozygotes* in particular (Miller, Wankerl, Stalder, Kirschbaum, & Alexander, 2013). This heightened reactivity highlights the potential for S homozygotes to develop differently than other children with respect to emotion regulation. Moreover, additional meta-analytic work indicates that the S allele moderates the effects of a variety of environmental exposures, at least in Caucasian children, in a manner consistent with differential-susceptibility thinking (van IJzendoorn et al., 2012). With regard to parameterizing heterozygotes (SL) with S or L homozygotes, the literature is equivocal (see, e.g., van IJzendoorn, et al., 2012). For this reason, we conduct preliminary analyses to address this issue before testing competing models of GXE.

In general, prior research has raised the prospect that L carriers may be less prone to emotional dysregulation. As a result, attachment security, as an environmentally induced regulatory mechanism, could be especially important for the development of emotion regulation among more reactive S carriers. In fact, S carriers have been found to be most affected by their attachment styles with regard to self-regulation in preschool (Kochanska et al., 2009), as well as autonomy and aggression (Zimmermann, Mohr,

& Spangler, 2009) and stress and depression (Starr, Hammen, Brennan, & Najman, 2013) in adolescence. Whereas the research by Kochanska et al. (2009) proved consistent with the diathesis-stress model, the work of Starr et al. (2013) and Zimmermann et al. (2009) appears more consistent with differential-susceptibility theorizing.

In summary, the purpose of this study is threefold: (a) to document stability and change in children's attachment security from 4 to 6 years of age as measured by the MCAST; (b) to evaluate whether change in attachment predicts subsequent change in children's emotion regulation from 6 to 8 years of age; and (c) to determine whether such predictions are moderated by the *5-HTTLPR* polymorphism in a differential-susceptibility- or diathesis-stress-related manner, with S carriers proving more susceptible to environmental influences than L carriers.

Method

Participants and Recruitment

TESS is a representative cohort study with the aim of detecting risk and protective factors in child development. The Regional Committee for Medical and Health Research Ethics in Mid-Norway approved all research procedures prior to conducting this study. The procedure and recruitment have been presented elsewhere (Wichstrøm et al., 2012); hence, only a limited outline follows. The data collection began in 2007. All children born in 2003 and 2004 in the city of Trondheim, Norway (approx. 185,000 inhabitants) and their caregivers were invited to participate in the study. The families were recruited via the municipal well-child clinics, which perform mandatory health checkups. A letter of invitation and the Strengths and Difficulties Questionnaire (SDQ) 4–16 version (Goodman, 1997) were mailed to the caregivers with their ordinary scheduled appointments for their 4-year-olds. The SDQ is a 31-item measurement of mental health problems in children from 4 to 18 years of age. Public health nurses informed the families about TESS and obtained written consent for participation. The consent rate among eligible families was 82.1%.

To increase sample variability, children with higher scores on the SDQ were oversampled. Accordingly, the SDQ scores on the problem subscales (emotional problems, conduct problems, hyperactivity/inattention, and peer relationship problems) were divided into four strata using the cut-off ranges of 0–4 (44.2% of the population), 5–8 (29.5% of the population), 9–11 (18.5% of the population), and 12–40 (7.8% of the population). Using a random number generator, 38.1%, 49.1%, 71.4%, and 89.2% of children in strata 1, 2, 3, and 4, respectively, were drawn to participate in a comprehensive study within the 6 weeks following the health checkup. Of the 1,250 invited families, 995 (79.5%) children ($M_{age} = 4.5$, $SD = 0.25$) accompanied by one caregiver attended the subsequent assessment at the university clinic. One participant had missing information on the SDQ and could not be included in the analyses. At T1, 845 (85%) caregivers were mothers, and 149 (15%) were fathers. At T2, 648 (81.5%) were mothers, and 147 (18.5%) were fathers.

Regarding attrition during the recruiting phase, the dropout rate was not different across the four SDQ strata ($\chi^2 = 5.70$, $df = 3$, NS) or between genders ($\chi^2 = 0.23$, $df = 1$, NS). A follow-up took place after 2 (T2) and 4 (T3) years; 795 children participated at T2

when they had started first grade (M_{age} = 6.7 years, SD = 0.17), and 699 children participated at T3 when they were in third grade (M_{age} = 8.8 years, SD = 0.24). Almost equal numbers of girls (49.5% and 51.3%) and boys (50.5% and 48.7%) participated at T2 and T3, respectively.

To address dropout beyond the recruiting phase, attrition analyses were run with all study variables. Attachment (T1, T2) did not predict attrition. Children's verbal comprehension predicted attrition from T1 to T2 (Odds Ratio (OR) = 0.99, 95% CI = 0.99-.99) and from T2 to T3 (OR = 0.99, 95% CI = 0.98–0.99). Emotion regulation at T1 predicted attrition from T2 to T3 (OR = 0.51, 95% CI = 0.34–0.76). However, when analyzing the total explained variance in attrition from T2 to T3, emotion regulation was no longer significant (OR = 0.68, 95% CI = 0.44–1.06), and the combined effect of predictors of attrition was modest (Cox & Snell R^2 = 0.018, Nagelkerke R^2 = 0.039). The effect of predictors from T1 to T2 was also modest (Cox & Snell R^2 = 0.005, Nagelkerke R^2 = 0.009).

With consent from the parents, the child's primary teacher completed a questionnaire concerning the child's emotion regulation at T2 and T3. There were approximately three children from each class participating in TESS, but some classes and even schools had only one participating child. Children in Norway start school when they are 6 years old, and the teacher respondent had known the child for an average of 6 months at T2 and 2.5 years at T3. The response rate was 99.1% at T2 and 86.1% at T3. The majority of teachers was female (84.6%, n = 666 at T2; 77.7%, n = 470 at T3).

The final sample included in the current study is based on the children who were successfully genotyped (n = 678). The genotyped children did not diverge from those not genotyped in terms of the study variables except in the case of verbal comprehension (OR = 0.99, CI = 0.98–0.99). Notably, the participants in TESS were ethnically homogenous. At T2, when DNA was sampled, 99.7% of the children were Caucasian.

Measures

Attachment security. The children's attachment representations were assessed at T1 and T2 using the MCAST (Green et al., 2000). The MCAST has been applied in a range of low- and high-risk studies, and a number of findings have underscored its reliability, internal consistency, and key components for validity (see Barone & Lionetti, 2012 for a summary).

The MCAST integrates age-relevant aspects from the Strange Situation procedure (SSP; Ainsworth et al., 1978), which measures behavior, and the Adult Attachment Interview (AAI; George, Kaplan, & Main, 1996), which measures narratives (Green et al., 2000). Therefore, the MCAST uses doll play and story stems to evoke attachment representations. Procedurally, the child is shown a non-attachment-related vignette to establish the testability of the child (i.e., a breakfast vignette), followed by four attachment-related stories designed to elicit distress and that provide the basis of scoring attachment security. The administrator establishes a story that includes a child doll and a mommy or daddy doll (depending on the gender of the parent that accompanied the child to the clinic). The child's identification with the doll figure is emphasized but made implicitly (e.g., "So this is the (name of child) doll, and this is the mommy/daddy doll"). The stories begin

with everyday events followed by a distressing event: the child (a) is alone when waking up from a nightmare in the middle of the night, (b) hurts a knee while biking, with pain and bleeding, (c) experiences acute abdominal pain when watching TV alone, and (d) becomes lost while with the parent at a large shopping mall. This format is designed to activate the child's attachment system and, hence, attachment-related behaviors and thoughts, which resemble those used in the SSP or the "five adjective questions" in the AAI. As the story climaxes, the administrator asks, "What happens next?" to facilitate the completion of the child's narrative. The child is then asked about the feelings experienced by the child and the parent doll.

For the sake of clarity, the MCAST was administered in a suitable room at our university clinic, and the parent was not in the room with the child during the MCAST procedure. The entire MCAST procedure was videotaped, and reliable coders unaware of any information regarding the child and family coded each attachment vignette according to the MCAST coding manual (Green, Stanley, Goldwyn, & Smith, 2007). Different teams coded T1 and T2, and all coders were certified for research purposes in collaboration with the MCAST founders at the University of Manchester, U.K. A random 10% of the MCAST videos were recoded by blinded coders. As regards coders' agreement of security ratings, the ICC reliability (see, e.g., Janson & Olsson, 2004) across multiple pairs of coders was .81 at T1 and .86 at T2.

