Curious minds: stimulating parent-child interaction to foster neurocognitive functioning in four- to eight-year-olds

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Curious Minds

Stimulating parent-child interaction to foster neurocognitive functioning in four- to eight-year-olds

Andrea M. Spruijt

When you're curious, you find lots
of interesting things to do

Walt Disney

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CURIOUS MINDS

STIMULATING PARENT-CHILD INTERACTION TO FOSTER NEUROCOGNITIVE FUNCTIONING IN FOUR- TO EIGHT-YEAR-OLDS

Andrea Maria Spruijt

Colofon

Andrea Maria Spruijt

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CHAPTER 1

General introduction

Adaptive behavior, or the ability to respond in a constructive manner to adjust to a situation, reflects a person's ability to meet the demands of everyday life. This behavior is known to depend largely on the development of Executive Functioning (EF): a broad concept that encompasses various neurocognitive functions that regulate thoughts, feelings and behavior, like inhibition, cognitive flexibility, and working memory, as well as the more complex functions such as problem-solving and planning (Diamond, 2013). Together with attentional control (sometimes considered to be part of the EF domain), social cognition, and language development, EF is essential for the goal-oriented and adaptive social behavior that is expected of children at school and at home (e.g. Best, Miller, & Jones, 2009; Diamond, 2013; Garon, Bryson, & Smith, 2008; Green, Bunge, Briones Chiongbian, Barrow, & Ferrer, 2017; Miller Singley & Bunge, 2014; Shala, 2013). Extensive interest in fostering the development of these functions during childhood stems from associations with quality of functioning in many important aspects of life, such as school performance, health, and job success (e.g. Diamond, 2013).

During the transition from dependence to greater autonomy, young children's neurocognitive development is influenced by the relationship with their parents and the conditions in their caregiving environment (Bernier et al., 2012; Diamond, 2013; Fox & Calkins, 2003). Children become more active participants in parent-child interactions as they reach primary school age, which leads to parents systematically having to increase their contingent instructions (i.e. following the child's lead) to adaptively challenge their child's skills (Conner & Cross, 2003). Parents require understanding of their children's changing developmental needs during the early school years to provide them with these supportive, age-appropriate contingent responses (Landry, Smith, Swank, & Guttentag, 2008). Educating parents in child neurocognitive development can better equip them to recognize their child's level of competence. With increased understanding of how their child reasons and learns, parents may be better able to facilitate neurocognitive development through parent-child interaction. Whether and to what extent parents can be educated to provide an optimal learning environment to facilitate the development of neurocognitive functions by adaptively challenging their child's skills during parent-child interaction, however, warrants further study (Bierman & Torres, 2016; Diamond, 2013).

The studies discussed in this thesis will focus on the associations between aspects of parent-child interaction and two major neurocognitive components underlying goal-oriented and adaptive social behavior: an attentional/ executive component and a social cognitive component.

Executive functions are adaptive neurocognitive processes fundamental to problem-solving that enable us to plan, guide and control goal-oriented behavior (Best et al., 2009). *Attentional control* is tightly intertwined with executive functioning and entails both the ability to actively focus on one thing without being distracted (i.e. focused attention) and the ability to maintain attention over prolonged periods of time (i.e. sustained attention) (Cohen, 2014; Garon et al., 2008). There is general agreement that the three core executive functioning components inhibitory control, working memory and cognitive flexibility are interrelated but can be distinguished (Miyake et al., 2000). Inhibitory control often refers to the ability to suppress a dominant or automatic response also known as response inhibition, but it also encompasses an attentional component known as interference control: the ability to selectively attend to certain stimuli and ignore irrelevant stimuli (Diamond, 2013). Working memory refers to the ability to temporarily hold, manipulate and control information in the mind (Garon et al., 2008), and cognitive flexibility is the ability to shift between mental sets or tasks and adapt to changing situations (Best et al., 2009).

Social cognition can be described as the neurocognitive mechanisms underlying social competence, including the ability to interpret, predict, and empathize with others' mental states and behaviors (Baron-Cohen et al., 1999). Though linked with executive functioning and attentional control, research has shown that social cognition can be conceptualized as a separate construct. For instance, research in clinical populations has shown impairments in the social cognitive component but not in the attentional/executive component and vice versa (see Beauchamp & Anderson, 2010). Together with adequate communicative skills, such as expressive and receptive language, all these neurocognitive functions are fundamental to social interaction and reasoning and problem-solving in general.

In this thesis I will address how parent-child interaction is related to the child's level of attentional control, executive functioning and social cognitive development during the early school-age years. Furthermore, I will address whether educating parents how to adapt parent-child interactions to support neurocognitive development improves the interaction with their child, and subsequently can promote the development of the neurocognitive functions underlying children's goal-oriented and adaptive social behavior.

Neurocognitive functions during the early school-age years

Even though rudimentary forms of attentional control, executive functioning and social cognition already emerge early in life, they do not reach their full potential until much later. For instance, infants as young as 9 months of age are already capable of updating information in their working memory, while the ability to retain large amounts of information and mentally manipulate this information continues to develop well into adolescence (see Diamond, 2013). Early childhood is known to mark a time of rapid growth in children's neurocognitive development (e.g. Casey, Tottenham, Liston, & Durston, 2005). Nonetheless, a growing body of neurodevelopmental research indicates that a substantial part of the development of attentional control, executive functions and social cognition takes place after the age of four, designating the school-age years also as an interesting developmental period for researching possible influences from the child's environment (see Best & Miller, 2010; Peterson, Wellman, & Slaughter, 2012). Neurocognitive development during the school-age years appears to be especially rapid between ages five and eight and becomes more moderate between ages nine to twelve, suggesting the early school years may be of particular interest as a developmental window of opportunity for environmental influences (Korkman, Kemp, & Kirk, 2001; Korkman, Lahti-Nuuttila, Laasonen, Kemp, & Holdnack, 2013; Romine & Reynolds, 2005). During the early school years children also experience many novel challenges, such as dealing with unfamiliar adults and children, staying seated in class, and joining group discussions, which ask for adaptive behaviors and reasoning skills. Thus far, however, most studies on the normal development and enhancement of neurocognitive functions have mainly focused on the preschool years (Best et al., 2009). In this thesis I will focus on the early school years, specifically on four- to eight-year-olds.

Fostering neurocognitive development

Different environmental influences such as sensory stimuli, hormones, parent-child interactions or family stress may result in differential effects on neurocognitive development. This is nicely captured by the description of Kolb & Gibb (2011, p. 265): "the development of the brain reflects more than the simple unfolding of a genetic blueprint but rather reflects a complex dance of genetic and experiential factors that shape the emerging brain". Adverse environmental conditions may have a negative impact on developing neurocognitive functions, but optimal environmental conditions may provide opportunities to foster development. As Bjorklund (2018) describes in his overarching theory of cognitive development ***(Evolutionary developmental psychology)***, children are equipped with developing neurocognitive mechanisms such as executive functioning, which are designed to be sensitive to environmental factors in order to learn and achieve adaptive behavior. It has been suggested that biological maturation may especially be important in the development of neurocognitive functions in young children, whereas environmental factors may be more influential in older children, who are becoming more active participants during interactions due to developmental phase (Best et al., 2009).

Social interaction is essential to the development of neurocognitive functions; an insight posed by Vygotsky (1978) no less than 40 years ago. Significant others, like parents and teachers, play an important role in shaping the child's environment. In this thesis I will focus on the role of parents in fostering the development of neurocognitive functions through parent-child interaction. Parental behavior has been shown to be a valuable factor in promoting the development of neurocognitive functions in their children during infancy and the pre-school years through adequate stimulation, support and practice (e.g. Fay-Stammbach, Hawes, & Meredith, 2014; Lengua, Honorado, & Bush, 2007; Spinrad et al., 2007), and is assumed to continue to play a very important part during the early school years and beyond. Parents provide their children with learning opportunities to practice and internalize functions that will help them to control their behavior, like attention, executive functions, and social cognition, and are responsible for communicating social rules (e.g. Attili, Vermigli, & Roazzi, 2010; Bennett, Farrington, & Huesmann, 2005; Diamond, 2013; Vygotsky, 1978). Parents can help their children to take a step back during problem-solving and reflect upon the problem at hand, helping them to practice these skills (Giesbrecht, Muller, & Miller, 2010). By analogy, just as a parent holds onto a child learning to ride a bike before letting go and letting him experience the balancing on his own, so may parents help children experience executive functioning skills before they can adequately implement these skills themselves. For instance, asking questions to focus the child's attention on important aspects of the problem that the child was not yet able to notice on its own, will challenge the child's mental representations and will facilitate internalization of attentional control. As such, parent-child interaction is assumed to play an important role in children's neurocognitive development.

Parents as change-agents

Attempts to foster the development of children's neurocognitive functions have especially proven to be successful when including social interactive components in the real-life social context, with children being guided by a familiar adult (e.g. Bierman & Torres, 2016; Engelmann, Neuhaus, & Fischer, 2016; Hofmann et al., 2016). Furthermore, repetition appears to be essential for the best results, in which skills are continually challenged with increasing demands, adaptive to the child's age and ability (e.g. Bergman Nutley et al., 2011; Diamond, 2013; Holmes, Gathercole, & Dunning, 2009; Thorell, Lindqvist, Bergman Nutley, Bohlin, & Klingberg, 2009). This places parents in an ideal position, provided that they are informed about different ways to help stimulate their child's neurocognitive functioning, adaptive to his or her age and ability, and that they will continually stimulate these aspects at home. Thus far, the majority of studies linking parenting dimensions and children's neurocognitive development focus on parent-child interactions during infancy and the preschool years (e.g. Fay-Stammbach et al., 2014) even though the fostering influence of parents on neurocognitive development may be equally important at later ages.

Parenting dimensions that have been associated with neurocognitive development in younger children include sensitivity, i.e. parents' ability to perceive and adequately respond to their child's signals, and scaffolding, i.e. providing their child with structure (for a review, see Fay-Stammbach et al., 2014). In this thesis I will focus on the associations between children's neurocognitive functions and two aspects of parental sensitivity: ***supportive presence***, referring to affective and supportive caregiving, and ***intrusiveness***, referring to negative and controlling parenting behaviors interfering with the child's autonomy (Dotterer, Iruka, & Pungello, 2012). In addition, caregivers use scaffolding to enable the child to gain control over his or her cognitive performance and behavior, basically helping the child to engage in a complex task by providing structure when needed, either verbally (e.g. asking questions) or non-verbally (e.g., attention redirection behaviors) (Lewis & Carpendale, 2009). In this thesis I will also focus on the associations between children's neurocognitive functions and parental ***verbal scaffolding***, which can be defined as the parental input during parent-child interaction promoting independent problem-solving and learning (Dieterich, Assel, Swank, Smith, & Landry, 2006; Mermelshtine, 2017). Verbal input can be subdivided into directive (i.e. telling the child what to do) and elaborative verbalizations (i.e. comment on the child's own course of action). Directive verbalizations leave little room for the child to reflect on the problem on his own, while elaborative verbalizations evoke self-guided exploration and conceptual thinking (Bibok et al., 2009; Bonawitz et al., 2011). During elaborative verbal scaffolding parents provide their children with age-appropriate contingent responses (i.e. they follow the child's conversational lead), respecting the child's autonomy and stimulating explorative behavior. A specific scaffolding strategy to enhance effective self-guided exploration is the use of open-ended and metacognitive questioning when asking for explanations, such as “Why do you think this is happening?” (Hmelo-Silver & Barrows, 2006). In this thesis I am specifically interested in the associations between parental questioning style and children’s neurocognitive functions.

Adaptive parenting

The current thesis aims to investigate the associations between parent-child interaction with children’s attentional control, executive functioning, social cognition, and reasoning skills, a higher order executive functioning component, in four- to eight-year-old boys and girls. It is believed that small improvements in neurocognitive skills may result in large benefits regarding outcomes in later life, as self-control in childhood follows a gradient linked to outcomes such as better health, less substance dependence, and less criminality (Moffitt et al., 2011). This emphasizes the importance of an optimal environment to foster the development of neurocognitive functions in young children. In comparison, one could provide a sapling with sufficient water and nutrition and it will grow, but provide optimal care adaptive to the individual tree and it will thrive.

However, the development of neurocognitive functions is not only influenced by, but also reciprocally influences the interactions with others, illustrating the subtle nature of these interactions between parent and child and child development. According to the ***Evolutionary developmental psychology*** perspective (Bjorklund, 2018), each stage of child development is functional in adapting to the environment and learning complex neurocognitive skills. For instance, children’s immature cognition may play a role in evoking certain parenting behaviors necessary for development, as adults have been shown to attribute positive affect more frequently to children expressing some forms of immature cognition compared to more mature children (see Bjorklund, Periss, & Causey, 2009). This suggests some aspects of children’s immature cognitive development may evoke more parental investment as parents either consider it endearing or are triggered to stimulate their child to catch up in development. Dubas (2009) extended this view with the notion that inappropriate overinvestment of parents may, however, become maladaptive, suggesting: “…a saturation point for investment in children has been reached and that at some point the level of involvement begins to do more harm than good” (p. 144). This would suggest that non-linear effects may represent the best fit to depict parental influence on child development (Kiel, Premo, & Buss, 2016). It is important to learn more about these subtle associations between parent-child interaction and children's neurocognitive development, as they are reciprocal in nature and define future quality of functioning in many important aspects of the child's life.

Age and gender may affect the way neurocognitive functions are related to and stimulated through parent-child interaction. At different ages and developmental stages, children may need customized stimulation and guidance adapted to the situation, their needs, and the task at hand. For instance, parental directiveness has been shown to have a positive effect on cognitive development in toddlers, but this effect reversed after age four, in line with the child's diminished need for structure (Landry et al., 2000). Individual differences between boys and girls may cause different needs for parental guidance and can also result in a differential impact of environmental influences on child behavior (Rutter, Caspi, & Moffitt, 2003), similar to the shifting associations between parenting and child behavior with age (Bradley, Pennar, & Iida, 2015). Adaptive and supportive parenting requires parental understanding of changing developmental needs during the early school years (Landry et al., 2008). Parents may become more involved in their children's learning when they are educated about how their child reasons and learns, and how neurocognitive functions develop (Gleason & Schauble, 1999). Educating parents about their children's neurocognitive development may result in them being better equipped to recognize their child's level of competence and allow them to elicit optimal development by adaptively challenging their child's attentional control, executive functioning, reasoning and social cognitive skills during daily interactions. This raises the question of whether key aspects of parenting strategies are related to attentional control, executive functioning, reasoning and social cognition during the early school years, and to what extent age and gender moderate these associations. Consequently, it also raises the question whether parents can be educated on the neurocognitive development of their children to adjust their daily interactions with their child, in order to provide an optimal environment to adaptively foster the development of these functions.