Given interest in testing diathesis-stress versus differential-susceptibility models of Person × Attachment interaction, as well as to increase variation and thus statistical power (Futh, O'Connor, Matias, Green, & Scott, 2008), we employed a continuous approach in analyzing attachment security. Following a procedure described by Hygen, Guzey, Belsky, Berg-Nielsen, and Wichstrøm (2014) and also implemented elsewhere (Viddal et al., 2015; Wichstrøm, Belsky, & Berg-Nielsen, 2013), the primary categorization (A, B, C, and D) of each vignette was coded as 1 (*present*) or 0 (*absent*). However, secondary classifications should also be considered when attachment is viewed continually. Given that secondary classifications are not as decisive as primary classifications; they were given a weight of 0.5 if present. The total attachment scores were computed by averaging the primary and secondary scores (range 0–1) across the four story completion vignettes. Hence, a child who was given a primary classification of B on three of the total of four vignettes in the MCAST and a secondary classification of B on one vignette would be given a B-score of 0.875 ([1 + 1 + 1 + 0.5] divided by four vignettes to attain a mean score). Accordingly, the highest B-mean score attainable was 1.0. Conversely, a score of 0 would result if the child evinced insecure or disorganized attachment in all four vignettes. Notably, this analytic approach does not violate the manual's principles; rather, it takes into account that children's strategies may vary within and across vignettes. Additionally, this method has previously been employed to the current sample by developers of the MCAST (see Viddal et al., 2015), and has been shown to be valid in predicting self-regulation (Viddal et al., 2015), aggression, and social skills (Hygen et al., 2014).

Due to the risk that language ability could affect attachment measurements, especially in light of evidence that securely attached children have stronger verbal skills than their insecurely attached counterparts (McElwain, Booth-LaForce, Lansford, Wu, & Dyer, 2008), the children's *receptive language ability* was

measured at T1 using the Norwegian version of the Peabody Picture Vocabulary Test (PPVT-III; Dunn & Dunn, 1997; $a = 0.98$) and served as a control variable in all statistical analyses.

Emotion regulation. Emotion regulation was measured with the Emotion Regulation Checklist (ERC; Shields & Cicchetti, 1997), which was completed by teachers at T2 and T3. The ERC consists of 24 items, for which an adult who is familiar with the 6- to 12-year-old child judges how characteristic each statement is of a particular child on a Likert scale ranging from 1 (*almost always*) to 4 (*never*). For the purposes of this study, we applied the ER subscale ($\alpha = .78$ [T2, T3]), which comprises eight items describing situationally appropriate affective displays, empathy, and emotional self-awareness (e.g., "can say when s/he is feeling sad, angry or mad, fearful, or afraid;" "seems sad or listless;" or "displays appropriate negative emotions in response to hostile, aggressive, or intrusive acts by peers"). The ER scale was chosen due to its particular focus on regulation and to avoid a subscale that too closely resembles the temperament trait "negative affect," which has been suggested as a plasticity factor itself (Belsky et al., 2007) and therefore could complicate the interpretation of any findings.

5-HTTLPR genotyping. Genotyping was performed using two milliliters of saliva collected from children at T2 using the Oragene DNA/saliva kit (DNA Genotek, Ottawa, Ontario). DNA was later extracted and stored according to the manufacturer's protocol. The PCR of the *5-HTTLPR* polymorphism was performed with the Ampli Taq® 360 DNA polymerase kit (Applied Biosystems). The amplification reactions were performed with a total volume of 25 µl containing 10–100 ng genomic DNA, 1.25 units of AmpliTaq 360 DNA polymerase, 0.75 mM MgCl2, 16% (vol/vol) 360 GC Enhancer, 0.5 mM dNTP, and 0.3 µmol/L of each primer. The *5-HTTLPR* marker was genotyped by the size separation of the PCR product on the ABI 3730 DNA Analyzer (Applied Biosystems) and was sized utilizing the GeneScan 600 LIZ Size Standard (Applied Biosystems) and the ABI PRISM Gene Mapper® software, version 4.0 (Applied Biosystems). The *5-HTTLPR* genotype frequencies were consistent with the Hardy-Weinberg equilibrium ($\chi^2 = 2.77$, $p = .10$). Of 716 saliva samples, 678 were successfully genotyped. In all, 18.4% ($n = 125$) of the children were identified as the SS genotype, 51.5% ($n = 349$) were identified as the SL genotype, and 30.1% ($n = 204$) were identified as the LL genotype.

Statistical Analyses

Descriptive and regression analyses. The effect of the development of attachment security on the development of emotion regulation was investigated via growth curve modeling using Mplus version 7.31 (Muthén & Muthén, 1998–2012). The level (i.e., intercept, set at age 6) and change in emotion regulation from 6 to 8 years of age were regressed on the intercept (set at age 4), and change in attachment security from age 4 to 6. Additionally, change in attachment and change in emotion regulation were regressed on their respective intercepts, and verbal comprehension was adjusted for. Missing data were handled through a Full Information Maximum Likelihood (FIML) procedure (see, e.g., Enders, 2001). Notably, due to the lack of a third measurement point for attachment and emotion regulation, the error terms were set to zero, which implied that we analyzed observed (not latent) growth, which in practice is a difference score. Furthermore, by adjusting

for intercepts in all analyses, regression to the mean was taken into account.

Because we oversampled for children with high SDQ scores, all analyses were performed with weights proportional to the number of children in a specific stratum divided by the number of participants in that stratum; this strategy yielded corrected population estimates. A robust maximum likelihood estimator was applied, which also provided robust standard errors; notably, this approach is robust to moderate deviations from normality.

Testing for differential susceptibility. Due to the expectation that short-allele carriers would prove more susceptible to environmental, and thus attachment influences, and given our focus on changes in attachment predicting changes in emotion regulation, we employed a modified version of the competitive, model-fitting approach advocated by Widaman et al. (2012) and Belsky et al. (2013) for testing differential-susceptibility versus diathesis stress. More specifically, two modifications were applied. First, the Widaman approach concerns whether the crossover point of the regression slopes among more and less susceptible individuals deviates significantly from the minimum and maximum observed values of the exposure. Thus, there is no prior testing of whether an interaction exists at the outset. To ensure that there was indeed a GXE interaction, we examined whether the effect of intercept and change in attachment on intercept and change in emotion regulation differed across the three allelic groups of SS, SL, and LL. This examination was performed via a multigroup analysis, in which the model fit when fixing the regression coefficient as equal in two allelic groups was compared with a model with a freely estimated coefficient. The resulting difference in model fit was tested with a Wald test with 1 *df*. The literature is equivocal in regards to the placement of the SL group. Therefore, we examined whether the prospective effects differed between the SS and SL carriers, as well as between the SL and LL carriers.

Second, in the original approach (Widaman et al., 2012), a procedure to test whether the crossover point differs from 0 is described, which is appropriate if the lines cross near the *y*-axis. Thus, in the present case, this would imply testing for differences in emotion regulation when children mostly change and become more insecurely attached. However, the slopes may also cross near the other end of the attachment spectrum (which runs from 0 to 1 in the present case), that is, when children predominantly become more securely attached over time. Therefore, we also tested whether the crossover point was different from 1 (moving from insecure to fully securely). For the sake of order, please note that, similar to the analyses of main effects of attachment, baseline attachment was also controlled in the GXE analyses.

Results

Descriptives

Table 1 presents the descriptive statistics and correlations between all variables included in the analyses. Attachment security was modestly stable from 4 to 6 years of age. This rank-order stability was observed in the context of increasing levels of attachment security during this period, as shown by the significant mean growth per year ($M_{growth} = 0.08$, 95% $CI = 0.06{-}0.09$, $p = {<}0.001$). The level of emotion regulation slightly increased from 6 to 8 years of age ($M_{growth} = 0.02$, 95% $CI = 0.00{-}0.05$,

Table 1

Descriptive Statistics and Zero-Correlations for All Study Variables

Variables	M/%	SD	Min	Max	1	2	3	4	5
1. Attachment security 4 years	.52	.39	.00	1.00	—				
2. Attachment security 6 years	.67	.34	.00	1.00	.28***	—			
3. Emotion regulation 6 years	3.33	.47	1.25	4.00	.10*	.20***	—		
4. Emotion regulation 8 years	3.42	.49	1.50	4.00	.14**	.24***	.43***	—	
5. Verbal comprehension 4 years	6.73	1.92	.8	10.3	.12*	.10*	.13**	.05	—
6. *5-HTTLPR* SS	18.2				.05	.06	−.03	−.11*	−.02
7. *5-HTTLPR* SL	51.2				.00	.00	.00	.02	.01
8. *5-HTTLPR* LL	29.6				−.05	−.05	.03	.06	.00

* $p < .05$. ** $p < .01$. *** $p < .001$.

$p = .02$). Verbal comprehension was correlated with both attachment and emotion regulation, underscoring its potential role as a confounder in the attachment–emotion regulation relation, and the importance of adjusting for verbal comprehension in further analyses.

Level and Change in Attachment Security Predicting Level and Change in Emotion Regulation

For the sake of order, there were no differences in the levels of attachment security to mothers and to fathers at T1 [Mothers ($M = 0.51$, $SD = 0.33$), Fathers ($M = 0.49$, $SD = 0.32$), $t(804) = −0.64$, $p = .526$] or T2 [Mothers ($M = 0.52$, $SD = 0.33$), Fathers ($M = 0.49$, $SD = 0.34$), $t(653) = −0.93$, $p = .353$].