AIMS AND STRUCTURE OF THIS THESIS

The central aims of this thesis are: (i) to explore the associations between parent-child interaction with children's attentional control, executive functioning and social cognition in four- to eight-year-old children (**Chapter 2 and 3**); (ii) to investigate the impact of age and gender on the associations between parent-child interaction and neurocognitive functioning in four-to eight-year-olds (**Chapter 2 and 3**); (iii) to explore to what extent parents can be educated to enhance their supportive presence, intrusiveness and questioning style in parent-child interaction (**Chapter 4 and 5**); and (iv) to explore whether improved parent-child interaction results in enhanced neurocognitive functioning (**Chapter 4**) and reasoning (**Chapter 5**) in their four-to eight-year-old children.

Curious Minds: Aims, design and procedures

The research described in this thesis was conducted as part of the Curious Minds Consortium. The Curious Minds Consortium is a collaboration of seven Dutch and Flemish research institutes studying the development of science and technology reasoning skills and exploratory behavior in children in the context of excellent learning environments (Van Geert, 2011). The studies described in this thesis are embedded within the Leiden Curious Minds program: a longitudinal program investigating the development of neurocognitive functioning in primary school-aged children in the Netherlands, and the effects of a compact psycho-educational parent and a teacher program.

Design. The Leiden Curious Minds program uses a pre-test post-test care-as-usual control group design (see Figure 1). Participants in the Leiden Curious Minds program are typically developing children between four and eight years of age, their parents and their teachers. Parents of 404 children from the lowest four grades of two Dutch primary schools were invited to participate in this Curious Minds cohort. Of the 233 participating children, 95 took part in the teacher program part of the program and were not included in the studies described in this thesis. The remaining students (N = 138) were randomly assigned to either the parent educational program condition (N = 69) or the control condition (N = 69).

Procedures. Children's neurocognitive functions were measured at baseline and after the parent educational program was completed: (i) attentional control; (ii) executive functioning; (iii) social cognition; (iv) social reasoning level; and (v) scientific reasoning, using paper-and-pencil tasks, computer-based performance tasks, and hands-on tests during individual test sessions at school. Parent and teacher reports on social behavior at school and at home were also obtained. Parental strategies were measured on four

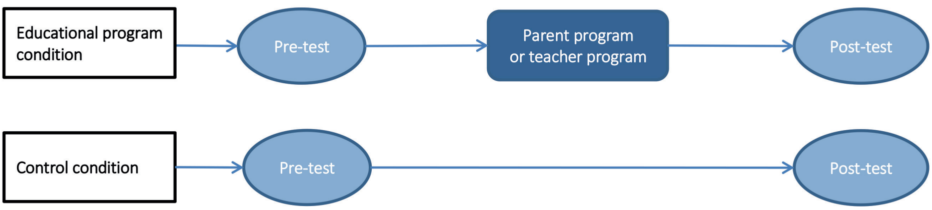

Figure 1. Design of the Leiden Curious Minds study.

dimensions at baseline and after the parent educational program was completed: (i) supportive presence; (ii) intrusiveness; (iii) question format; and (iv) question category, using observational data of parents' problem-solving interactive behavior with their child collected during home visits. Children and their parents were randomly assigned to either task version A or task version B of each task at pre-test, which were reversed at post-test to avoid test-retest learning effects. Pre-test baseline data were collected in the period between November 2013 and February 2014 (school 1) and between May and June 2014 (school 2). Post-test data were collected in the period between June and July 2014 (school 1) and between January and February 2015 (school 2).

Parent educational program. The Curious Minds parent educational program consisted of four, monthly group-sessions of approximately two hours each at the child's school and was provided by a skilled clinical neuropsychologist specialized in child and adolescent neurodevelopment. The content of the program was inspired by the Vygotskian principles of the Tools of the Mind curriculum for pre-school children (Bodrova & Leong, 2007; Diamond, Barnett, Thomas, & Munro, 2007), which focuses on supporting and scaffolding the development of cognitive, social-emotional and self-regulatory skills necessary for adaptive behavior and learning, using a familiar adult in a real-life setting as a change agent. The aim of the program was twofold: (1) to educate parents to recognize and foster the attentional control, executive functioning and social cognition in their children; and (2) to stimulate their children's explorative behavior and reasoning abilities, by teaching parents how to scaffold their children's experiences and by practicing this during home assignments. Each session focused on a specific (neuro) cognitive mechanism, for which parents received basic information about development, illustrations using everyday examples of parent-child interaction and a workbook with corresponding home assignments. These home assignments were discussed during the following session, allowing parents to learn from the trainer's feedback and each other's day-to-day experiences.

Outline of this thesis

Chapter 2 discusses the results of a cross-sectional study focusing on the associations between child attentional control and executive functioning with parental supportive presence, intrusiveness and questioning style. At different ages, children need parental stimulation and guidance adapted to the situation, their needs, and the task at hand. The associations between aspects of parenting behavior and child behavior have been shown to shift with age (Bradley, Pennar, & Iida, 2015). That is why in this study, both linear and curvilinear associations between parental strategies and child neurocognitive functioning were examined, as well as the moderating effect of age. We hypothesized that supportive and non-intrusive behavior of parents and parents who scaffold the interaction with their child by asking more open-ended and elaborative questions have children who show better attentional control and executive functioning.

Chapter 3 examines whether the different aspects of parental strategies (i.e. supportive presence, intrusiveness, and the amount and type of questions parents ask their children) are associated with various aspects of children's social competence (social cognition and social behavior at home and at school). We assumed that gender and age would influence the social interaction between parents and children and the development of social (cognitive) skills. Therefore, we examined to what extent (1) these parental strategies mediated the relation between gender and social competence (differential socialization model) and (2) whether gender and age moderated these relations, distinguishing a differential susceptibility model (for better and for worse) from a diathesis-stress model (for worse).

Chapter 4 evaluates whether the Curious Minds parent educational program was successful in improving parental supportive presence and intrusiveness by educating parents about their child's neurocognitive development and practicing ways to foster neurocognitive functions during daily parent-child interactions using home-assignments. We hypothesized that parents in the educational program condition would show greater improvements in parental support and intrusiveness than parents in the control condition. As these parenting strategies have been shown to be associated with children's attentional control and executive functioning, we explored whether this would result in improved attentional control and executive functioning in their children.

Chapter 5 evaluates whether the Curious Minds parent educational program was successful in improving the manner in which parents scaffold their children's experiences by enhancing their questioning style. Furthermore, we explored if this resulted in improved social and scientific reasoning, as scaffolding has been shown to be associated with children's reasoning skills. We hypothesized that parents in the educational program condition would ask more open- than closed-ended questions and more elaborative questions than parents in the control condition, which would potentially result in improved social and scientific reasoning in their children.

Finally, **Chapter 6** reviews the conclusions of the studies presented in this thesis, implications for future research and recommendations to improve educational programs for parents to foster the neurocognitive development in their children.

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CHAPTER 2

Attentional control and executive functioning in school-aged children: Linking self-regulation and parenting strategies

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ABSTRACT

Good parenting strategies can shape children's neurocognitive development, yet little is known about the nature of this relation in school-aged children and whether this association shifts with age. We aimed to investigate the relation between parenting strategies observed during a home visit, and children's performance-based attentional control and executive functioning (*N* = 98, aged 4 to 8). Linear and curvilinear regression analyses showed that children of parents who were more supportive, less intrusive, and who asked more open-ended questions, displayed better inhibitory control. In addition, children of parents who asked relatively more open-ended than closed-ended questions showed better performance on inhibition, working memory and cognitive flexibility tasks. Curvilinear relations indicated the presence of an optimal amount of closed-ended and elaborative questions by parents, i.e. not too few and not too many, which is linked to increased performance on attentional and inhibitory control in children. Higher parental intrusiveness and more frequent elaborative questioning were associated with decreased inhibitory control in younger children, whereas no such negative associations were present in older children. These results suggest that susceptibility to certain parenting strategies may shift with age. Our findings underscore the importance of adaptive parenting strategies to both the age and needs of school-aged children, which may positively affect their self-regulation skills.

Key words: attentional control, executive functioning, supportive presence, intrusiveness, verbal scaffolding

As children grow up, executive functions (EF) and attentional control (AC) become increasingly important for children's successful navigation in their educational environment and daily functioning at home (Best, Miller, & Jones, 2009; Diamond, 2013; Garon, Bryson, & Smith, 2008). Executive functions are adaptive effortful mental processes that enable us to plan, guide and control goal-oriented behavior and are especially critical when solving novel problems (Best et al., 2009; Garon et al., 2008). There is general agreement that three core EF can be defined, namely inhibition, working memory and cognitive flexibility (e.g. Miyake et al., 2000). Miyake et al. (2000) argued that these three EF components share a common underlying mechanism, often referred to as effortful attentional control (AC) (Garon et al., 2008). AC is tightly intertwined with EF, both as a foundation on which EF components build and as an ongoing process playing an important role during EF development (Garon et al., 2008).

Inhibitory control is commonly described as the ability to suppress a dominant or automatic response (Best et al., 2009; Diamond, 2013). Inhibitory control is often studied in congruence with this definition of response inhibition, but it also encompasses an attentional component known as interference control: the ability to selectively attend to certain stimuli and ignore irrelevant stimuli (Diamond, 2013). Inhibitory control shows a rapid development during the preschool years, but also improves between ages five and eight (Best et al., 2009). Working memory (WM) refers to the ability to temporarily hold, manipulate and control information in the mind (Garon et al., 2008). WM is commonly subdivided by content and conceptualized as verbal WM and visual-spatial WM (Diamond, 2013). WM emerges during the preschool years and shows a linear development between ages four and fifteen, though the development of visual-spatial WM seems to reach its peak around age eleven (Best et al., 2009; Davidson, Amso, Anderson, & Diamond, 2006). The final core EF component is cognitive flexibility, the ability to shift between mental sets or tasks and adapt to changing situations (Best et al., 2009). Cognitive flexibility builds on both WM and inhibition, and shows a longer developmental trajectory, at least until early adolescence (Davidson et al., 2006). Research on AC differentiates between focused and sustained attention as underlying processes. Focused attention refers to being able to actively focus on one thing without being distracted by other stimuli and sustained attention can be defined as the ability to maintain concentrated attention over prolonged periods of time (Cohen, 2014). Early AC development peaks during the preschool years, though continues to develop during the primary school period, alongside the emergence of the core EF components (Garon et al., 2008).

The development of AC and EF in children is influenced by their relationship with their significant caregivers and the conditions in their environment (Diamond, 2013; Yu & Smith, 2016). This is not a novel insight, as Vygotsky (1978) posed nearly 40 years ago that social interaction is essential to the development of self-regulation, as did Kopp (1982) and Calkins (1994) in the decades that followed. Building on Vygotsky's work, Sigel's model of psychological distancing (2002) incorporates how parents can promote the development of self-regulation in children. Sigel states that parents can help children to take a step back during problem-solving and reflect upon the problem at hand (i.e. create psychological distance) by nonverbal or verbal actions such as asking questions (Giesbrecht, Muller, & Miller, 2010). For instance, asking questions to focus the child's attention on important aspects of the problem that the child was not yet able to notice on its own, will challenge the child's mental representations and will facilitate internalization of self-regulatory skills. Studies on quality of parenting in relation to child AC and EF have focused on four dimensions of parenting: (i) sensitivity; (ii) scaffolding; (iii) stimulation; and (iv) control (Fay-Stammbach, Hawes, & Meredith, 2014). The majority of these studies focus on parent-child interactions during infancy and the preschool years (e.g., Blair, Raver, & Berry, 2014; Clark & Woodward, 2015; Fay-Stammbach et al., 2014; Kok et al., 2013; Meuwissen & Carlson, 2015; Mileva-Seitz et al., 2015; Rochette & Bernier, 2016; Yu & Smith, 2016). The current study addresses an older age group of 4- to 8-year-olds and focuses on aspects of (i) sensitivity and (ii) verbal scaffolding in relation to child AC and EF.

Sensitivity refers to the parents' ability to perceive and adequately respond to their child's signals. Aspects of parental sensitivity include supportive presence, referring to affective and supportive caregiving, and intrusiveness or lack of autonomy support, referring to negative and controlling parenting behaviors interfering with the child's autonomy (Dotterer, Iruka, & Pungello, 2012). Parental sensitivity has been linked to child EF (e.g., Blair et al., 2011; Kok et al., 2013; NICHD Early Child Care Research Network, 2005; Rhoades, Greenberg, Lanza, & Blair, 2011), though studies focusing on supportive presence and intrusiveness specifically, show inconclusive results. In some studies maternal support predicted child EF task battery composite scores, while intrusiveness was not investigated (e.g., Kraybill & Bell, 2013; Sulik et al., 2015). In other studies supportive presence was not associated with child EF composite scores, but intrusiveness was (Clark & Woodward, 2015; Holochwost, 2013, as cited in Fay-Stammbach et al., 2014). Bernier and colleagues (2010) also concluded that especially autonomy support (i.e. low intrusiveness) was most robustly associated with child EF. In another study, intrusiveness was also negatively related to an EF composite score at 36 months of age, but this finding was not observed at 24 months (Cuevas et al., 2014), suggesting that the effect of parental intrusiveness on child EF might be moderated by age. Associations between aspects of parental sensitivity and child AC also show inconclusive results. While Gaertner and colleagues (2008) concluded that parental support is associated with increased AC in 2 and 3 year-olds, a recent study showed that increased parental intrusiveness was associated with lower levels of AC in 4 to 5 year-olds, while no relation was found for parental supportive presence (Mathis & Bierman, 2015). This finding, though based on younger children than the current sample, also suggests that age may moderate the association between parental support and child AC.