As shown in Table 2, a higher level of attachment security at 4 years of age predicted a higher level of emotion regulation at 6 years of age as well as increased emotion regulation from the ages of 6 to 8. Beyond these effects of attachment security, children who evinced further increases in security from 4 to 6 years of age also evinced greater emotion regulation at age 6 and greater increases in emotion regulation from ages 6 to 8. Thus, there was an effect of change in attachment even when the intercept of attachment was controlled.

5-HTTLPR × Attachment

Before addressing the issue of genetic moderation of changes in attachment on changes in emotion regulation, it should be noted that SS carriers evinced decreased emotion regulation from 6 to 8 years of age compared with LL carriers ($\beta = −0.10$, $p = .035$; see

Table 2). Thus, a main effect of *5-HTTLPR* on changes in emotion regulation was observed.

With regard to genetic moderation, inspection of Table 3 revealed no moderation by *5-HTTLPR* of the effect of age-4 level and ages 4-to-6 changes in attachment on the level of emotion regulation at age 6. However, the effect of change in attachment from ages 4 to 6 years on change in emotion regulation from ages 6 to 8 years did prove to be genetically moderated, in that the effect in question was strongest for the SS group ($\beta = 0.63$, $p = .001$) and significantly different from that of the SL carriers (*Wald* = 16.36, $p = .001$) and LL carriers (*Wald* = 5.33, $p = .021$). The latter two groups did not differ from one another regarding this effect on change in emotion regulation; hence, L carriers were grouped together in the subsequent analysis.

Differential Susceptibility versus Diathesis Stress

Notably, changes in attachment theoretically range from −1, a result of being fully secure at age 4 and becoming fully insecure at age 6, to 1, a result of being fully insecure at age 4 and becoming fully secure at age 6. A score of 0 indicates no change in attachment security over time. Because such scoring revealed that some children obtained scores of either −1 or 1, the crossover point central to distinguishing the two models of interaction should be significantly different from these maximum and minimum observed values to conform to differential susceptibility.

As illustrated in Figure 1, the results from the Widaman et al. (2012) method provided support for the differential susceptibility model. Not only did the crossover point for the simple slopes of the two allelic groups—S homozygotes and L carriers—fall quite

Table 2

Predictors of Emotion Regulation at 6 Years and From 6 to 8 Years of Age

Predictors	Emotion regulation at 6 years of age				Change in emotion regulation from 6 to 8 years of age			
	B	95% CI	β	p	B	95% CI	β	p
Emotion regulation at 6 years of age	—	—	—	—	−.31	−.35; −.26	−.58	<.001
Attachment security at 4 years of age	.28	.12; .44	.27	<.001	.09	.02; .17	.23	<.001
Attachment security—change from 4 to 6 years of age	.52	.27; .77	.26	<.001	.20	.08; .31	.19	<.001
5-HTTLPR SS* carriers	−.05	−.12; .07	−.02	.313	−.04	−.09; .00	−.10	.035
5-HTTLPR SL* carriers	.03	−.05; .11	.04	.389	.01	−.03; .05	.02	.657
Verbal comprehension at 4 years of age	.06	.01; .05	.11	.007	.00	.02; .09	−.02	.626

* In comparison to LL carriers (baseline).

Table 3

Emotion Regulation at 6 Years and from 6 to 8 Years of Age According to Attachment Security at 4 Years of Age as Well as Change From 4 to 6 Years of Age Across Three 5-HTTLPR Genotypes

Attachment Security	5-HTTLPR-SS		5-HTTLPR-SL		5-HTTLPR-LL		SS vs. SL		SS vs. LL		SL vs. LL	
	β	p	β	p	β	p	Wald	p	Wald	p	Wald	p
	Emotion regulation at 6 years of age											
Attachment at 4 years of age	.31	.047	.17	.052	.36	<.001	.45	.50	.25	.62	2.31	.13
Attachment change from 4 to 6 years of age	.24	.11	.21	.014	.33	<.001	.00	.97	.58	.45	1.08	.30
	Change in emotion regulation from 6 to 8 years of age											
Attachment at 4 years of age	.51	<.001	.14	.052	.27	.01	4.63	.031	1.18	.28	.98	.32
Attachment change from 4 to 6 years of age	.63	<.001	.06	.32	.25	.006	16.36	<.001	5.33	.021	1.00	.32

close to 0, but the 95% *CI* included neither the minimum observed value (i.e., −1) nor the maximum observed value (i.e., 1; *C* = 0.29, 95% *CI* = −0.02–0.59).

The question thus remained whether the results conformed to weak or strong differential susceptibility. The strong version presumes that the less-susceptible group is not susceptible at all, whereas the weak version presumes only that the less-susceptible group is less—but still—susceptible than the more-susceptible group. Following Belsky et al. (2013), we compared a strong model, in which the effect of change in attachment on later emotion regulation was fixed at zero for the L carriers, with a weak model, in which the effect was freely estimated. The difference in model fit using Satorra and Bentler's (2001) procedure was significant ($\chi^2 = 6.05$, *df* = 1, *p* = .01), thereby supporting weak differential susceptibility. However, the effect among L carriers (the combined SL/LL group) was modest (β = 0.13, *p* = .01) compared with the stronger effect among SS carriers (see Table 3).

Secondary Analyses and Supplementary Material

In light of other data available in the TESS Study archive, questions could be raised regarding what the results of our study
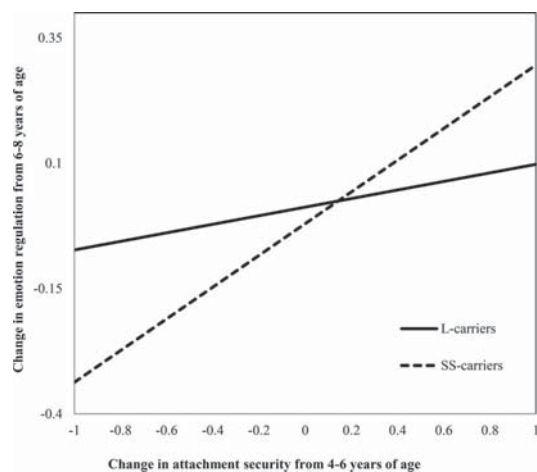
Figure 1. The effect of change in attachment on the change in emotion regulation according to 5-HTTLPR.

would be if we had relied on parent rather than teacher reports of child emotion regulation or focused on disorganized attachment. We therefore conducted secondary analyses.

Parent-reported emotion regulation. First, we reran the analyses with the parent-reported ERC (*a* = .65). The correlations between parent and teacher reports were only modest (*r* = .12 to-.22); hence, similarity in the findings between teacher and parent ratings should not be expected. There were no main effects of attachment (neither intercept nor change) on parent-reported emotion regulation (neither intercept nor change). However, as can be seen in the online supplement (Table S1), findings resembling those obtained with teacher reports were found with respect to our GXE analyses: (a) increased attachment security predicted better emotion regulation at 6 years of age for the SS group. This result was significantly different from that of the LL group (*W* = 5.34, *p* = .021), and there was a tendency for SS to have a steeper increase than the SL group (*W* = 3.0, *p* = .084), and (b) increased attachment security predicted increased emotion regulation from 6 to 8 years of age for the SS group, and this increase was significantly stronger than in the LL group (*W* = 4.30, *p* = .038). Overall, the analyses with parent-reported emotion regulation replicated some of the teacher-generated data but were insufficient to conduct the original analyses of differential susceptibility versus diathesis-stress.

Attachment disorganization. Second, our main findings pertained to the degree of attachment security. However, because children are rated on organized insecure attachment strategies (A and C) as well as disorganization (D; Main & Solomon, 1990), it could be that low security scores, and thus our findings, did not merely reflect insecurity but rather disorganization. We therefore tested whether the effect of security (on teacher-reported emotion regulation) would remain if we adjusted for disorganization. The disorganization variable was scored similarly to attachment security, and these variables proved to be highly and negatively correlated (*r* = −.68 at T1, *r* = −.62 at T2).

The effects of disorganization on emotion regulation were first investigated alone (for full results, see online supplemental Table S2). Disorganization at 4 years predicted emotion regulation at 6 years (β = −.32, *p* < .001) and change in emotion regulation from 6 to 8 years of age (β = −.21, *p* = .002). Furthermore, change in disorganization from 4 to 6 years of age predicted emotion regulation at 6 years (β = −.23, *p* = .001). However, change in disorganization only predicted change in emotion regulation from 6 to 8 years of age to a marginal extent (β = −.12, *p* = .091).

When all analyses from which these results emerged were rerun controlling for attachment security, all effects of disorganization were reduced to insignificance (online supplemental Table S3; note: multicollinearity diagnostics revealed acceptable values [Variance Inflation Factors (VIF) <1.9]). These results dissuaded us from addressing the GXE issue using disorganization as the E variable. In sum, secondary analyses provided some additional, although not identical, evidence that attachment is related to future emotion regulation and that attachment disorganization does not add predictive power over and above attachment security.