Scaffolding can be used by caregivers to provide structure to enable the child to gain control over his cognitive performance and behavior, basically helping the child to engage in a complex task, either verbally (e.g. asking questions) or non-verbally (e.g., attention redirection behaviors) (Lewis & Carpendale, 2009). Aspects of verbal scaffolding quality have been found to be positively related to preschoolers' EF skills in general (Hammond, Müller, Carpendale, Bibok, & Liebermann-Finestone, 2012), and to AC and EF components specifically. Several longitudinal studies have demonstrated that scaffolding quality predicts WM and cognitive flexibility (Bernier, Carlson, & Whipple, 2010; Conway & Stifter, 2012; Hughes & Ensor, 2009; Matte-Gagné & Bernier, 2011), while in cross-sectional studies scaffolding has been observed to be related to enhanced AC, inhibitory control and cognitive flexibility (Bibok, Carpendale, & Müller, 2009; Hopkins, Lavigne, Gouze, LeBailly, & Bryant, 2013; Mendive, Bornstein, & Sebastián, 2013). This study focuses on verbal scaffolding aspects.

Verbal scaffolding can be subdivided into directive (i.e. telling the child what to do) versus elaborative verbalizations (i.e. comment on the child's own course of action), in which directive verbalizations leave little room for the child to reflect on the problem on his own, while elaborative verbalizations evoke self-guided exploration and conceptual thinking, allowing the child to practice self-regulatory skills such as EF (Bibok et al., 2009; Bonawitz et al., 2011). Self-guided exploration without adequate guidance is not effective (Alfieri, Brooks, Aldrich, & Tenenbaum, 2011; Kirschner, Sweller, & Clark, 2006; Mayer, 2004). A specific scaffolding strategy to enhance self-guided exploration is the use of open-ended and metacognitive questioning when asking for explanations, such as "Why do you think that?" (Hmelo-Silver & Barrows, 2006). Indeed, it has been shown that parents who are less directive and who instead ask more questions and engage their child in problem-solving discussions may enhance the development of self-regulation in preschoolers (Eisenberg et al., 2010; Mathis & Bierman, 2015; Neitzel & Stright, 2003). For instance, Landry and colleagues (2000) showed that up to toddlerhood, parental directiveness had a positive effect on cognitive development, but that this effect reversed after age four, in line with their child's diminished need for structure. In contrast, elaborative parental utterances have been found to predict child EF independent of age (Bibok et al., 2009; Landry et al., 2000; Smith, Landry, & Swank, 2000), suggesting that parents should reduce directive scaffolding in favor of elaborative scaffolding when their child becomes more independent.

At different developmental stages, children need customized stimulation and guidance adapted to the situation, their needs, and the task at hand (Bradley, Pennar, & Iida, 2015). A recent study in 4- to 11-year-olds demonstrated that the relationship between parenting behaviors and child agency shifts with age (Bradley et al., 2015), in line with the findings of Landry and colleagues (2000), Cuevas and colleagues (2014), and Mathis and Bierman (2015). Since AC and EF skills are considered crucial in goal-directed behavior (Giesbrecht et al., 2010) and rapid improvements in AC and EF skills occur between the ages four and eight (Best & Miller, 2010), this raises the question whether key aspects of parenting strategies are related to AC and EF, and to what extent age moderates this relationship in 4- to 8-year-olds.

In the current study, we aim to investigate whether parental supportive presence and intrusiveness and aspects of verbal scaffolding are associated with child AC and EF skills during the early school years and to what extent age moderates these relations. We hypothesize that supportive and non-intrusive parents have children who show better AC and EF skills. As both self-guided exploration without adequate guidance and too much directiveness are not expected to be effective in stimulating self-regulation, we assume that the relation of AC and EF with level of parental intrusiveness and the amount of closed-ended questions parents ask, will be curvilinear. Furthermore, we hypothesize that in older children AC and EF are more negatively associated with higher levels of intrusiveness and more closed-ended questions. In addition, it is hypothesized that parents who are supportive and who scaffold the interaction with their child by asking more open-ended and elaborative questions, have children who show better AC and EF skills.

METHOD

Participants

The current study is embedded within the Curious Minds program: a longitudinal program investigating the development of executive and social functioning in primary school children in the Netherlands and the effects of a parent and a teacher intervention program (approved by the Ethical Board of the department of Education and Child Studies at Leiden University (ECPW-2010016)). The Curious Minds Consortium is a collaboration of seven Dutch and Flemish research institutes studying the development of science and technology reasoning skills and exploratory behavior in children in the context of excellent learning environments (Van Geert, 2011).

Parents of 138 4- to 8-year-old children from the lowest four grades of two Dutch primary schools (pre-school to second grade in USA school system), from towns that are part of the urban agglomeration of Rotterdam and the conurbation of The Hague, agreed to participate in this study, and signed an informed consent letter. The current study used child computer-based neurocognitive measures of AC and EF and observational data of parents' interactive behavior with their child collected during a home visit. Parents of 99 out of 138 children agreed to a home visit (response = 71.7%, 10.1% fathers). Participants who agreed to a home visit did not significantly (all $p > .05$) differ on age, gender, school, grade, single parenthood status, parental education or prevalence of referral to mental health care in the past year from those who did not agree to a home visit. One child refused to complete the neurocognitive assessments and was excluded from analyses (Final $N = 98$). Children ranged in age from 4 to 8 years ($M = 6.2$ years, $SD = 1.2$) and 56.1% were male. No parents or children were excluded because of problems with oral or written proficiency in Dutch. For detailed sample characteristics, see Table 1.

Procedure

Computer-based performance tasks were administered during an individual test session (approximately 60 minutes) in a separate room at the child's school. Tests were administered by two trained master students or by one of the main investigators (AMS, MCD). After the session the children could choose a small present as a token of appreciation. All home visits were conducted by master student pairs. Data were collected in the period between November 2013 and February 2014 (school 1) and between May and June 2014 (school 2).

Measures

Demographic characteristics

Parents were asked to fill out a complementary background information questionnaire, using the online survey software Qualtrics (http://www.qualtrics.com/). The highest completed level of education by the parent who participated in the home visit was used as an indicator of educational attainment according to the Dutch Standard Classification of Education (SOI) which is based on UNESCO's International Standard Classification of Education (ISCED) ("SOI 2003 (Issue 2006/'07),"): 1. primary education (SOI level 1 to 3; at most vocational training); 2. Secondary education (level 4 of SOI); and higher education (level 5 to 7 of SOI; bachelor's degree or higher). Single parenthood status was established for the parent who participated in the home visit, and was defined by not having the child's other parent or a new caregiver living in the same household. Mental health care referral was assessed by asking, parents whether their child had been referred, examined or treated for emotional and behavioral problems in the past year.

Parenting strategies

Parent's interactive behavior with their child was videotaped during a home visit, while each parent-child dyad was engaged in two joint activity tasks. These tasks consisted of a sorting task and a combining task of approximately five to ten minutes, both based on tasks designed by Utrecht University (Corvers, Feijs, Munk, & Uittenbogaard, 2012). Parent-child dyads were randomly assigned to either complete task version A (N = 50, 51%) or task version B of each joint activity task (N = 48, 49%), as required for other parts of the Leiden Curious Minds Research Program. Version A of the joint tasks battery consisted of sorting different types of toy animals and combining four different eyes and four different mouths to form smiley faces with various facial expressions, and version B of the joint tasks battery consisted of sorting different types of toy food and combining four different flower petals with four different disks to form unique flowers. Parent-child dyads were free to sort and combine the items according to their own strategy, as long as all combinations in the combining task were different. Parents were instructed to support their child as they would normally do. The videotapes were coded afterwards for level of parental supportive presence and intrusiveness and the amount of different types of questions asked by the parent.

Aspects of parental sensitivity

Parental supportive presence and intrusiveness were coded using the revised Erickson 7-point scale for Supportive Presence (SP) and Intrusiveness (Egeland, Erickson, Clemenhagen-Moon, Hiester, & Korfmacher, 1990). A parent scoring high on SP shows emotional support to the child and is reassuring when the child is having difficulty with the task. A parent scoring high on Intrusiveness lacks respect for the child's autonomy and does not acknowledge the child's intentions or desires. The subscales SP and Intrusiveness were coded for each joint activity task by three coders who were blind to other data concerning the child or the parent. For each parent-child dyad, the combining task and sorting task were coded independently and by different coders. All coders completed an extensive training, consisting of several practice and feedback sessions supervised by an expert coder. Reliability of the coders (intraclass correlation (ICC)) was assessed directly after completion of the training and at the end of the coding process to detect possible rater drift. ICCs between coders directly after training were .92 for the SP scale (N = 12) and .81 for the Intrusiveness scale (N = 12). At the end of the coding process, ICCs were .91 for the SP scale (N = 12) and .92 for the Intrusiveness scale (N = 12), suggesting no significant rater drift. Whenever interactions were difficult to score due to an ambiguous interaction (N = 14), consensus was sought after a discussion with all coders. Although parent-child dyads were randomly assigned to either joint task battery A or B, each task battery may have elicited a somewhat different interaction between parent and child. Therefore, level of SP and Intrusiveness was computed by standardizing each task version score (A or B) within each task (sorting or combining), followed by averaging these Z-scores over both joint activity tasks.

Aspects of parental verbal scaffolding

The form and type of questions parents asked their child during the two joint activity tasks were used as a measure of verbal scaffolding. All questions were coded from video recordings using transcribed verbatim reports. Each question was first coded as either being (i) *open-ended* (e.g., "How do you want to start?"; (ii) *multiple choice* (e.g., "Does a kangaroo live in the zoo or in the ocean?"; or (iii) *closed-ended* (e.g., "Is a cow a farm animal?"). Next, questions were coded in the following categories: (a) ***observational** leading questions* (e.g., "What's the color of this food", enquiring about observable aspects during the task); (b) *procedural questions* (e.g., "How are you going to sort the animals?", enquiring about an action plan); and (c) *explanatory questions* (e.g., "Why can't the toad be in the ocean group?", enquiring about explanations for decisions).

The form and category of each question was coded for both joint activity tasks by three coders who were blind to other data concerning the child or the parent and who were not involved in coding SP and Intrusiveness. All coders completed an extensive training, consisting of several practice and feedback sessions supervised by the main researcher. Interrater reliability (Cohen's kappa) was large, with .84 on average for the sorting task ($N_{questions}$ = 122) and .87 on average for the combining task ($N_{questions}$ = 115). For each question form and category within each task the number of questions per minute was calculated. Although parent-child dyads were randomly assigned to either joint task battery A or B, each task battery may have elicited a somewhat different interaction between parent and child. Therefore, we standardized the number of questions per minute within each task (sorting or combining) for each task version (A or B), followed by averaging these Z-scores over the joint activity tasks. Due to very low occurrence of multiple-choice questions (2.4%), this form was excluded from further analyses. The difference score between the standardized amounts of open- and closed-ended questions was calculated as a relative measure of question format preference during the tasks. A higher ratio score indicates that the parent asked more open-ended than closed-ended questions relative to the other parents. From now on, the term 'verbal scaffolding' will be used to address both the form and category of questions.

Self-regulation

We assessed aspects of attentional control and executive functions as measures of self-regulation with several neuropsychological tasks from the Amsterdam Neuropsychological Tasks (ANT, version 2.0), a well-validated computerized test battery (De Sonneville, 2005; 2014). The ANT has been used extensively in both clinical and non-clinical populations and contains widely used paradigms such as the Go/No-Go paradigm, with adequate test-retest stability and discriminant validity in children (Kindlon, Mezzacappa, & Earls, 1995). The ANT test battery requires a processor supporting Windows XP or higher and can be obtained via www.sonares.nl, including a demo-version. All computer tasks were preceded by instructions and practice trials.

Attentional control

Attentional control was measured with the ANT Focused Attention Objects - 2 keys (FAO2) task and the ANT Sustained Attention Objects - 2 keys (SAO2) task. Due to a ceiling effect on number of correct responses (58.8% of the children had an error rate of less than 10% on the FAO2; 49.4% on the SAO2), mean reaction time on correct responses was used to assess level of focused and sustained attention. Besides the number of correct responses, reaction time is commonly used to assess (sustained) attention (see Flehmig, Steinborn, Langner, Scholz, & Westhoff, 2007). Sarter et al. (2001) specifically suggest using reaction time as the critical measure of performance when participants show high levels of correct responses and low levels of errors. Variation in reaction time (SD) was significantly and highly correlated with mean reaction time on correct responses (r = .82 on the FAO2; r = .83 on the SAO2), resulting in a redundant measure of performance, and was therefore not included in further analyses.

Focused attention. In the FAO2 task, participants are presented with a fruit bowl on the computer screen, in which four pieces of fruit are displayed. Participants are instructed to click the mouse button on their dominant hand side ('yes-button') whenever they perceive the cherries (target signal) in one of the horizontal locations (at the left- or right-side of the screen). Whenever the cherries are displayed at one of the vertical locations (at the top or bottom of the screen) or when the cherries are not displayed at all, participants are instructed to click the mouse button on their non-dominant hand side ('no-button'). In total, 28 relevant targets (hits), 14 irrelevant targets (incorrect location), and 14 non-targets (incorrect fruit) are presented. Mean reaction time on correct responses was used to assess level of focused attention.

Sustained attention. In the SAO2 task, participants are presented with a house with three windows and a doorframe on the computer screen. In each trial, an animal is displayed randomly in one of the windows or the doorframe. Participants are instructed to click the mouse button on their dominant hand side ('yes-button') whenever they see the bee (target signal). Each time a different animal is displayed, participants are instructed to click the mouse button on their non-dominant hand side ('no-button'). In total, six different targets and six different non-targets are randomly presented on screen in 20 series of 12 trials. Whenever the participant errs, an auditory feedback signal (a beep) is given in order to reestablish attention. Mean reaction time on correct responses was used to measure level of sustained attention.

Inhibitory control

Inhibitory control was measured with the ANT Go-NoGo (GNG) task and the ANT Response Organization Objects (ROO) task. As suggested by Friedman & Miyake (2004), we used multiple measures of the inhibition related process as a practical solution to issues related to task impurity and low reliability. In the GNG task, either a square with a gap (Go-signal) or without one (NoGo-signal) is presented centered on the computer screen. Participants are instructed to click the mouse button when the Go-signal is displayed, but withhold this response whenever the NoGo-signal is displayed. In total, 56 Go-signals (75%) and 18 NoGo-signals (25%) are evaluated. The number of false alarms on this task was used as a measure of level of response inhibition, as well as the number of missed Go-signals. A higher amount of false alarms (e.g. the participant clicks when the target signal is not presented) indicates that a child is less able to inhibit a prepotent response. A lower amount of missed target signals (e.g. the participant does not click when the target signal is presented) indicates better interference control (i.e. selectively attending to the target signal and ignoring irrelevant targets).

During the ROO task, a green ball (part 1) or red one (part 2) appears at the left or right side of a white fixation cross. During the first part of the task, participants are instructed to click the mouse button that corresponds to the side where the green ball is presented (compatible prepotent response). During the second part of the task, participants are instructed to click the mouse button on the opposite side of where the red ball is presented (incompatible response), inhibiting the prepotent response from part 1. Both parts consist of 40 trials each. The number of errors in part 2 was used to assess the extent to which a child is able to inhibit a prepotent response in order to give another response.

Working memory

Visual-spatial working memory was measured with the ANT Spatial Temporal Span (STS). In this task, nine squares are presented on the computer screen in a three-by-three matrix. During each trial, an incremental sequence of these squares (two up to a maximum of nine) is pointed out by a hand animation. The participant is instructed to reproduce this sequence by clicking the same squares in reversed order (part 2, backward span). In each trial the sequence is preceded by an auditory cue (a beep). In each sequence, the number of appointed squares is presented in two successive trials. The task aborts automatically whenever two successive trials of the same sequence number are incorrect (e.g., both 5-squares sequences incorrect). The number of correct sequences (maximum = 88) in identical order backwards was used to assess level of working memory.

Cognitive flexibility

Cognitive flexibility was measured with the ANT Response Organization Objects (ROO) task. During the third part of the ROO task, the color of the ball alternates randomly between green and red. Whenever the green ball appears, a compatible prepotent response is required (as in part 1), but when the red ball appears an incompatible response is required (as in part 2). This part consists of 80 trials; 40 trials requiring a compatible response and 40 trials requiring an incompatible response. The overall amount of errors in part 3 was used to measure level of cognitive flexibility.

Data analyses

Data were analyzed using IBM SPSS version 23. Demographic characteristics for both schools were compared with chi-square tests, independent t-tests and Fisher exact tests. For test variables with non-normal distributions, either square root or natural log transformations were performed prior to further analyses. Hierarchical linear regression analyses were performed to assess whether parenting strategies explained additional variance of child AC and EF above or in interaction with age. Age was centered and all aspects of parenting were standardized to z-scores. Separate regression analyses were performed for each AC and EF component (dependent variable) and each parenting strategy (independent variable). In each regression analysis the following models were tested: (i) the aspect of parenting strategy and age were included (M1); (ii) the quadratic term of the independent variable was added to test for curvilinearity (M2); (iii) the interaction term between the aspect of parenting strategy and age was added (M3); (iv) the interaction between the quadratic term of the aspect of parenting strategy with age was added (M4) (Ganzach, 1997). ***F*** for change in R^2 was used to assess whether a more extensive model significantly improved the amount of variance explained in comparison with the previous more parsimonious model. Predicted R^2 was computed as a cross-validation measure. A negative predicted R^2 or a sizeable difference between predicted and regular (adjusted) R^2 can be an indication of an overfit model (i.e. predicting random noise). Significant interactions were probed with regression analyses that included a conditional moderator variable (e.g., low-age: 1 *SD* below $M_{age;}$ and high-age: 1 *SD* above M_{age}) (Holmbeck, 2002). Regression lines were plotted based on the resulting regression equations and significance t-tests were reported for each simple slope. For all significant effects, standardized beta coefficients address effect size (0.2 = small effect; 0.5 = moderate effect; 0.8 = strong effect), as well as adjusted R^2 values (0.4 = small effect; .25 = moderate effect; .64 = strong effect) were reported (Ferguson, 2009). In case of a significant curvilinear effect, a positive beta coefficient corresponds with a concave association and a negative beta coefficient corresponds with a convex association. Alpha for significant effects was set at $p < .05$.

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RESULTS

Sample characteristics and descriptive statistics for the variables of interest are displayed in Table 1. Schools did not significantly differ on background characteristics of the participants. Simple correlations between all independent parenting variables and all dependent AC and EF measures and age are presented in Table 2. Verbal scaffolding, especially asking closed-ended questions, was significantly associated with AC and EF measures. In addition, supportive presence was correlated with interference control. Correlations between all AC and EF measures were in the small to moderate range, except for the two AC measures, which were more strongly related (r = .76). Age was significantly associated with all AC and EF measures, in the expected direction (i.e. with increasing age, AC and EF performance improved). Hierarchical regression analyses, including age, were conducted to assess the nature of the associations (e.g. curvilinearity, moderation) between parenting variables and all AC and EF measures in more depth. Results of the most parsimonious model of each hierarchical regression analysis of SP and Intrusiveness explaining AC and EF are presented in Table 3. Results concerning verbal scaffolding explaining AC and EF are presented in Table 4 (parental question format) and Table 5 (question category). The predicted R^2 value of each model was reasonably close to the corresponding adjusted R^2 value, indicating that overfitting was not an issue. Model 4, including the interaction between the quadratic term of the aspect of parenting strategy with age, was never the most parsimonious model and is thus not presented in the tables.

Parenting strategies and AC

SP and Intrusiveness

A significant interaction effect for intrusiveness with age was found for sustained attention (β = -.17, p = .04, adjusted R^2 = .39) (See Figure 1). Post hoc probing showed that intrusiveness was only significantly associated with a longer reaction time on the sustained attention task in younger children (β = .27, p = .03, adjusted R^2 = .42). No significant association between child AC and supportive presence was found.

Verbal scaffolding

No significant associations were found between child AC and open- or closed-ended questions, nor between child AC and leading observational questions. A significant interaction effect for procedural questions with age was found both for focused attention (β = .20, p = .03, adjusted R^2 =.28) and sustained attention (β = .17, p = .04, adjusted

R^2 = .42). Post hoc probing, however, showed that amount of procedural questions was not significantly related (all $p > .05$) in either age group to the reaction time on the focused (β_{young} = -.22; β_{old} = .22) and the sustained attention task (β_{young} = -.17; β_{old} = .18). Explanatory questions showed a curvilinear relation that was positively accelerated with reaction time on the focused attention task (β = .21, p = .04, adjusted R^2 = .28). This convex relation indicated that children of parents who asked relatively more explanatory questions had a shorter reaction time, but only up to a certain point (inflection point = .67, <1 *SD* above the mean; see Figure 2a). Beyond the inflection point asking more explanatory questions was associated with worse focused attention task performance.

Table 1. *Participant characteristics and descriptive statistics variables of interest.*

	Total (*N*=98) %	M (SD)[b]	Range[b]
Age in months (*M (SD)*)	56.12	74.30 (14.56)	49-101
Sex (male)			
Parental education[a]			
High	40.43		
Medium	52.13		
Low	7.45		
Single parenthood (%)	6.38		
Referral to mental health care past year	6.38		
Parental sensitivity			
Supportive presence		3.95 (1.46)	1.00 - 6.75
Intrusiveness		3.76 (1.42)	1.00 - 7.00
Number of questions per minute			
Closed-ended questions		2.16 (.94)	0 - 4.19
Open-ended questions		1.86 (.95)	.17 - 5.18
Observational leading questions		.64 (.48)	0 - 2.28
Procedural questions		.14 (.18)	0 - .73
Explanatory questions		.16 (.18)	0 - .89

[a]Background information was missing for *N*=4 children due to non-response on parental questionnaires. [b]Original values before transformation and standardization.

Table 2. *Correlations amongst observed parenting behaviors, AC and EF measures, and age.*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Supportive presence	-	-.80**	.34**	.17	.15	.29**	.22*	.21*	.01	.04	-.24*	-.06	-.16	.03	.12	-.11
2. Intrusiveness		-	-.23*	-.04	-.18	-.32**	-.18	-.23*	-.08	-.05	.15	.03	.14	.08	-.07	.20*
3. Open-ended questions			-	.42**	.53**	.54**	.16	.29**	.06	.18	.05	.11	.06	-.19	.04	-.32**
4. Closed-ended questions				-	-.55**	.47**	.09	.08	.05	.24*	.23*	.10	.28*	-.38**	.26*	-.36**
5. Ratio questions					-	.06	.06	.19	.01	-.06	-.17	.01	-.21*	.19	-.21*	.05
6. Observational leading questions						-	-.06	.25*	.12	.20*	.15	.05	.09	-.21*	.07	-.32**
7. Procedural questions							-	.02	-.01	-.02	-.02	.14	-.19	.09	-.18	.06
8. Explanatory questions								-	-.08	-.06	.02	-.01	.10	-.04	-.03	-.02
9. Focused attention									-	.76**	.46**	.26*	.20*	-.45**	.19	-.51**
10. Sustained attention										-	.47**	.26*	.32**	-.44**	.22*	-.64**
11. Inhibitory control: GNG misses											-	.36**	.51**	-.65**	.23*	-.63**
12. Inhibitory control: GNG FA												-	.37**	-.40**	.21*	-.26**
13. Inhibitory control: ROO 2													-	-.58**	.53**	-.37**
14. Working memory														-	-.38**	.64**
15. Cognitive flexibility															-	-.31**
16. Age																-

Note: *$*p$<.05; **p<.01.

Table 3. *Hierarchical regression analysis results of most parsimonious models for supportive presence and intrusiveness explaining child AC and EF.*

		Attentional control		Executive functions				
				Inhibitory control			Working memory	Cognitive flexibility
		Focused RT	Sustained RT	Interference control GNG misses	Prepotent GNG FA	Prepotent ROO part 2	STS	ROO part 3
Parental sensitivity		B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Supportive Presence								
Intercept		1684.53 (42.51)	1145.57 (21.37)	1.33 (.07)	2.03 (.08)	1.46 (.12)	4.15 (.17)	2.98 (.15)
M1	SP	-23.80 (45.95)	-5.10 (23.24)	-.32 (.08)***	-.08 (.09)	-.28 (.13)*	.25 (.18)	.14 (.16)
	Age	-204.80 (35.51)***	-143.83 (17.95)***	-.53 (.06)***	-.18 (.07)**	-.43 (.10)***	1.17 (.14)***	-.39 (.13)**
Adj. R^2 / Pred. R^2		.25 / .22	.39 / .37	.49 / .47	.06 / .03	.16 / .13	.41 / .39	.09 / .06
ΔR^2 / $F \Delta R^2$		.26 / 16.64***	.41 / 32.26***	.50 / 47.58***	.08 / 3.89*	.18 / 10.09***	.43 / 35.11***	.11 / 5.50**
Intrusiveness								
Intercept		1684.53 (42.56)	1141.36 (29.20)	1.33 (.07)	2.03 (.08)	1.46 (.12)	4.15 (.17)	2.98 (.15)
M1	I	13.01 (48.35)	31.94 (24.69)	.30 (.08)***	.07 (.09)	.32 (.14)*	-.14 (.19)	-.01 (.17)
	Age	-204.67 (36.05)***	-145.42 (18.22)***	-.55 (.06)***	-.18 (.07)**	-.45 (.10)***	1.17 (.14)***	-.40 (.13)**
M2	I^2		15.20 (25.87)					
M3	I x Age		-40.72 (19.93)*					
Adj. R^2 / Pred. R^2		.24 / .22	.41 / .39	.47 / .45	.05 / .03	.17 / .13	.41 / .38	.08 / .05
ΔR^2 / $F \Delta R^2$		.26 / 16.51***	.03 / 4.17*	.48 / 43.92***	.07 / 3.78*	.18 / 10.54***	.42 / 33.97***	.10 / 5.09**

Note: M1: first model with linear independent variable and age; M2: second model adding quadratic independent variable; M3: third model adding linear interaction. Variables marked with superscript 2s are curvilinear variables. Adjusted R^2 and predicted R^2 of the most parsimonious model are reported. *ΔR^2:* Change in R^2 in comparison with the previous model. *$F \Delta R^2$: F* for change in R^2 in comparison with the previous model, with *p<.05; **p<.01; ***p<.0001.

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Table 4. *Hierarchical regression analysis results of most parsimonious models for question format explaining child AC and EF.*

		Attentional control		Executive functions				
				Inhibitory control			Working memory	Cognitive flexibility
		Focused RT	Sustained RT	Interference control GNG misses	Prepotent GNG FA	Prepotent ROO part 2	STS	ROO part 3
Parental scaffolding		B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Closed questions								
Intercept		1681.88 (42.03)	1145.86 (21.38)	1.21 (.09)	1.90 (.09)	1.25 (.15)	4.14 (.17)	2.99 (.15)
M1	Closed	-85.10 (52.93)	6.76 (27.07)	<-.01 (.10)	.01 (.10)	.26 (.16)	-.44 (.21)*	.30 (.19)
	Age	-223.87 (37.26)***	-141.83 (19.01)***	-.50(.07)***	-.17 (.07)*	-.34 (.11)**	1.04 (.15)***	-.33 (.13)*
M2	Closed²			.16 (.07)*	.18 (.07)*	.30 (.11)**		
Adj. R^2 */ Pred.* R^2		.26 / .23	.40 / .37	.42 / .39	.10 / .05	.20 / .17	.43 / .41	.10 / .08
$\Delta R^2 / F \Delta R^2$		.28 / 18.21***	.41 / 32.27***	.03 / 5.70*	.06 / 6.62*	.06 / 7.25**	.44 / 37.34***	.12 / 6.51**
Open questions								
Intercept		1684.18 (42.23)	1145.52 (21.36)	1.33 (.07)	2.03 (.08)	1.46 (.13)	4.15 (.17)	2.98 (.15)
M1	Open	-66.12 (53.28)	-8.03 (26.83)	-.20 (.09)*	.03 (.10)	-.11 (.16)	.05 (.21)	-.13 (.19)
	Age	-217.61 (37.04)***	-145.22 (18.81)***	-.55 (.07)***	-.16 (.07)*	-.43 (.11)***	1.16 (.15)***	-.43 (.13)**
Adj. R^2 */ Pred.* R^2		.26 / .23	.40 / .37	.42 / .40	.05 / .03	.12 / .09	.40 / .38	.08 / .05
$\Delta R^2 / F \Delta R^2$		.27 / 17.50***	.41 / 32.30***	.43 / 35.65***	.07 / 3.48*	.14 / 7.72**	.41 / 33.59***	.10 / 5.34**
Ratio open-closed								
Intercept		1684.17 (42.57)	1145.87 (21.35)	1.33 (.07)	2.03 (.08)	1.47 (.12)	4.15 (.17)	2.99 (.15)
M1	Ratio	14.91 (47.36)	-.11.36 (23.59)	-.15 (.08)	.02 (.09)	-.29 (.14)*	.37 (.18)*	-.34 (.17)*
	Age	-203.07 (35.33)***	-143.23 (17.85)***	-.50 (.06)***	-.17 (.07)*	-.40 (.10)***	1.13 (.14)***	-.40 (.12)**
Adj. R^2 */ Pred.* R^2		.24 / .21	.40 / .37	.41 / .39	.05 / .02	.16 / .12	.43 / .41	.12 / .08
$\Delta R^2 / F \Delta R^2$		.26 / 16.53***	.41 / 32.42***	.42 / 34.69***	.07 / 3.45*	.18 / 10.02***	.44 / 37.11***	.14 / 7.39**

Note: M1: first model with linear independent variable and age; M2: second model adding quadratic independent variable. Variables marked with superscript 2s are curvilinear variables. Adjusted R^2 and predicted R^2 of the most parsimonious model are reported. ΔR^2: Change in R^2 in comparison with the previous model. $F \Delta R^2$: F for change in R^2 in comparison with the previous model, with *p<.05; **p<.01; ***p<.0001.