Discussion

Attachment researchers have theorized and provided evidence that secure attachment promotes the development of emotion regulation, with other work making clear that emotion regulation is predictive of a wide range of psychosocial outcomes and psychopathological conditions. However, beyond the early childhood years, the available evidence consistent with the claim that attachment security enhances emotion regulation is modest and methodologically limited (Parrigon et al., 2015). Thus, we sought to extend existing research, taking advantage of a three-wave longitudinal study of a Norwegian community sample to investigate whether changes in attachment predicted changes in emotion regulation and whether such an anticipated effect proved most pronounced among children who were homozygous for the 5-HTTLPR-S allele. Recall that analytic possibilities were circumscribed by the fact that attachment was only measured at ages 4 and 6 and emotion regulation only at ages 6 and 8.

The most notable finding emerging from this inquiry was that an increase in attachment from 4–6 years of age forecast an increase in emotion regulation from 6–8 years of age, even with initial levels of attachment security and emotion regulation controlled. This effect was considerably stronger for children who were homozygous for the S allele of 5-HTTLPR than for the L carriers. However, because the effect in question also proved evident in the case of L carriers, the weak rather than strong version of differential susceptibility best characterized the findings. In other words, although an increase in security predicted a prospective increase in emotion regulation for all children, irrespective of their genotype, this effect was most pronounced in the case of S homozygotes. These results extend research on the putative effect of attachment security on emotion regulation beyond the preschool years and add further evidence of differential susceptibility in the context of 5-HTTLPR. They also contribute to the literature on change and stability in attachment representations. We elaborate on these observations below, beginning with the last point.

Stability and Change in Attachment Security

The stability of attachment security from 4 to 6 years of age, as measured by the MCAST, was modest to moderate in magnitude. Only two other studies have investigated change and stability in attachment security as measured at a representational level during early childhood. Our results closely resemble Stievenart et al.'s (2014) findings of modest 2-year stability among 3- to 8-year-olds, but they diverge from Green et al.'s (2000) report of high stability across a 6-month interval in 5- to 7-year-olds.

The level of stability identified herein accords well with meta-analytic findings of moderate stability of attachment (Fraley, 2002;

Pinquart et al., 2013; see also Groh et al., 2014). In so doing, these results prove somewhat inconsistent with Pinquart and associates' (2013) meta-analysis, which indicated that studies such as ours (which focus on attachment after infancy rely on a representational measure of attachment, assess stability within a 2-year period and include a representative community sample) should generate larger stability coefficients. Although impossible to determine at this time, this divergence could be due to the developmental period studied, during which considerable sociocognitive change takes place involving, for example, moral concepts and theory of mind (see Smetana, 2013). It is possible that as attachment stability increases after the age of 6 (Pinquart et al., 2013; see also Green et al., 2000), the current findings may represent a time window in development in which considerable change in attachment takes place before IWMs become more consolidated.

Beyond the question of stability of individual differences, and in accordance with Stievenart et al. (2014), repeated measurements of attachment security revealed increasing levels of security, on average, over time. This developmental trend has, to some extent, been indicated by others when studying attachment from infancy to the late preschool years (see Solomon & George, 2008). Correspondingly, increased insecurity has been reported with a risk sample (Vondra et al., 2001).

Despite the normative finding of increased security across time, it should be noted that factors beyond attachment could influence the current results. Even though very young children are capable of generating narratives (Szaflarski et al., 2012), these capacities improve with age (Curenton, 2011). However, MCAST's scoring criteria does not adjust for age, and although narrative abilities are strongly grounded in linguistic skills and general cognitive skills (Szaflarski et al., 2012), only verbal comprehension was controlled in this study. Consequently, we cannot exclude the possibility that the children simply became better at telling secure stories. It should be noted, however, that stories may become more coherent without becoming more secure. Notably, MCAST scoring requires coding not only the children's speech but also how they have the dolls behave (Green et al., 2007).

Changes in Attachment Forecast Changes in Emotion Regulation

Because development is ongoing and because attachment earlier in life is presumed to influence subsequent behavior later in life (Sroufe, 2016), we predicted that whether a child became more secure or insecure over time would forecast whether he or she became more skilled in emotion regulation. Beyond indicating that attachment and emotion regulation continue to develop over the 2-year period that each was studied, we found that the level and change in attachment security across the late preschool years predicted the subsequent level and change in capacities for emotion regulation into the early middle childhood years. These findings linking development in a relational arena, attachment, with future development in the capacity to regulate emotions could be of clinical importance, especially given the central role of emotion regulation in most forms of psychopathology (Cole & Deater-Deckard, 2009). Hence, efforts to foster secure attachment relationships should not be restricted to the very first years of life, as increasing security across the transition to school and/or preventing its decline would clearly seem to have prospective benefits.

The focus on security per se seems to be important in light of the results of the secondary analysis. Recall that upon including both security and disorganization in the same model, we found that security rather than disorganization emerged as a significant predictor of emotion regulation. This was true despite the rather strong correlation between the two attachment measures.

Differential Susceptibility and 5-HTTLPR

By adopting a GXE approach, we investigated whether the effect of changes in attachment security on changes in emotion regulation would vary as a function of child genotype. This turned out to be the case. Upon becoming more secure, children who were homozygous for the 5-HTTLPR-S allele displayed the greatest increase in emotion regulation. Just as importantly, SS carriers evinced less positive growth in emotion regulation—and more so than other children—when attachment security decreased over time; indeed, for the SS children, the effect of change in attachment security on change in emotion regulation proved rather strong ($\beta = 0.63$, $p < .001$).

This pattern is consistent with the theory that children may vary in terms of their developmental plasticity, and such increased responsiveness to the environment operates in a for-better-and-for-worse manner (Belsky et al., 2007). Notably, the present findings are consistent with meta-analytic evidence indicating that the moderation effects of 5-HTTLPR of diverse environmental factors and processes prove more consistent with differential susceptibility than diathesis stress (van IJzendoorn et al., 2012; van IJzendoorn & Bakermans-Kranenburg, 2015), and that emotional reactivity is especially linked to individuals who are homozygous for the S allele (Miller et al., 2013).

In considering the differential-susceptibility-related results emerging from this investigation, it is important to remember that even L carriers were affected by changes in attachment security, just not as much as S homozygotes; these results are consistent with the weak version of differential susceptibility. When considering the limited prevalence of 5-HTTLPR SS homozygotes in the current sample (SS = 18.4%), changes in attachment seemed to exert a strong impact on only a minority of the children. For the majority of children, this impact was more limited.

Teacher versus parent reports of emotion regulation yielded somewhat mixed findings with regard to genotype moderation at 6 years of age. Here, the effect of attachment at 4 years of age only came out significant with parent reports. Given that previous studies have reported Attachment × 5-HTTLPR effects in preschoolers (Kochanska et al., 2009) and adolescents (Starr et al., 2013; Zimmermann et al., 2009), our mixed GXE results at 6 years of age may be methodological rather than substantial. Notwithstanding, our results discerned a main effect of the SS genotype on emotion regulation at 8 years of age. Thus, we cannot exclude that there are processes taking place beyond the preschool years, as middle childhood begins, in which the 5-HTTLPR polymorphism comes into play as a more potent moderator as well as a predictor. We can only speculate about possible age effects: Although individual differences in brain development related to emotion regulation are far from identified (Johnstone & Walter, 2014), it is, for example, documented that children apply increasingly more cognitive emotion-regulation strategies with age (Perlman & Pelphrey, 2010). This was illustrated with a sample of 5- to 11-year-olds, in which the older children were reported to use the more dorsal "cognitive" areas of the anterior cingulate cortex (a specialized prefrontal region implicated in emotion regulation), whereas the younger children engaged the more ventral "emotional" areas (Perlman & Pelphrey, 2010). Thus, possibly, from 6–8 years we may be tapping in to the shift in prefrontal activation in which the more reactive SS carriers may lag behind their less reactive peers, while at the same time profiting from the more secure strategies in times of distress. Indeed, social experiences throughout the life span influence the development of brain areas involved in self-regulation (see Kolb et al., 2012 for a review). However, such development does not seem to be linear or easy to predict (Ahmed, Bittencourt-Hewitt, & Sebastian, 2015); hence, age effects could be a complex matter. In addition, age, even ethnicity, may further be involved in regard to which alleles function as susceptibility factors (Davies & Cicchetti, 2014; van IJzendoorn et al., 2012).

Along with possible biological explanations, children's contexts extend and become more complex as well. With respect to the increasing external demands in school/early middle childhood, we suspect that SS children struggle to adapt in school, perhaps especially from 7 to 8 years of age, given that the first year in Norwegian schools with 6 year-olds is less demanding and more similar to day care.