Table 5. *Hierarchical regression analysis results of most parsimonious models for question category explaining child AC and EF.*

		Attentional control		Executive functions				
				Inhibitory control			Working memory	Cognitive flexibility
		Focused RT	Sustained RT	Interference control GNG misses	Prepotent GNG FA	Prepotent ROO part 2	STS	ROO part 3
Parental scaffolding		B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Leading observational questions								
Intercept		1684.44 (42.51)	1145.62 (21.37)	1.20 (.10)	2.03 (.08)	1.46 (.13)	4.15 (.17)	3.25 (.20)
M1	Obs.	-29.50 (56.70)	-1.61 (28.46)	-.06 (.10)	-.04 (.11)	-.05 (.17)	-.02 (.23)	-.10 (.20)
	Age	-208.83 (37.18)***	-143.79***	-.55 (.07)***	-.18 (.07)*	-.42 (.11)***	1.14 (.15)***	-.35 (.14)*
M2	Obs.^{2}			.22 (.10)*				-.44 (.20)*
Adj. R^2 / Pred. R^2		.25 / .22	.39 / .37	.42 / .39	.05 / .03	.12 / .09	.40 / .38	.11 / .09
ΔR^2 / $F \Delta R^2$		.26 / 16.64***	.41 / 32.23***	.03 / 4.47*	.07 / 3.50*	.14 / 7.51**	.41 / 33.55***	.04 / 4.61*
Procedural questions								
Intercept		1656.95 (53.86)	1134.90 (27.22)	1.33 (.08)	2.03 (.08)	1.46 (.12)	4.15 (.17)	2.98 (.15)
M1	Proc.	-15.90 (61.69)	-3.57 (31.27)	.02 (.10)	.15 (.10)	-.27 (.16)	.13 (.22)	-.32 (.20)
	Age	-194.47 (35.29)***	-139.18 (17.89)***	-.50 (.06)***	-.18 (.07)**	-.39 (.10)***	1.14 (.14)***	-.39 (.13)**
M2	Proc.^{2}	32.87 (60.06)	11.82 (29.06)					
M3	Proc. x Age	103.61 (48.62)*	47.01 (23.61)*					
Adj. R^2 / Pred. R^2		.28 / .26	.42 / .39	.39 / .37	.07 / .05	.14 / .11	.40 / .38	.10 / .07
ΔR^2 / $F \Delta R^2$		.03 / 4.54*	.02 / 3.96*	.40 / 32.00***	.09 / 4.70*	.16 / 9.01***	.42 / 33.87***	.12 / 6.52**

Table 5. Continued

		Attentional control		Executive functions				
				Inhibitory control			Working memory	Cognitive flexibility
		Focused RT	Sustained RT	Interference control GNG misses	Prepotent GNG FA	Prepotent ROO part 2	STS	ROO part 3
Explanatory questions								
Intercept		1610.55 (54.92)	1145.28 (21.35)	1.33 (.08)	2.06 (.10)	1.46 (.13)	4.15 (.17)	2.98 (.15)
M1	Exp.	-134.56 (64.85)*	-15.94 (29.15)	<.01 (.10)	.04 (.12)	.16 (.17)	-.08 (.22)	-.09 (.20)
	Age	-209.48 (34.61)***	-143.22 (17.85)***	-.50 (.06)***	-.20 (.06)**	-.40 (.10)***	1.15 (.14)***	-.41 (.13)**
M2	$Exp.^2$	132.40 (63.65)*			-.06 (.12)			
M3	Exp. x Age				-.26 (.09)**			
Adj. R^2 / Pred. R^2		.28 / .24	.40 / .37	.39 / .37	.11 / .08	.13 / .10	.40 / .38	.08 / .05
ΔR^2 / $F \Delta R^2$		.03 / 4.44*	.41 / 32.47***	.40 / 31.98***	.08 / 8.87**	.15 / 7.96**	.42 / 33.66***	.10 / 5.20**

Note: M1: first model with linear independent variable and age; M2: second model adding quadratic independent variable; M3: third model adding linear interaction. Variables marked with superscript 2s are curvilinear variables. Adjusted R^2 and predicted R^2 of the most parsimonious model are reported. ΔR^2: Change in R^2 in comparison with the previous model. $F \Delta R^2$: F for change in R^2 in comparison with the previous model, with *$p<.05$; **$p<.01$; ***$p<.0001$.

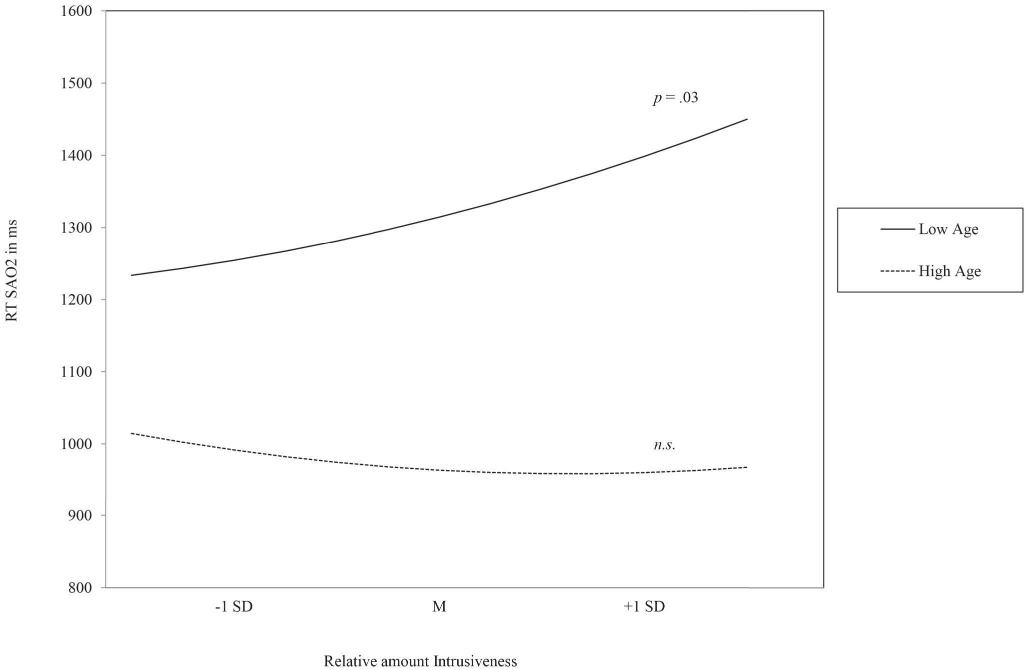

Figure 1. Moderation effect of age on the relation between parental intrusiveness and reaction time sustained attention task (RT SAO2).

Parenting strategies and EF

SP and Intrusiveness

Higher supportive presence was associated with fewer misses on the GNG task (β = -.32, p <.001, adjusted R^2 = .49) and fewer errors on the ROO-2 task (β = -.20, p = .04, adjusted R^2 = .16), both tasks assessing aspects of inhibitory control. Higher intrusiveness was related to more misses on the GNG inhibition task (β = .29, p <.001, adjusted R^2 = .47) and more errors on the ROO-2 inhibition task (β = .22, p = .02, adjusted R^2 = .17) too. No significant association of parental support and intrusiveness with working memory or with cognitive flexibility was found.

Verbal scaffolding

The relative amount of closed-ended questions asked by parents had a positively accelerated curvilinear relation with number of false alarms (β = .26, p = .01, adjusted R^2 = .10) and number of misses (β = .20, p = .02, adjusted R^2 = .42) on the GNG task, as well as with number of errors on the ROO-2 task (β = .26, p <.01, adjusted R^2 = .20), all assessing inhibitory control. These convex relations indicate that initially, parents who ask relatively more closed-ended questions have children who do better on these inhibition tasks, but only until a certain point. After this inflection point, asking more closed-ended questions is increasingly associated with inhibition errors (both GNG inflection points = .19, <1 ***SD*** above the mean; ROO inflection point = -.25, <1 ***SD*** below the mean; see Figure 2b). In addition, children of parents who asked more closed-ended questions identified fewer targets on the working memory task (β = -.17, *p* = .04, adjusted R^2 = .43). Asking more open-ended questions was linked to fewer misses on the GNG inhibition task (β = -.17, *p* = .04, adjusted R^2 = .42). Furthermore, a higher open- versus closed-ended questions ratio score was associated with fewer errors on the ROO-2 task (β = -.20, *p* = .04, adjusted R^2 = .16), assessing inhibitory control, and on the ROO-3 task (β = -.20, *p* = .04, adjusted R^2 = .12), assessing cognitive flexibility. In addition, children of parents with a higher open versus closed-ended questions ratio score identified more targets on the working memory task (β = .16, *p* = .04, adjusted R^2 = .43).

Observational leading questions showed a curvilinear relation that was positively accelerated with number of misses on the GNG inhibition task (β = .17, *p* = .04, adjusted R^2 = .42), and that was negatively accelerated with number of errors on the ROO-3 flexibility task (β = -.22, *p* = .03, adjusted R^2 = .11) (see Figure 2c). The convex relation with number of misses on the GNG indicated that more observational leading questions were associated with fewer inhibitory control errors, but once the amount of questions reached a higher level (inflection point = .20, <1 ***SD*** above the mean), children of parents who asked relatively more observational leading questions had more misses. In contrast, the concave relation with cognitive flexibility indicated that more observational leading questions were associated with increasingly fewer errors as the relative amount of questions reached a certain point (inflection point = -.21, <1 ***SD*** below the mean; see Figure 2c). In addition, a significant interaction effect for explanatory questions with age was found for the number of false alarms on the GNG inhibition task (β = -.30, *p* <.01, adjusted R^2 = .11) (See Figure 2d). Post hoc probing showed that amount of explanatory questions was associated with more false alarms in younger children (β = .29, *p*= .03, adjusted R^2 = .12), but with fewer false alarms in older children (β = -.28, *p* = .03, adjusted R^2 = .12). No significant association between question category and working memory was found.

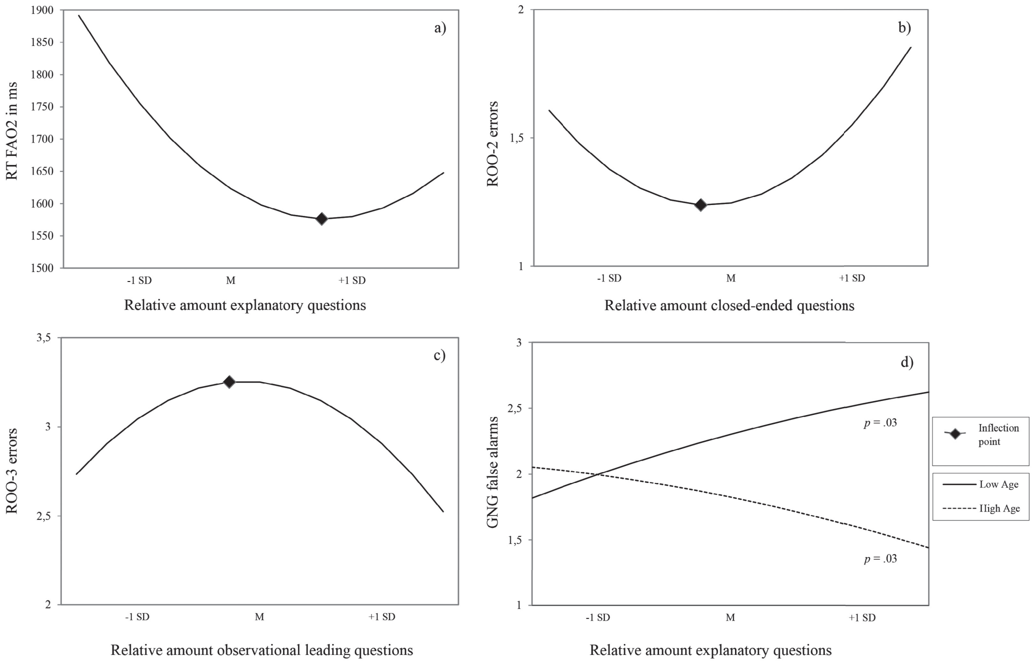

Figure 2. Convex relation between relative amount of explanatory questions and reaction time focused attention task (RT FAO2) (a). Convex relation between relative amount of closed-ended questions and number of errors inhibition task (ROO-2) (b). Concave relation between relative amount of observational leading questions and number of errors cognitive flexibility task (ROO-3) (c). Moderation effect of age on the relation between amount of explanatory questions and number of false alarms on an inhibition task (GNG) (d).