What is especially important to appreciate is that no matter how interesting the results of the current investigation prove to be, much remains to be learned about the serotonergic system (Canli & Lesch, 2007). In fact, readers need to be cautioned that the moderational effect detected herein may not even be a function of 5-HTTLPR but rather of some other polymorphisms that are associated with 5-HTTLPR variants. Indeed, similar to most GXE work, this work remains correlational in character as it is based on observational data. However, it should be highlighted that recent experimental work has chronicled the moderation effect of 5-HTTLPR (Belsky et al., 2013; Belsky & van IJzendoorn, 2015; van IJzendoorn & Bakermans-Kranenburg, 2015).

From a clinical perspective, this study indicates that interventions for dysregulated children should include a relational focus, which takes underlying attachment insecurity into account. This requires parent involvement. However, the current results also imply that clinicians should expect attachment interventions to be efficient for some children more than for others. Future replication studies, as well as randomized interventions studies, may further clarify the direct implications of our GXE findings.

Strengths and Limitations

The stringent recruitment procedure, relatively large community sample, and longitudinal design are indisputable strengths of this study. Additionally, observational measures of attachment representations across time are rare for large samples; due to the potential bias of self-reported or parent-reported emotion regulation, the use of teacher reporting should also be considered a strength of this investigation (Adrian et al., 2011). Certainly, the reduction of reporter bias is especially important when testing differential-susceptibility, as a self-reported assessment of environment—in this case, parent–child attachment—could involve heritable response biases (van IJzendoorn & Bakermans-Kranenburg, 2015). Another strength of this inquiry was the com-

petitive evaluation of alternative models of Person × Attachment interactions (i.e., diathesis-stress vs. differential susceptibility).

Like most other research, the work presented herein was not without limitations. Although this study was informed by prior GXE research and studies documenting (modest) associations between parenting and attachment security (Fearon & Belsky, 2016), one should not presume that attachment security is a pure reflection of the rearing environment. Although behavior-genetic studies have consistently indicated that attachment is not heritable in infancy (see Fearon, Shmueli-Goetz, Viding, Fonagy, & Plomin, 2014 for a discussion), a recent study documented significant heritability in adolescents (Fearon et al., 2014). Thus, we cannot rule out the possibility that the attachment effects chronicled herein reflected genetic or other organismic influences rather than true environmental ones. In fact, given that environmental measures are more error prone than genetic measurements (van IJzendoorn & Bakermans-Kranenburg, 2015), it would be especially useful for experimentalists to determine whether the effects documented herein can be more or less replicated when efforts are made, via intervention, to foster attachment security across the transition to school.

Furthermore, the current study was not positioned to examine child effects. Undoubtedly, the effect of attachment development on emotion regulation does not exclude the possibility of the reverse relation; thus, reciprocal analyses of the dynamics between attachment and emotion regulation are warranted (Parrigon et al., 2015). Beyond reciprocity, the lack of complete measurement points of attachment and emotion regulation created limitations with respect to the temporal ordering of change processes. Although we can only assume that changes from 4 to 6 years of age continued to operate from 6 to 8 years of age independently of possible later changes in attachment, theory (Bowlby, 1969), and evidence (Pinquart et al., 2013) suggest that attachment is substantially more stable beyond the ages of 6.

With regard to measurement, it should be noted that the measure of emotion regulation applied herein does not provide insight into the regulation of emotions in real time due to the use of a questionnaire. Rather, it provides what can be described as a depiction of emotions "as regulated" and in rather general terms. Thus, future work should consider measuring emotion regulation in real time. Lastly, the findings should be interpreted in the context of substantial missing information. However, this attrition was only marginally associated with the study variables, and FIML was applied to adjust for missingness.

Conclusions

Despite these important limitations, the results of our investigation indicate that changes in attachment representations are common and that such changes across the transition to school forecast changes in emotion regulation early in the elementary school years; this is more so the case for a minority of children who are homozygous for the *5-HTTLPR* short-allele than for other children. Thus, our findings extend the limited literature on attachment and emotion regulation in the "forgotten years" of early middle childhood.

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Call for Papers

Guest Editors

Mike C. Parent, PhD. Texas Tech University, Department of Psychological Sciences, Lubbock, Texas.

Francisco J. Sánchez, PhD. University of Missouri, Department of Educational, School, and Counseling Psychology. Columbia, Missouri.

Psychology of Men & Masculinity is soliciting papers for a Special Issue examining men and boys, masculinity, and physical health. Our goal with this special issue is to further our understanding of what contributes to masculine norms and how masculine norms affect men's and boys' physical health. Men's health issues are an important public health concern, and the interplay between the psychology of men and masculinity and men's physical health is complex. Research has already uncovered important links between the enactment of masculine norms and physical health. The enactment of masculinity is a vital component of men's health, and this Special Issue seeks to centralize the intersection of masculinity and health.

We are calling for contributions to this special issue that include quantitative and qualitative research encompassing social, psychological, medical, and public health perspectives. We especially encourage submissions that focus on the health experiences of minority individuals, broadly defined.

Examples of potential submission topics include:
1. Men and boys, masculinity, and cancer, including prostate, skin, and lung cancers
2. Men and boys, masculinity, and cardiovascular health and heart disease, including dietary and exercise perspectives
3. Masculinity in the context of disability and chronic disease conditions
4. Men and boys, masculinity, and obesity and diabetes
5. Men and boys, masculinity, and healthful aging
6. Men and boys, masculinity, and sexual health (e.g., use of PrEP)
7. Biological bases for men's and boys' health

The submission deadline is November 1, 2017. All submissions should adhere to APA 6th edition style requirements.

Please contact Dr. Mike Parent (michael.parent@ttu.edu) or Dr. Francisco Sanchez (sanchezf@ missouri.edu) with any further questions.

STUDY/PAPER III

Is not included due to copyright

APPENDIX

Year	Author	Title
1951	**Bowlby**	Maternal Care and Mental Health
1958	**Bowlby**	The Nature of the Child`s Tie to His Mother
1967	**Ainsworth**	Infancy in Uganda: Infant Care and the Growth of Love
1969	**Bowlby**	Attachment and Loss: Vol. 1. Loss
1973	**Bowlby**	Attachment and Loss, Vol. 2: Separation
1977	**Sroufe & Waters**	Attachment as an Organizational Construct
1978	**Ainsworth**	Patterns of Attachment: A Psychological Study of the Strange Situation
1978	**Belsky & Steinberg**	Effects Of Day-Care - Critical-Review
1979	**Bronfenbrenner**	The Ecology of Human Development: Experiments by Nature and Design
1980	**Bowlby**	Attachment and Loss, Vol. 3: Loss, Sadness and Depression
1981	**Rothbart & Derryberry**	Development of Individual Differences in Temperament
1982	**Bowlby**	Attachment and Loss: Vol. 1. Loss, 2nd ed.
1985	**Stern**	The Interpersonal World of the Infant
1985	**Main & Cassidy**	A Move to the Level of Representation
1986	**Main & Solomon**	Discovery of a New Insecure-disorganized-disoriented Attachment Pattern
1994	**Cassidy**	Emotion Regulation: Influences of Attachment Relationships
1997	**NICHD Study of Early Child Care**	The Effects of Infant Child Care on Infant-Mother Attachment Security
1997	**Belsky**	Variation in Susceptibility to Rearing Influences: An Evolutionary Argument
2003	**Fraley & Spieker**	Are Infant Attachment Patterns Continuously or Catgorically Distributed? A Taxometric Analysis of Strange Situation Behavior.
2007	**Belsky, Bakermans-Kranenburg & van IJzendoorn**	For Better and for Worse: Differential Susceptibility to Environmental Influences
2015	**van IJzendoorn & Bakermans-Kranenburg,**	Genetic Differential Susceptibility on Trial: Meta-Analytic Support from Randomized Controlled Experiments

Table A. Historical Timeline with Examples of Some of The Main Publications That Have Informed This Thesis.