DISCUSSION

The aim of the current study was to investigate whether aspects of parenting strategies, i.e. supportive presence, intrusiveness and aspects of verbal scaffolding, are also associated with child AC and EF skills in this older age group of 4- to 8-year-olds as they are in younger children, and to what extent these relations were similar within this age range. This study showed that aspects of AC and EF were related to these parenting strategies in this low risk group of typically developing children. AC components were significantly associated with intrusiveness and some aspects of verbal scaffolding. Regarding EF skills, especially inhibitory control showed robust associations with parental intrusiveness, supportive presence and aspects of verbal scaffolding. Working memory and cognitive flexibility were related to aspects of verbal scaffolding, but not to aspects of parental sensitivity. An interesting finding was the observation that several relations between parental strategies and AC or EF appeared to be moderated by age and that some relations were curvilinear.

Parenting strategies: relation with AC and EF

Parents who were more supportive, less intrusive, and who asked more open-ended questions had children with better inhibitory control. In addition, parents who asked relatively more open-ended than closed-ended questions had children with better inhibitory control, working memory skills and cognitive flexibility. This may suggest that parenting strategies can influence their children's EF skills also during early school years, in line with Sigel's model of psychological distancing (2002), and extending results from previous studies in younger age groups (e.g. Bernier et al., 2010; Conway & Stifter, 2012; Eisenberg et al., 2010; Hughes & Ensor, 2009; Kraybill & Bell, 2013; Matte-Gagné & Bernier, 2011; Neitzel & Stright, 2003; Sulik et al., 2015). Sigel's model entails that children learn self-regulation through interacting with parents who are sensitive and able to adequately scaffold experiences, building on earlier models emphasizing the importance of parent-child interaction in the development of self-regulation (e.g. Vygotsky, 1978; Kopp, 1982; Calkins, 1994). Nonetheless, the current study cannot give a definite answer on causality in this association. It may also mean that parents are, at least partially, adapting their behavior in accordance with their child's needs at that point in time. Certain parenting strategies could either be a cause or an effect of their child's self-regulation skills, or both; suggesting a reciprocal relation between parental strategies and children's functioning. For instance, Eisenberg and colleagues (2010) concluded that individual differences in self-regulatory skills predicted maternal scaffolding, suggesting that child skills may evoke specific parenting strategies. On the other hand, in a more recent study, Eisenberg and colleagues (2015) reported a bidirectional association between parental intrusiveness and child self-regulation, comparable to the reciprocal associations reported by Belsky, Fearon and Bell (2007) between parental sensitivity and child attentional control.

An interesting finding was that some associations between parenting strategies and child AC and EF were curvilinear. Children with better inhibitory control had parents who asked more than just a few, but not too many closed-ended or observational leading questions relative to other parents. Children with better AC had parents who asked relatively many explanatory questions, though not too many. On the other hand, children with better cognitive flexibility had parents who either asked a few or a lot of observational leading questions compared to other parents. These curvilinear associations may indicate that an adequate parenting strategy requires more than merely asking more questions and that asking questions in itself does not define adaptive parenting behavior. A recent study focusing on the association between child anxiety and parental intrusiveness also concluded that curvilinear effects may be the best fitting to depict parental influence on child development, as anxiety increased when mother's intrusiveness was on either end of the continuum (i.e. high or low) (Kiel, Premo, & Buss, 2016).

Our findings suggest that child self-regulation is likely to be influenced by parental strategies but a reversed relation is also possible, building on the idea of bidirectionality in parenting strategies and child functioning. Furthermore, more is not necessarily better, underscoring the importance of adaptive parenting strategies.

Age matters

Not all aspects of parenting and child self-regulation were associated across the entire age-range in this study. For instance, only younger children with parents who were less intrusive had better AC. At the same time supportive parenting was not at all related to AC in 4- to 8-year-olds. These findings are in line with the study of Mathis and Bierman (2015), who concluded that although parental intrusiveness was associated with low levels of child AC in 4- to 5-year-olds, no relation was found for parental support. As it was hypothesized that especially in older children parental intrusiveness would be negatively related to child AC, the absence of this association in our study was surprising (Cuevas et al., 2014). Though AC continues to develop during the primary school period, AC development is thought to have its peak during the preschool period (Garon et al., 2008). This might suggest that AC skills have mostly developed by the time children reach primary school age and parental influence on AC development may be limited afterwards, though our finding of an association between intrusiveness and AC in younger children suggests there may still be plasticity in AC development around age four to five.

Within our sample of 4- to 8-year-olds, we did not find age to act as a moderator in the relation between parental supportive presence or intrusiveness with EF development. Our findings supported the presence of a robust relation between supportive presence and intrusiveness with inhibitory control, but no association with working memory or cognitive flexibility was detected. The influence of parental support and intrusiveness on EF might only be detectable at an older age, as both working memory and cognitive flexibility show a longer developmental trajectory than inhibitory control (Best et al., 2009). This is in agreement with a recent study, showing parental sensitivity predicted inhibitory control but not working memory in four-year-olds (Mileva-Seitz et al., 2015). It should be noted, however, that parental sensitivity may already be associated with neural development at an earlier age. Even though brain activity may change dramatically, this does not always lead to improved task performance (Johnstone et al., 2007) or these changes in neural activation may take time to result in improved behavioral performance (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005). However, Bernier and colleagues (2010; 2012) have linked autonomy support (i.e. low intrusiveness) to an EF factor containing inhibitory control, working memory and cognitive flexibility, already in early childhood. These findings, however, may be mainly explained by the inclusion of inhibitory control in their EF factor. On the other hand, this study's observation that verbal scaffolding was already associated with the more demanding EF tasks assessing working memory and cognitive flexibility in 4- to 8-year-olds, might suggest that scaffolding challenges children's self-regulation skills more than aspects of parental sensitivity do. These tentative conclusions ask for longitudinal studies in large samples to disentangle the role of specific aspects of parenting in EF development.

Age also mattered in the relation between certain aspects of verbal scaffolding and AC and EF. Most interesting was the moderation effect of age on the association between explanatory questions and inhibitory control. Parents of older children with better inhibitory control asked relatively more explanatory questions, while this effect was reversed in younger children. An explanation of this interaction effect might be related to the difficulty level of the questions parents ask. According to Eshach and colleagues' (2014) taxonomy of question difficulty, this study's explanatory questions would be identified as high-order questions. Our finding may thus be due to the higher difficulty level of this question category in general. Perhaps asking explanatory questions is too demanding for younger children, while it is likely to be more adaptive for the older age group.

In sum, in the current study several associations between parental strategies and children's cognitive self-regulatory skills were found, suggesting that also young school-aged children could benefit from interacting with supportive, non-intrusive parents who ask challenging and relatively more open-ended questions. Several limitations of the current study need to be acknowledged. Parents may have acted differently than their usual self, due to the somewhat artificial, though only slightly structured play setting during the joint-activity tasks. However, it should be noted that observing parent-child interaction under these relatively more natural conditions in the home is unlikely to distort the nature of interaction much (Gardner, 2000). Secondly, our coding system focused on parenting behaviors. Consequently, real-time bidirectional relations between parenting strategies and child behavior could not be investigated. Thirdly, children from only two Dutch schools in the same provincial region were included in this study, which limits the generalizability of our findings. Parents participating in this study were more likely to be highly educated (Central Bureau for Statistics [CBS], 2013) and the current sample may not accurately represent families from a lower educational background. Fourthly, relatively complex analyses were conducted using a modest sample size. However, cross-validation to avoid overfit models raised no major concerns and sample size was sufficient to detect at least moderate to even smaller effect sizes (Green, 1991). Finally, the current study assessed associations between parental strategies and child self-regulation cross-sectionally, and no inferences concerning developmental changes within children or causality can be made. This is particularly relevant for the age interaction effects described in this study, which may have been caused by differences between children instead of developmental differences within the same child, asking for studies examining these relations over time.

Strengths of this study include the assessment of AC and EF using well-validated age-appropriate neuropsychological tasks and the objective coding of observed parenting behaviors. This study points to possible opportunities to also teach parents of young school age children to be more supportive, less intrusive, and ask more open-ended and elaborative questions to help optimize their children's self-regulatory skills. Our findings suggest that age moderates the association between some aspects of parenting strategies and child self-regulation. Our results show that what may be an adequate parenting strategy for one child is not necessarily adequate for another child, whether the latter deviates in age, development or both. Diamond (2011) concluded that self-regulatory skills can be improved; our study suggests that parents may influence self-regulatory skills in their children by using adaptive parenting strategies and being able to flexibly change the way they interact with their child over time. Educating and training parents could benefit children's AC and EF development and the aspects of parental strategies investigated in the current study could be useful objectives. Research into the effectiveness of educating and training parents of low risk children about parental strategies that can stimulate their child's self-regulatory skills is needed to investigate whether changing parenting skills will result in better AC and EF skills in children.

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APPENDIX

Correlations amongst all predictor variables

Table 1. *Intercorrelations among observed parenting behaviors.*

	1	2	3	4	5	6	7	8
1. Supportive presence	-	-.80**	.34**	.17	.15	.29**	.22*	.21*
2. Intrusiveness		-	-.23*	-.04	-.18	-.32**	-.18	-.23*
3. Open-ended questions			-	.42**	.53**	.54**	.16	.29**
4. Closed-ended questions				-	-.55**	. 47**	.09	.08
5. Ratio open-closed					-	.06	.06	.19
6. Leading observational questions						-	-.06	.25*
7. Procedural questions							-	.02
8. Explanatory questions								-

CHAPTER 3

Linking parenting and social competence in school-aged boys and girls: Differential socialization, diathesis-stress or differential susceptibility?

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ABSTRACT

Girls generally demonstrate superior skill levels in social competence compared to boys. The exact relations of parenting with these gender differences are currently unclear. Gender differences may occur due to exposure to different parenting strategies (differential socialization model) or due to a different impact of similar parenting strategies for boys and girls (differential susceptibility & diathesis-stress model). In this study we assessed both hypotheses using a multi-method multi-informant approach. We investigated (1) to what extent different parenting strategies mediate the relation between gender and social competence and (2) whether gender and age moderate the relation between parenting strategies and social competence. Parenting strategies were observed during home visits and social competence was assessed using parent and teacher questionnaires and performance-based neurocognitive tasks (N = 98, aged 4 to 8). (1) Parenting strategies did not mediate the relation between gender and social competence. (2) Gender moderated the association between parental questioning style and children's level of social competence: parents asking fewer questions was associated with poorer social cognitive skills in boys only. Parental supportive presence and intrusiveness were related to aspects of social competence irrespective of gender. Age moderated the relation between parenting and aspects of social competence, though in various (unexpected) directions. Our findings do not support the differential socialization hypothesis and provide partial evidence for a diathesis-stress model as an explanation for parental influence on gender differences in social competence.

Keywords: Social cognition, Social skills, Gender differences, Parent-child interaction

When children start school their world begins to open up as they increasingly interact with children and adults outside their family. The new school environment requires adaptive social skills in order to build friendships, learn to cooperate, and optimally benefit from learning opportunities. The cognitive, emotional and social skills necessary for effective social interactions can be described as social competence (Kostelnik et al., 2014). Social competence is particularly important at school entry and in the first few years of school, when social interactions are critical for academic success (Raver, 2002). Social competence has repeatedly been linked to school performance (e.g. Shala, 2013) and is considered to be as important for school success as academic skills are (NICHD, 2004; Raver & Zigler, 1997). Parents play a crucial role herein as parent-child interaction is considered the foundation on which social development is built (Laible & Thompson, 2007).

Social cognition can be described as the neurocognitive mechanisms underlying social competence, including the ability to interpret, predict, and empathize with others' mental states and behaviors (Baron-Cohen et al., 1999). According to the social information processing approach (Crick & Dodge, 1994), several successive social cognitive steps are taken to interpret and adequately respond to each new social situation. The child first focuses on specific social cues, such as facial expressions, and interprets these cues within the social context. The child then considers and evaluates possible responses to this situation from his own personal database, based on past experiences. Finally, this database is used as a guide to choose the perceived most adequate response. This process is iterative and is highly influenced by the social environment, as the personal database is constantly updated with the most recent social encounters. Lemerise and Arsenio (2000) argued that social information processing cannot be seen separately from emotion processes and therefore proposed a revised model into which emotion processes are integrated and can both influence and be influenced by each step of social information processing. For instance, mood and social situation influence how social cues are interpreted and responses are evaluated. Children with better social information processing skills have been found to be more socially competent, both in preschool (Ziv, 2013) and in primary school (Mayeux & Cillessen, 2003).

The development of social cognitive and behavioral skills originates within the relationship with the child's parents or significant caregiver (Attili et al., 2010; Vygotsky, 1978). Parents provide their child with early social learning opportunities and are responsible for communicating social rules to their children, supporting the development of a database of adequate social behavior (Bennett et al., 2005). When children start school, these skills are necessary to build adequate relationships with peers and form friendships. In turn, having prosocial friends can promote social competence (Wentzel et al., 2004). Aspects of parental sensitivity, such as parental support and intrusiveness, have repeatedly been found to predict the development of social competence (e.g. Barnett et al., 2012; Lengua et al., 2007; Spinrad et al., 2007). Parental support refers to warm and affective caregiving, while intrusiveness refers to negative and controlling parenting or lack of autonomy support (Dotterer et al., 2012). In addition, the manner in which parents verbally interact with their children, e.g. through scaffolding and asking open-ended questions, helps children to practice their communication skills, which in turn promote social development (Gallagher, 1993; Lee et al., 2012; Vygotsky, 1978). Even though there is compelling evidence relating parental scaffolding to children's cognitive abilities and school achievement, studies focusing on the association between scaffolding and social development are scarce (For a review, see Mermelshtine, 2017).

The development of social understanding can be described by successive social cognitive stages and largely takes place between four years of age and adolescence (Selman, 1980, 2003). Even though there is a gradual increase in social understanding with increasing age (e.g. Marcone et al., 2015), the presence of great individual variability among same-aged children persists. In particular, during middle childhood quite robust gender differences in social understanding favoring girls have been found (e.g. Abdi, 2010; for a meta-analysis, see Fabes & Eisenberg, 1998). Girls tend to develop their social information processing skills more rapidly, which allows them to interpret and learn from social interactions at an earlier age than boys do (Bennett et al., 2005). For instance, especially during infancy and the preschool period, girls have been found to outperform boys in facial emotion processing (for a meta-analysis, see McClure, 2000) and emotion knowledge (Denham et al., 2015). Gender differences in social competence may be explained by parents using different parenting strategies towards sons and daughters, assuming a differential socialization model (Lytton & Romney, 1991). Alternatively, differences in social functioning can be considered a result of a differential impact of parenting strategies on social development for boys and girls (Rutter et al., 2003).