Figure I

TESS Flowchart

Figure II

TESS Stratification

Invited
N = 3,456

Excluded
n =176, 4.2 %

Attended well-child clinic
n = 3,358, 97.2%

Missed being asked to participate
n = 166 , 5.2%

Met inclusion criteria
n = 3,182, 94.8%

Asked to participate
n = 3,016; 94.8 %

Declined
n =539, 17.9%

Consented
n = 2,475; 82.1%

SDQ 0-4
Total n = 1,095
Drawn n = 407, 37.2%

SDQ 5-7
Total n = 731
Drawn n = 351, 48.0%

SDQ 8-11
Total n = 455
Drawn n = 320, 70.3%

SDQ 12-40
Total n = 194
Drawn n = 172, 88.7%

Interviewed
n = 316, 77.6%

Interviewed
n = 292, 83.2%

Interviewed
n =249, 77.8%

Interviewed
n = 138, 80.2%

Observation
n=301, 95.2%

Observation
n=272, 93.2%

Observation
n=238, 95.6%

Observation
n=127, 92%
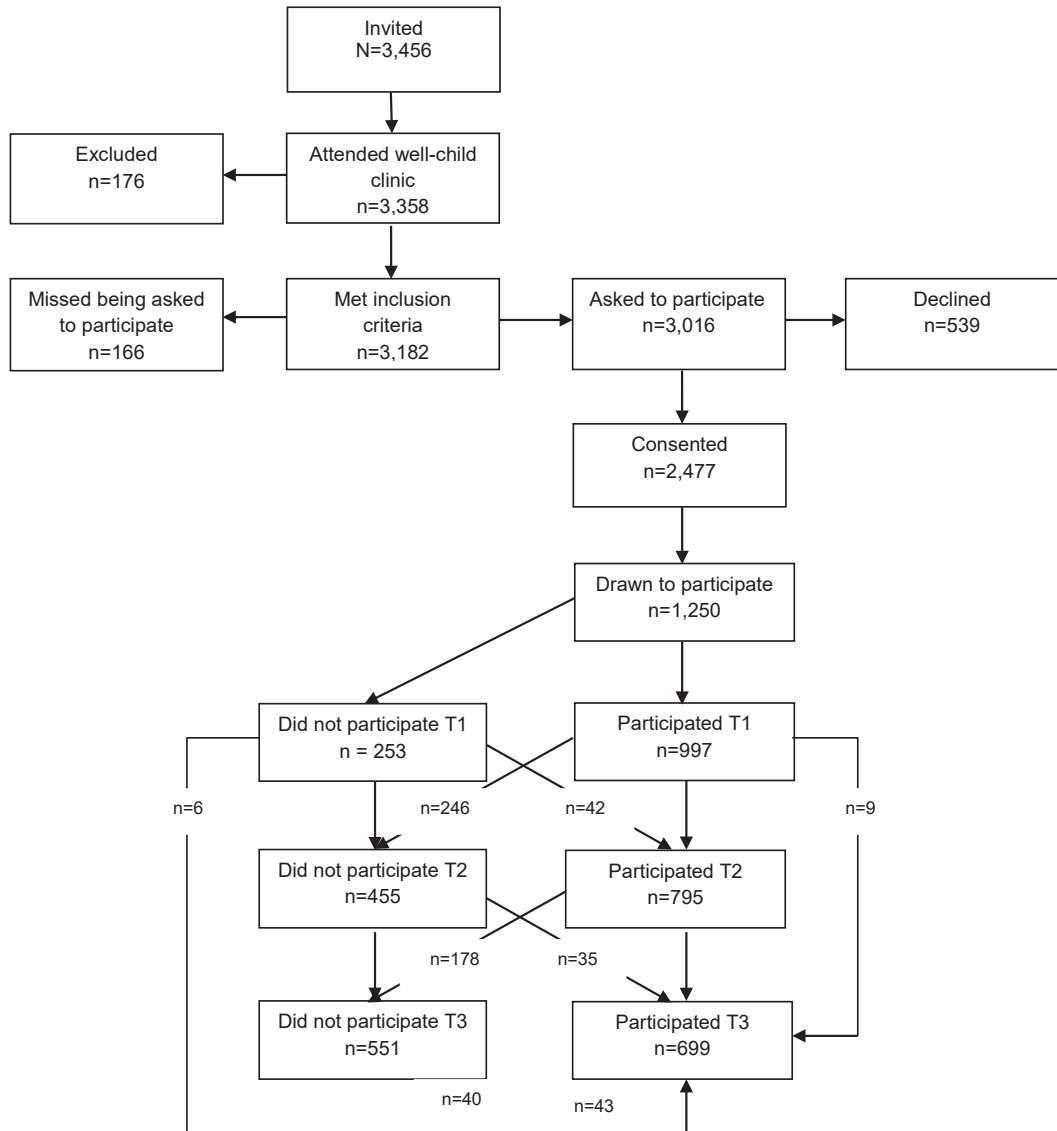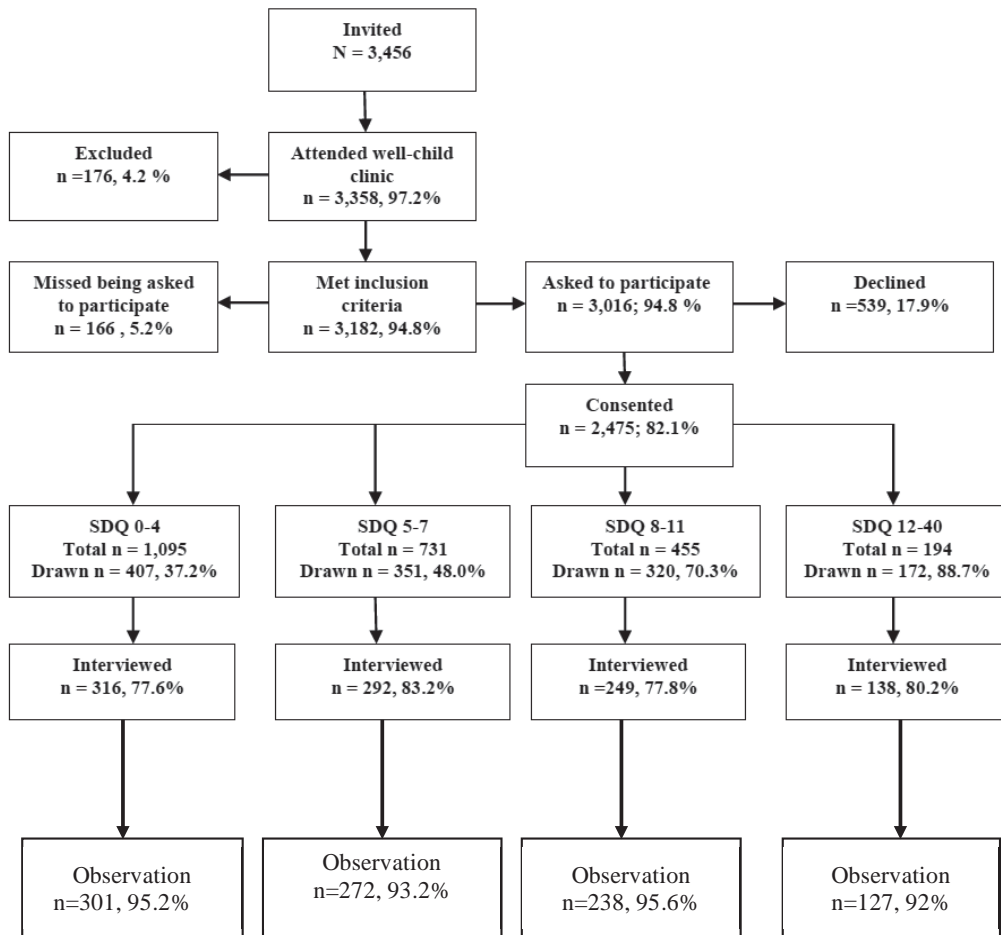
SDQ=Strengths and Difficulties Questionnaire (Goodman, 1997)

Table B. Summary of Instruments and Factors Applied in this Thesis

Time wawe	Instrument/ Factor	References	Psychometrics	Concept	Method	Performed by	Coded	Predictor/ Moderator	Outcome
O	SDQ	Goodman, 1997	α=0.74	Screening	Questionnaire	Parent			
T1, T2	MCAST	Green et al., 2000	ICC[1] at T1 B=0.81, D=0.73 ICC at T2 B=0.86, D=0.75	Attachment representations	Observational	Child	∨	∨	∨
T1	EAS	Biringen et al., 2014	ICC at T1 =0.71	Parental sensitivity	Observational	Parent with child	∨	∨	
T1, T2	CBQ	Rothbart et al., 2001	α=0.84 (T1) α=0.75 (T2)	Temperament: Effortful control	Questionnaire	Parent			∨
T2, T3	ERC	Shields & Cicchetti, 1997	α=0.78 (T2, T3) (α=0.65 (T2, T3))	Emotion Regulation	Questionnaire	Teacher, (Parent)			∨
T1	PPVT-III	Dunn & Dunn, 1997	α=0.98	Language comprehension	Observational	Child	∨		
T2	Oragene DNA/saliva kit		---	Serotonin transporter	Biological sample	Child		∨	
T1	Hours in Childcare from ages 0-4		---	Quantity of Childcare	Questionnaire	Parent		∨	
T1	Socioeconomic status		---		Interview	Parent			
-	Child gender		---					∨	

[1] Intra Class Correlations; B=Attachment Security; D= Attachment Disorganization.

Table S1

Parent-reported emotion regulation at 6 years and from 6 to 8 years of age according to attachment security at 4 years of age as well as change from 4 to 6 years of age across three 5-HTTLPR genotypes

| | Emotion regulation at 6 years of age | | | | | | | | | | | |
| | 5-HTTLPR-SS | | 5-HTTLPR-SL | | 5-HTTLPR-LL | | SS vs. SL | | SS vs. LL | | SL vs. LL | |
	β	p	β	p	β	p	Wald	p	Wald	p	Wald	p
Attachment at 4 years of age	.33	0.019	.10	.24	.04	.66	1.81	0.18	2.60	0.11	0.18	0.67
Attachment change from 4 to 6 years of age	.35	0.021	.05	.51	-.06	.51	3.0	0.084	5.34	0.021	0.87	0.35
Change in emotion regulation from 6 to 8 years of age												
Attachment at 4 years of age	.25	.095	.16	.037	.02	.80	.00	0.97	1.34	0.25	1.57	0.21
Attachment change from 4 to 6 years of age	.27	.036	.05	.51	-.07	.51	1.75	0.19	4.30	0.038	0.87	0.35

Table S2

Predictors of emotion regulation at 6 years and from 6 to 8 years of age

	Emotion regulation at 6 years of age				Change in emotion regulation from 6 to 8 years of age			
	B	95% CI	β	p	B	95% CI	β	p
Emotion regulation at 6 years of age	-	-	-	-	-.29	-.33; -.25	-.56	<0.001
Disorganization at 4 years of age	-.62	-.91; -.34	-.32	<0.001	-.21	-.35; -.08	-.21	0.002
Disorganization-change from 4 to 6 years of age	-.81	-1.31; -.32	-.23	.001	-.21	-.45; .03	-.12	0.091
5-HTTLPR SS* carriers	-.01	-.11; .08	-.01	0.787	-.04	-.09; .01	-.08	0.078
5-HTTLPR LL* carriers	.03	-.05; 12	.04	0.457	.01	-.03; .05	.01	0.740
Verbal comprehension at 4 years of age	.03	.00; .05	.12	0.003	-.02	-.01; .01	-.02	0.639

Note: *In comparison to SL carriers (baseline)

Table S3

Emotion regulation at 6 years and from 6 to 8 years of age according to secure and disorganized attachment at 4 years of age as well as change from 4 to 6 years of age across three 5-HTTLPR genotypes

| | Emotion regulation at 6 years of age | | | | | | Change in emotion regulation from 6 to 8 years of age | | | | | |
| | 5-HTTLPR-SS | | 5-HTTLPR-SL | | 5-HTTLPR-LL | | 5-HTTLPR-SS | | 5-HTTLPR-SL | | 5-HTTLPR-LL | |
	β	p	β	p	β	p	β	p	β	p	β	p
Security of Attachment at 4 years of age	.61	0.003	.07	0.523	.27	0.071	.71	<0.001	.11	0.219	.11	.480
Disorganized attachment at 4 years of age	.38	0.068	-.16	0.318	-.14	0.450	.28	0.198	.03	0.802	-.25	0.216
Change in secure attachment from 4 to 6 years of age	.41	0.020	.19	0.072	.29	0.026	.74	<0.001	.13	0.102	.16	0.177
Change in disorganized attachment from 4 to 6 years of age	.24	0.139	-.04	0.762	-.07	0.688	.16	0.385	.16	0.169	-.15	0.280

Note: Adjusted for emotion regulation at 6 years of age and verbal comprehension at 4 years of age.

Figure III
Summary of main
findings
(Study I-III)

Emotion
Regulation

5-HTTLPR

Emotion
Regulation

Attachment
Security

Effortful
control

Language
comprehension

Gender

Attachment
Security

Effortful
control

Parental SES

Parental
(in)sensitivity

Time in childcare

X

Main effects

Moderation

Cumulative Risk

1-4 years of age

4 years of age

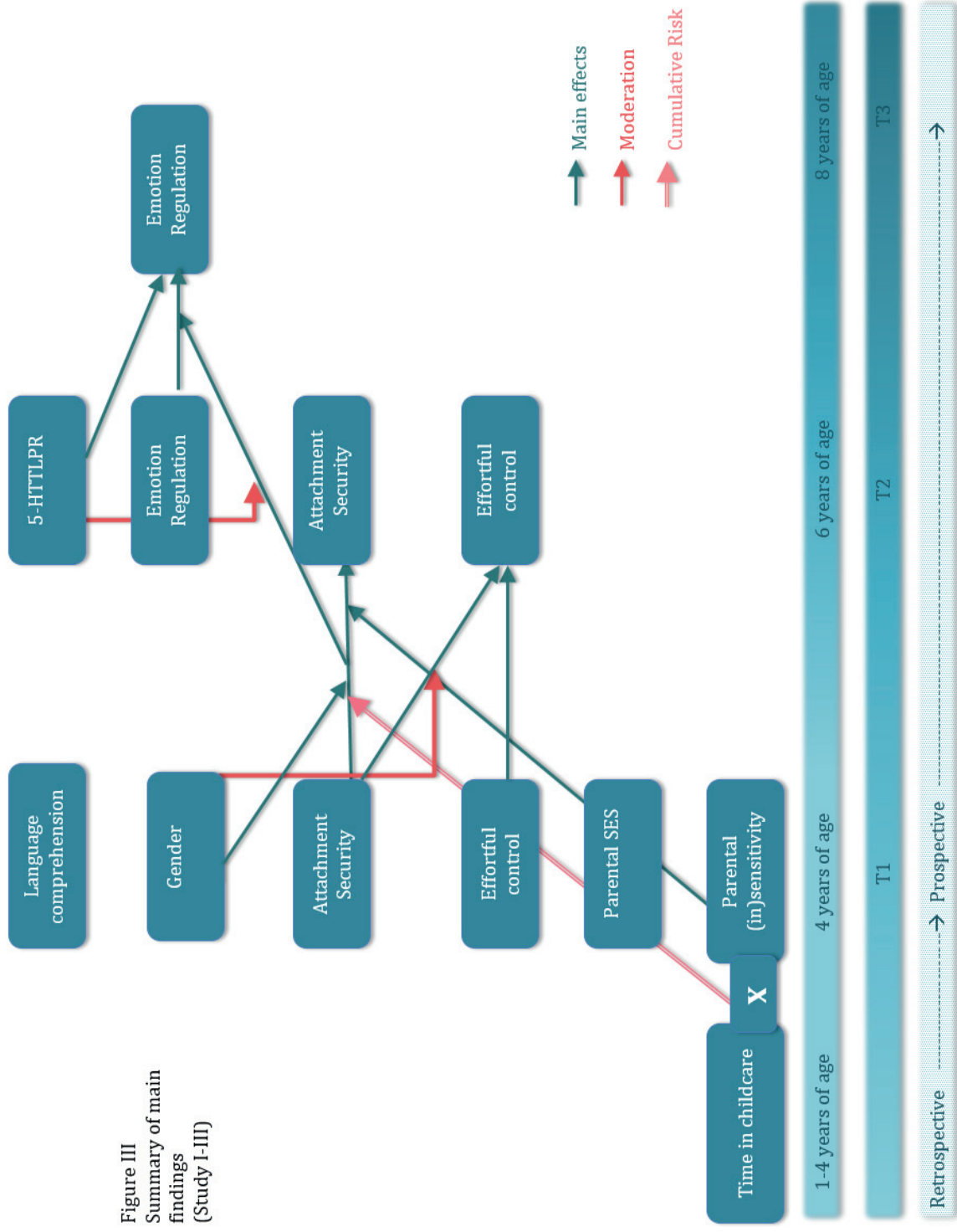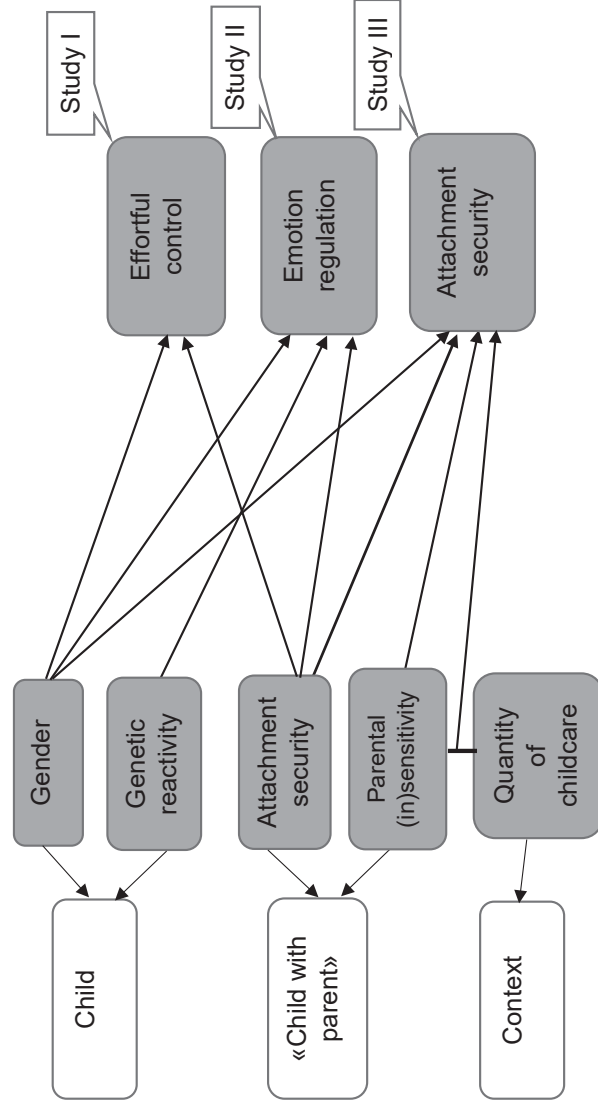6 years of age

8 years of age

T1

T2

T3

Retrospective

Prospective

Figure IV

Socioemotional Development across Preschool to School Age

Simplified Model of Factors
and Paths Investigated in This
Thesis

NTNU

Trondheim

Samtykkeerklæring

Jeg er blitt informert skriftlig og muntlig om undersøkelsen

"Tidlig trygg i Trondheim"

Jeg er også blitt informert om formålet med undersøkelsen og om at deltakelsen er frivillig. Jeg er kjent med at dataene om meg og mitt barn blir behandlet strengt fortrolig og at undersøkelsen er godkjent av Datatilsynet. Undersøkelsen er forelagt Den regionale komité for medisinsk forskningsetikk. Jeg eller barnet mitt kan på et senere tidspunkt be om å bli slettet fra registeret uten å oppgi grunn. Jeg er videre kjent med at dataene vil bli anonymisert ved prosjektslutt i 2020.