The differential socialization model assumes that parenting strategies may mediate the relation between gender and level of social competence. Girls may elicit different responses from their social environment than boys. This might for example be due to different social expectations or as a result of their more mature skills. For instance, parents may initiate more or other types of verbal interaction with their daughters because they are more responsive (Leaper, 2002). Leaper and colleagues (1998) showed in their meta-analysis that mothers were more talkative with their daughters than with their sons. In addition, research shows that parents talk more about emotions with their four-year-old daughters than with their sons (Aznar & Tenenbaum, 2015; Fivush et al., 2000). In turn, more emotion talk predicts emotion understanding, an important aspect of social cognition, six months later in four- to six-year-olds (Aznar & Tenenbaum, 2013).

However, gender-differentiated socialization remains debated, and might only be true for some aspects of parenting in relation to social competence (For a review, see Leaper, 2002). In a recent meta-analysis focusing on parental sensitivity (Endendijk et al., 2016), it was concluded that differences in parenting of boys and girls are minimal, in line with an earlier meta-analysis by Lytton and Romney (1991). Leaper and colleagues (1998), who did find differences in parenting sons and daughters, argued that the discrepancy between Lytton and Romney's findings and their own may be due to the broadly defined parenting behaviors used by the former (e.g. amount of interaction, undifferentiated), possibly obscuring differential socialization of girls and boys. An additional explanation may be the focus on different aspects of parenting in these meta-analyses. Where Leaper and colleagues (1998) specifically focused on verbal interaction such as amount of talking and supportive and directive speech, Endendijk et al. (2016) examined parental support and intrusiveness. These findings suggest gender-differentiated parenting may only be true for some, but not all parenting strategies that have been associated with social competence and emphasizes the need to study different parenting strategies simultaneously.

Alternatively, a differential impact of environmental influences has been suggested to explain gender differences in child behavior (Rutter et al., 2003). This suggests boys and girls are exposed to similar parenting strategies, but that these strategies have different effects on their social and behavioral development. In other words, gender acts as a moderator in the relation between parenting strategies and social competence. The diathesis-stress model states that some individuals are more vulnerable to poor environmental experiences, such as low quality parenting, and will show worse developmental outcomes than individuals who are less vulnerable (Heim & Nemeroff, 1999). Gender may be a factor that distinguishes children who are more vulnerable to some environment-outcome relations from those who are not (e.g. Belsky, 2013). Research on the development of child behavioral problems supports this model, suggesting boys are more vulnerable to the negative effects of environmental adversity than girls (e.g. Barnett & Scaramella, 2013; Calkins, 2002; Crick & Zahn-Waxler, 2003). For example, Calkins (2002) reported that more parental intrusiveness was associated to emotional distress only in boys, and less maternal sensitivity has been found to predict more externalizing behavior in nine-year-old boys but not in girls (Miner & Clarke-Stewart, 2008).

However, positive parenting has also been related to fewer externalizing behaviors in boys but not in girls (for a review, see Rothbaum & Weisz, 1994); and positive parent-child interactions have been linked to fewer emotional problems only in boys (Browne et al., 2010). This is in line with a differential susceptibility model, which assumes that some individuals are not only more vulnerable to adverse environments (diathesis-stress), but that sensitivity to both negative and positive environments is enhanced (for reviews, see Belsky & Pluess, 2009; Ellis et al., 2011). In other words, some children are more susceptible to both positive (e.g. supportive presence and asking more open-ended questions) and negative (e.g. intrusiveness and asking fewer questions) aspects of parenting, which in turn leads to either the best or the worst developmental outcomes. In contrast, children who are relatively less affected by environmental influences will thrive less under optimal parenting conditions, but will also be less affected under adverse parental influences. Consistent with this differential susceptibility perspective, the association between sensitive parenting and social competence may also be stronger for boys than for girls (for a review, see Bornstein, 2005). For instance, maternal emotion talk has been found to predict 3-year-old boys' but not girls' emotion understanding, while there were no gender differences in amount of emotion talk, nor in their emotion understanding (Martin & Green, 2005). This suggests that in the case of emotion understanding, one of the elements of social competence, gender acts as a resiliency factor to the influence of parent-child interaction.

Age may also play a moderating role in the association between parenting and aspects of social competence, as parents adapt their expectations and parenting to their child's age, and as individual differences in environmental susceptibility may vary with age (Barnett & Scaramella, 2013; Ellis et al., 2011). Furthermore, the nature of the relation between parenting strategies and child behavior may shift with age (Bradley et al., 2015; Spruijt et al., 2018). For instance, parental directiveness (i.e. providing verbal structure) has been shown to have a positive effect on cognitive and social development, but this effect reverses after age four, in line with the child's diminished need for structure (Landry et al., 2000). When children grow-up and enter school, the school environment becomes increasingly important in providing a new setting to practice social skills with peers, relative to the impact of parenting. While children's emotion understanding and perspective taking abilities develop rapidly during the transition to school (Harris et al., 2016; Wellman, 2007) and the influence of peers on social development increases (Rubin et al., 2013), the relative influence of parents on the development of social functions will likely decrease (Flynn, 2007), suggesting a moderating effect of age. These findings suggest that boys' and girls' differential susceptibility to various parenting strategies may also change with age.

In the current study, we aimed to investigate whether different aspects of parenting strategies (e.g. parental support, intrusiveness, and the amount and type of questions parents ask their children) are associated with various aspects of children's social competence (social cognition, social behavioral competence at home and at school) during the early school years. We examined to what extent (1) these parental strategies mediate the relation between gender and social competence, substantiating the differential socialization model and (2) whether gender and age moderate these relations, substantiating the differential susceptibility or the diathesis-stress model. As both latter models posit statistical moderation, we will follow the recommendations proposed by Roisman et al. (2012) for distinguishing the differential susceptibility model (for better and for worse) from the diathesis-stress model (only for worse). Since social competence is linked to verbal ability (Gallagher, 1993; Milligan et al., 2007) and gender differences in verbal ability have been found (Toivainen et al., 2017), the current study evaluated whether associations were independent of children's verbal ability.

We expect a mediated effect of gender on social competence through (i) parental questioning style but not (ii) parental support and intrusiveness. This indirect effect would support the differential socialization model for parental questioning style. It is expected that parents ask more questions to their daughters than to their sons (Leaper et al., 1998), which results in girls to outperform boys in social competence. In contrast, aspects of parental sensitivity are not expected to differ much for boys and girls in general (Endendijk et al., 2016; Lytton & Romney, 1991).

Furthermore, we expect that the relative influence of parenting strategies on social competence will be moderated by gender. We hypothesize that boys are more susceptible to both (iii) positive (i.e. supportive presence and asking more (open-ended) questions) and (iv) negative (i.e. intrusiveness and asking less (open-ended) questions) aspects of parenting with regard to their social competence (Bornstein, 2005), which would support the differential susceptibility model. Furthermore, we expect that the relative influence of parenting strategies on social competence will (v) decrease with age (Flynn, 2007; Landry et al., 2000).

METHOD

Participants

The current study is embedded within the 'Leiden Curious Minds Research Program': a longitudinal program investigating the development of executive and social functioning in primary school children in the Netherlands and the effects of a parent and a teacher intervention program (approved by the Ethical Board of the Department of Education and Child Studies at Leiden University (ECPW-2010016)).

Parents of 4- to 8-year-old children from the lowest four grades of two Dutch primary schools (pre-school to second grade in USA school system), from towns that are part of the urban agglomeration of Rotterdam and the conurbation of The Hague, agreed to participate in this study by signing an informed consent letter. The current study uses child, paper-and-pencil tests to assess level of social cognitive skills and verbal ability, parent- and teacher reported social behavioral skills reports, and observational data on parents' interactive behavior with their child collected during a home visit. Parents of 99 out of 138 children agreed to a home visit (response = 71.7%; 10.1% fathers). Participants whose parents agreed to a home visit did not significantly differ from those who did not agree to a home visit by age, gender, school, grade, or referral to mental health care in the past year, nor did their families differ in single parenthood status or parental education. One child refused to complete the neurocognitive assessments and was excluded from analyses (Final *N* neurocognitive assessments = 98). Information on social behavioral skills was missing for seven children due to non-response on the parental questionnaire (Final *N* parent questionnaire = 91) and for nine children due to non-response on the teacher questionnaire (Final *N* teacher questionnaire = 89). Children ranged in age from 4 to 8 years (*M* = 6.2 years, *SD* = 1.2) and 56.1% were male. No parents or children were excluded because of problems with oral or written proficiency in Dutch. For detailed sample characteristics, see Table 1.

Procedure

Paper-and-pencil and computer-based performance tasks were administered in a separate room at the child's school, during two individual test sessions of approximately 60 minutes each. After each session the children could choose a small present as a token of appreciation. One session included fixed-order paper-and-pencil tasks and the other session mainly consisted of fixed-order computer tasks. Tests were administered by two trained Master's students or by one of the main investigators (AMS, MCD). All home visits were conducted by Master's student pairs. Test data were collected in the period between November 2013 and February 2014 (school 1) and between May and June 2014 (school 2).

Table 1. *Participant characteristics (N = 98) and descriptive statistics of variables of interest.*

	Total	Boys	Girls
N	98	55	43
Age in months (*M (SD)*)	74.30 (14.56) [49 – 101]	74.76 (14.91) [49 – 101]	73.42 (14.01) [49 – 101]
Parental education (%)[a]			
High	40.43	42.59	37.50
Medium	52.13	46.29	60.00
Low	7.45	11.11	2.50
Single parenthood (%)	6.38	7.41	5.00
Parental sensitivity[b]			
Supportive presence	3.95 (1.46) [1.00 - 6.75]	4.03 (1.39) [1.50 – 6.75]	3.84 (1.55) [1.00 – 6.75]
Intrusiveness	3.76 (1.42) [1.00 - 7.00]	3.75 (1.45) [1.00 – 6.50]	3.78 (1.38) [1.50 – 7.00]
Number of questions per minute[b]			
Total questions	4.19 (1.63) [0.17 - 9.27]	4.25 (1.61) [1.47 – 9.27]	4.12 (1.67) [.17 – 7.36]
Closed-ended questions	2.16 (0.94) [0 - 4.19]	2.16 (.93) [.64 – 4.90]	2.16 (.95) [0 – 4.66]
Open-ended questions	1.86 (0.95) [0.17 - 5.18]	1.90 (.92) [.43 – 5.18]	1.80 (.99) [.17 – 4.24]
Child social competence			
Social behavior at school	45.33 (10.46) [20.00 - 60.00]	42.00 (10.43) [20.00 – 59.00]	49.59 (8.93) [28.00 – 60.00]
Social behavior at home	55.10 (9.83) [29.00 - 75.00]	53.06 (9.54) [35.00 – 75.00]	57.95 (9.64) [29.00 – 71.00]
Social cognition	28.77 (14.72) [0 – 63.00]	27.62 (14.80) [0 – 61.00]	30.23 (14.66) [2.00 – 63.00]

Note. All data are presented as Mean (Standard deviation), [range] unless otherwise noted.
[a]Background information was missing for *N* = 4 children due to non-response on parental questionnaires.
[b]Original values before standardization.

Measures

Demographic characteristics

Parents were asked to fill out a complementary background information questionnaire, using the online survey software Qualtrics (http://www.qualtrics.com/). The highest completed level of education by the parent who participated in the home visit was used as an measure of educational attainment, according to the Dutch Standard Classification of Education (SOI), which is based on UNESCO's International Standard Classification of Education (ISCED) ("SOI 2003 (Issue 2006/'07),"): 1. primary education (SOI level 1 to 3; at most vocational training); 2. secondary education (level 4 of SOI); and 3. higher education (level 5 to 7 of SOI; bachelor's degree or higher). Single parenthood status was defined by not having the child's other parent or a new caregiver living in the same household. Mental health care referrals were assessed by asking parents whether their child had been referred, examined or treated for emotional and behavioral problems in the past year.

Verbal ability

Verbal ability was measured with the Concepts and Following Directions task of the Clinical Evaluation of Language Fundamentals (CELF-4NL) (Semel et al., 2010). This task gives an indication of the child's ability to interpret and act upon spoken directions of increasing length and complexity. Among several choices, participants were asked to point out the pictured objects that were mentioned, requiring them to remember the names, characteristics and order of mention. Administration took approximately 20 minutes. The task contains 49 items of increasing length and complexity. Upon reaching item 19, the task was aborted after seven consecutive incorrect answers. Administered items were afterwards coded to yield either 0 points for an incorrect answer or 1 point for a correct answer. Summed raw scores were used in the analyses. The test-retest reliability (r = .76) of this subtask is considered sufficient (Semel et al., 2010).

Social competence

Social behavioral competence

Parents and teachers were also asked to fill out the Social Skills Rating System (SSRS) to measure social skills at home or at school (Gresham & Elliott, 1990; Van der Oord et al., 2005). Parents filled out the SSRS questionnaire using the online survey software Qualtrics (http://www.qualtrics.com/), while teachers filled out a hardcopy version. The SSRS has satisfactory internal consistency, test-retest reliability and convergent and discriminant validity, and is used for children from 3 to 18 years old. The teacher and parent version of the SSRS are rated on a 3-point Likert scale ranging from 0 (never) to 2 (often). The SSRS teacher version consists of three subscales with 10 items each. The subscale “cooperation” assesses behavior like helping others. The subscale “assertion” assesses initiating behaviors such as asking for information. The subscale “self-control” assesses behavior like responding in conflict situations and taking turns. A sample item of this scale is “responds appropriately when pushed or hit by other children”. The three subscales form a total social skills scale score, with a range of 0-60. The Cronbach’s alpha for the teacher version of the SSRS in this sample was .93. The SSRS parent version consists of 4 subscales of 10 items each. In addition to the subscales “cooperation”, “assertion” and “self-control”, the parent version also contains the subscale “responsibility”. A sample item of this scale is “requests permission before leaving the house”. The 4 subscales form a total social skills scale score (range from 0-80). The Cronbach’s alpha for the parent version of the SSRS in this sample was .89. The total raw score on each questionnaire was used in the analyses. A higher score indicates better social skills.