Jeg samtykker i at mitt barn og jeg deltar i undersøkelsen.

Barnets navn:..

Trondheim, ... (dato)

....
Underskrift foresatt

Forespørsel om deltakelse i forskningsprosjektet

"Gener og miljø i barns sosiale utvikling"

Bakgrunn og hensikt

Dette er et spørsmål til deg om å delta i nye undersøkelser i forskningsstudien *Tidlig trygg Trondheim* for å undersøke barns psykiske og sosiale utvikling i forhold til: 1) hvordan gener samvirker med miljøfaktorer, 2) fysisk aktivitet, 3) hjerterytme og 4) evnenivå. Vi spør alle deltagere i Tidlig trygg i Trondheim, både foresatte og barn, om å delta. Miljøfaktorene er de opplysningene vi tidligere har samlet inn og vil komme til å samle inn i prosjektet, slik som spørreskjemaopplysninger fra deg og fra barnehagen/skolen, undersøkelser av barnet, eventuelle registeropplysninger og filmopptak av barnet og deg.

Hva innebærer studien?

Du har allerede deltatt i en tidligere undersøkelse når barnet var 4 år. Undersøkelsen denne gang vil bli lik den forrige, men med noen utvidelser. Utvidelsen består i at vi vil ta en spyttprøve av deg og av barnet ditt. Denne vil bli brukt til å undersøke mulige genetiske forhold som kan være viktige for psykologisk og sosial utvikling. I tillegg vil vi undersøke hjerterytmen hos barnet ditt, samt noen flere undersøkelser av barnets evner.

Undersøkelse av hjerterytme innebærer at vi vil feste noen elektroder på kroppen til barnet og at det vil bære en elektronisk sender mens dere er her. For å undersøke det fysiske aktivitetsnivået hos barnet ber vi om at hun/han bærer en liten måler som festes rundt livet (akselerometer) i 7 dager og returnere den til oss etter det.

Mulige fordeler og ulemper

Noen barn kan ha vansker med å få samlet nok spytt. Da vil vi gi dem et ufarlig smaksstoff som gjør at det produseres mer spytt. Elektrodene kan kjennes litt kalde mot kroppen med en gang, men dette går fort over. Prøvene innebærer ikke noen direkte fordeler for deg og barnet ditt utover det at dere er med på å gi kunnskap som kan være viktige for å forstå barns utvikling. Alle som deltar får en kompensasjon på kr. 300,- og er med i en trekning om en valgfri ferie for familien til kr. 40 000,-.

Hva skjer med prøvene og informasjonen om deg?

Prøvene tatt av deg og barnet, og informasjonen som registreres om deg og barnet, skal kun brukes slik som beskrevet i hensikten med studien. Alle opplysningene og prøvene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En tallkode knytter barnet ditt og deg til opplysninger og prøver fra dere gjennom en navneliste. Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som kan finne tilbake til deg. Etter godkjenning fra Datatilsynet vil opplysningene om deg og ditt barn kunne kobles med opplysninger om deg og ditt barn fra offentlige registre omkring sosiale, utdanningsmessige og helsemessige forhold, slik som FD-trygd, Norsk UtdanningsData Base, Medisinsk fødselsregister, Norsk pasientregister, Reseptbelagt medikamentregister, straffe- og bøteregistrene, samt med opplysninger fra undersøkelse og prøver på helsestasjon, barnehage og skole. Det vil ikke være mulig å identifisere deg eller ditt barn i resultatene av studien når disse publiseres.

Frivillig deltakelse

Det er frivillig å delta i studien. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta. Dersom du ønsker å delta i dette tillegget til Tidlig trygg i Trondheim, undertegner du samtykkeerklæringen på baksiden. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke uten at det har noen konsekvenser for deg eller barnet ditt. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du kontakte Heidi Birkelund på telefunnummer 948 84 004.

Ytterligere informasjon om studien finnes i kapittel *A – utdypende forklaring av hva studien innebærer.*
Ytterligere informasjon om biobank, personvern og forsikring finnes i kapittel B – *Personvern, biobank, økonomi og forsikring.*

Samtykkeerklæring følger etter kapittel B.

Kapittel A- utdypende forklaring av hva studien innebærer

Denne runden av Tidlig trygg i Trondheim har fire nye undersøkelser:
1. Tidligere forskning har antydet at noen typer gener kan påvirke effekten av miljøets betydning for barns psykologiske og sosiale utvikling. Slik sett kan noen barn være mer formbare eller robuste overfor oppvekstmiljøet. Akkurat hvilke gener som kan ha en slik betydning, og hvilke miljøforhold de samvirker med, har vi i dag liten kunnskap om. Det er dette vi har til hensikt å undersøke i denne tilleggsstudien til Tidlig trygg

i Trondheim. For å undersøke genene (DNA) trenger vi spytt fra deg og fra barnet. Spyttprøvene fryses ned og analyseres for DNA på et senere tidspunkt.

2. Det er også grunn til å tro at barnets kognitive (tenkemessige) evner har betydning for sosialt samspill med andre og tilpasning til bl.a. skolen. Vi vil derfor undersøke barnets generelle evner og spesielle evner knyttet til konsentrasjon og oppmerksomhet.

3. Barn varierer med hensyn til hvor lett de blir aktivert følelsesmessig, noen reagerer veldig lett mens andre har en høyere terskel. Hvor lett man reagerer, kan påvirke samspillet med andre og ha betydning for den mentale helsen. Undersøkelse av hjerterytme sier noe om hvor følelsesmessig aktivert en person er.

4. Grunnlaget for en persons fysiske aktivitetsmønster og vekt synes for mange å legges tidlig i livet. For barn er foreldrenes aktivitets- og kostholdsmønster særlig viktige. Vi vil derfor undersøke aktivitetsmønsteret til barnet. Dette gjøres ved å bære en måler som festes i livet i 7 dager. Etter disse 7 dagene sendes denne tilbake til NTNU i frankert konvolutt.

Kapittel B - Personvern, biobank, økonomi og forsikring

Personvern

Opplysninger som registreres om deg og ditt barn i form av genanalyser og andre undersøkelser vil bli koblet mot de opplysningene som du selv og barnet ditt tidligere har gitt i "Tidlig trygg i Trondheim". I de tilfeller du har samtykket til at opplysningene om deg og ditt barn kan kobles med offentlige registre, nærmere bestemt FD-trygd, Norsk UtdanningsData Base, Medisinsk fødselsregister, Norsk pasientregister, Reseptbelagt medikamentregister, straffe- og børteregistrene, samt med opplysninger fra undersøkelse på helsestasjon, barnehage og skole, vil de nye målingene også kobles mot disse. NTNU ved rektor er databehandlingsansvarlig.

Biobank

Spyttprøvene som blir tatt og informasjonen utledet av dette materialet vil bli lagret i en forskningsbiobank ved NTNU. Hvis du sier ja til å delta i studien, gir du også samtykke til at det biologiske materialet og analyseresultater inngår i biobanken. Dr. med. Olav Linaker er ansvarshavende for forskningsbiobanken. Biobanken planlegges å vare til 2020. Etter dette vil materiale og opplysninger bli destruert og slettet etter interne retningslinjer.

Rett til innsyn og sletting av opplysninger om deg og sletting av prøver

Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra studien, kan du kreve å få slettet innsamlede prøver og opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Økonomi

Studien og biobanken er finansiert gjennom forskningsmidler fra Norges forskningsråd og av NTNU.

Forsikring

NTNU er selvassurandør.

Informasjon om utfallet av studien

Alle deltagere vil få tilsendt opplysninger om resultatene av undersøkelsen i form av nyhetsbrev.

Samtykke til deltakelse i studien

Jeg er villig til å delta i studien og samtykker til at mitt barn kan delta

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(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)