Social cognitive competence

Social cognition was measured with two parallel versions (A or B) of the short form of the Social Cognitive Skill Test (SCST) (Van Manen, 2007). The SCST is a semi-structured interview, based on the structural developmental approach of social cognition as proposed by Selman and Byrne (1974). Participants completed either version A or B, corresponding their randomly assigned A or B condition during the home visit. Both versions consisted of three short stories with accompanying pictures depicting different social situations in which a child is confronted with a problem. Administration took approximately 20 minutes. Eight questions regarding emotion recognition and perspective taking, increasing in difficulty, were asked per story, which were afterwards coded to yield either: (i) 3 points; when the answer was correct straightaway; (ii) 1 point; when the answer was not completely correct, but after a supplementary question became correct; (iii) 0 points; when the answer was incorrect from the start or still not completely correct after a supplementary question. A story was aborted after two consecutive incorrect answers. Summed raw scores were used in the analyses. The correlation between version A and B has been shown to be .84 with test-retest reliability ranging from .77 for version A to .78 for version B (Van Manen, 2007).

Parenting strategies

Parent's interactive behavior with their child was videotaped during a home visit, while each parent-child dyad was engaged in two joint activity tasks of approximately five to ten minutes. These tasks consisted of a sorting task and a combining task based on tasks designed by Utrecht University (Corvers et al., 2012). Parent-child dyads were randomly assigned to either complete task version A (*N* = 50, 51%) or task version B of each joint activity task (*N* = 48, 49%). Version A of either task included sorting different types of toy animals and combining four different eyes and four different mouths to form smiley faces with various facial expressions, and version B consisted of sorting different types of toy food and combining four different flower petals with four different disks to form unique flowers. Parent-child dyads were free to sort and combine the items according to their own strategy, as long as all combinations in the combining task were different. Parents were instructed to assist their child as they would normally do. The videotapes were coded afterwards for global level of parental supportive presence and intrusiveness, as well as the amount of and different form of questions (i.e. open- or closed-ended) asked by the parent.

Parental supportive presence and Intrusiveness

Parental support and intrusiveness were coded using the revised Erickson 7-point scale for Supportive presence (SP) and Intrusiveness (Egeland et al., 1990). A parent scoring high on SP shows emotional support to the child and is reassuring when the child is having difficulty with the task. A parent scoring high on Intrusiveness lacks respect for the child's autonomy and does not acknowledge the child's intentions or desires. Three coders who were blind to other data concerning the child or the parent coded the joint activity tasks. For each parent-child dyad, the combining and sorting task were coded independently by different coders. All coders completed an extensive training, consisting of several practice and feedback sessions supervised by an expert coder. Reliability of the coders (intraclass correlation (ICC)) was assessed directly after completion of the training and at the end of the coding process to detect possible rater drift. ICCs between coders directly after training were .92 for the SP scale (*N* = 12) and .81 for the Intrusiveness scale (*N* = 12). At the end of the coding process, ICCs were .91 for the SP scale (*N* = 12) and .92 for the Intrusiveness scale (*N* = 12), suggesting no significant rater drift. Whenever interactions were difficult to score due to an ambiguous interaction (*N* = 14), consensus was sought after a discussion with all coders. Even though parent-child dyads were randomly assigned to either joint task battery A or B, each task battery may have elicited a somewhat different interaction between parent and child. Therefore, level of SP and Intrusiveness was computed by standardizing each task version score (A or B) within each task (sorting or combining), followed by averaging these Z-scores over both joint activity tasks.

Parental questioning style

The total number and form of questions parents asked their children during the joint activity tasks were coded from video recordings using transcribed verbatim reports. Each question was coded as either being (i) open-ended (e.g., "How do you want to start?"; (ii) multiple choice (e.g., "Does a kangaroo live in the zoo or in the ocean?"; or (iii) closed-ended (e.g., "Is a cow a farm animal?"). The form of each question was coded by three coders who were not involved in coding SP and Intrusiveness and who were blind to other data concerning the child or the parent. All coders completed an extensive training, consisting of several practice and feedback sessions supervised by the main researcher. Interrater reliability (Cohen's kappa) was high, with .84 on average for the sorting task ($N_{\text{questions}}$ = 122) and .87 on average for the combining task ($N_{\text{questions}}$ = 115). Within each task the number of questions per minute was calculated. Even though parent-child dyads were randomly assigned to either joint task battery A or B, each task battery may have elicited a somewhat different interaction between parent and child. Therefore, we standardized the number of questions per minute within each task (sorting or combining) for each task version (A or B), followed by averaging these Z-scores over the joint activity tasks. Due to very low occurrence of multiple-choice questions (2.4%), this form was excluded from further analyses. The difference score between the standardized amounts of open- and closed-ended questions was calculated as a relative measure of question format preference during the tasks. A higher open- versus closed-ended ratio score indicates that the parent asked more open-ended than closed-ended questions relative to the other parents. Total number of questions and open- versus closed-ended ratio score per minute were used as measures for parental questioning style.

Data analyses

Data were analyzed using IBM SPSS version 23. Demographic characteristics for both schools were compared with chi-square tests, independent t-tests and Fisher exact tests. Bootstrapping, a nonparametric resampling procedure recommended for small samples, was used to test the mediational models (Hayes, 2009; Preacher & Hayes, 2004). Bootstrapping with 5000 resamples was done to test for significant indirect effects, using an SPSS macro developed by Preacher and Hayes (2009). Verbal ability and age were controlled for in all analyses. In this analysis, mediation is significant if the 95% bias corrected and accelerated confidence intervals for the indirect effect do not include 0 (Hayes, 2013; Preacher & Hayes, 2004). Separate hierarchical linear regression analyses were performed to assess whether each parenting strategy (independent variables) explained additional variance in each aspect of social competence (dependent variables) above or in interaction with gender and age, while controlling for verbal ability. Age and verbal ability were centered and all aspects of parenting were standardized to z-scores. In each regression analysis the following models were tested: (model i) the aspects of parenting strategy, verbal ability, gender and age were included; (model ii) the quadratic term of parenting strategy was added to test for nonlinearity (Roisman et al., 2012) and avoid misleading interactions (Ganzach, 1997); (model iii) the interaction term between parenting strategy and gender was added; (model iv) the interaction between parenting strategy and age was added; (model v) the interaction between gender and age and the three-way interaction between parenting strategy, gender and age were added. F for change in R^2 was used to assess whether a more extensive model significantly improved the amount of variance explained in comparison with a previous nested and more parsimonious model. Predicted R^2 was computed as a cross-validation measure. A negative predicted R^2 or a sizeable difference between predicted and regular (adjusted) R^2 can be an indication of an overfitted model (i.e. predicting random noise). Significant interaction models were also examined by calculating the posterior probability favoring the alternative hypothesis (i.e. evidence for an interaction effect) using the JZS Bayes Factor (BF10, calculated with Rouder's web based application at http://pcl.missouri.edu/bayesfactor), which provides the odds ratio for the alternative/null hypotheses given the data (where 1 means that they are equally likely, larger values indicate more evidence for the interaction effect, and values below 1 indicate more evidence for the null hypothesis. Values between 1 and 3 are considered anecdotal evidence for the alternative hypothesis and values between -3 and 1 for the null, respectively) (Rouder & Morey, 2012). Significant interactions were consecutively probed with regression analyses that included a conditional moderator variable (e.g., low-age: 1 ***SD*** below Mage; and high-age: 1 ***SD*** above M_{age} or: male; and female) (Holmbeck, 2002). Regression lines were plotted based on the resulting regression equations and significance of t-tests were reported for each simple slope. Regions of Significance (RoS) tests were conducted (Preacher et al., 2006) whenever a significant moderation effect for gender was found, in order to differentiate between a diathesis-stress and differential susceptibility model.

This way it was analyzed if Y (social competence) and Z (gender) are related at both low and high ends (± 2 *SD*) or only at the low end (-2 *SD*) of the distribution of X (parenting strategies)), as recommended by Roisman et al. (2012). A graphic representation of all models is supplied in Figure 1. For all significant linear effects, standardized beta coefficients addressed effect size (0.2 = small effect; 0.5 = moderate effect; 0.8 = strong effect (Ferguson, 2009). Alpha for significant effects was set at $p < .05$.

RESULTS

Sample characteristics and descriptive statistics for the variables of interest are displayed in Table 1. The educational level and single parenthood status for parents of sons did not significantly differ from those for parents of daughters. Schools did not significantly differ on background characteristics of the participants: age (p = .63), gender (p =.13), single parenthood status (p = .16), parental education (p = .07) or prevalence of referral to mental health care in the past year (p = .93). Simple correlations between all independent and dependent variables and partial correlations controlled for verbal ability are presented in Table 2.

Mediation analyses: differential socialization

Bias-corrected bootstrapping analyses were conducted to test for an indirect effect of gender on social competence (social behavioral competence (i) at school and (ii) at home, and (iii) social cognition) through parenting strategies (parental supportive presence, intrusiveness and questioning style). Detailed results of the bootstrapping analyses with parenting strategies as a mediator in the relation between gender and social competence are provided in the Appendix.

Social behavioral competence at school

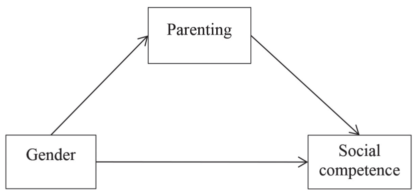
There was no mediation effect for gender on social behavioral competence at school via any of the parenting strategies. Standardized indirect effects via SP (b = -.34, SE = .48, 95% CI [-1.88, .27]) and intrusiveness (b = -.04, SE = .56, 95% CI [-1.28, 1.08]) were non-significant. Nor were standardized indirect effects via parental questioning style (b_{total} = .07, SE = .30, 95% CI [-.28, 1.12]; b_{ratio} = <.01, SE = .24, 95% CI [.-.53, .55]).

Social behavioral competence at home

There was no mediation effect for gender on social behavioral competence at home via any of the parenting strategies. Standardized indirect effects via SP (*b* = < -.01, SE = .23, 95% CI [-.60, .42]) and intrusiveness (*b* = < -.01, SE = .27, 95% CI [-.61, .55]) were non-significant. Nor were standardized indirect effects via parental questioning style (b_{total} = -.05, SE = .33, 95% CI [-1.07, .40]; b_{ratio} = .01, SE = .35, 95% CI [-.67, .81]).

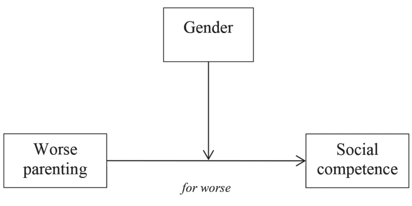
Social cognition

There was no mediation effect for gender on social cognition via any of the parenting strategies. Standardized indirect effects via SP (*b* = -.25, SE = .54, 95% CI [-1.84, .52]) and intrusiveness (*b* = -.05, SE = .50, 95% CI [-1.13, .95]) were non-significant. Nor were standardized indirect effects via parental questioning style (b_{total} = -.08, SE = .36, 95% CI [-1.15, .44]; b_{ratio} = -.04, SE = .26, 95% CI [-.82, .30]).



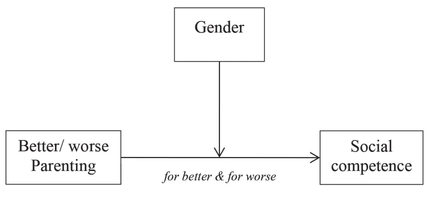
a.

Figure 1a. Graphical representation Differential socialization model (mediation model).



b.

Figure 1b. Graphical representation Diathesis stress model (moderation model). Social competence is only related to gender at the low end (-2 SD) of the distribution of parenting.



c.

Figure 1c. Graphical representation Differential susceptibility model (moderation model). Social competence is related to gender at both high (+2 SD) and low ends (-2 SD) of the distribution of parenting.

Table 2. *Intercorrelations among all variables.*

	1	2	3	4	5	6	7	8	9	10	11
1. Age	-	-.05	-.11	.20*	-.41**	.05	.05	.02	.62**	.01	.08
2. Gender	-.05	-	-.05	<-.01	<-.01	-.05	.36***	.25*	.09	.03	-.05
3. Supportive presence	<-.01	-.05	-	-.80**	.27**	.15	.11	-.02	.06	.29**	-.04
4. Intrusiveness	.08	<-.01	-.85**	-	-.13	-.18†	-.24*	-.07	-.04	-.31**	.13
5. Total questions	-.06	-.02	.16	<-.01	-	-.04	-.18†	.02	-.22*	-.06	-.13
6. Ratio open-closed questions	-.01	-.05	.18	-.27*	.01	-	-.03	.14	.05	.10	<.01
7. Social behavior at school	-.17	.34**	.19†	-.25*	-.10	.06	-	.24*	.15	.32**	-.10
8. Social behavior at home	-.14	.23*	-.01	-.08	.08	.16	.21†	-	.11	.24*	.02
9. Social cognition	.34**	.13	.16	-.17	.05	<.01	<-.01	.01	-	.08	.01
10. Parental education	-.14	.03	.31**	-.33**	.01	.10	.26*	.23*	-.01	-	-.07
11. Single parenthood	.22*	-.05	-.06	.14	-.19†	.01	-.10	-.01	.08	-.06	-

Note. Bivariate correlations among all variables above the diagonal; below the diagonal are partial correlations, controlling for verbal ability.

†p<.10; *p<.05; **p<.01; ***p<.001.

3

Moderation analyses: differential susceptibility or diathesis-stress

Results of the most parsimonious model of each hierarchical regression analysis of SP, intrusiveness and questioning style explaining each aspect of social competence are presented in Table 3 and 4. In each regression analysis the following models were tested: (model 1) the aspect of parenting strategy, verbal ability, gender and age were included; (model 2) the quadratic term of parenting strategy was added; (model 3) the interaction term between parenting strategy and gender was added; (model 4) the interaction between parenting strategy and age was added; (model 5) the interaction between gender and age and the three-way interaction between parenting strategy, gender and age were added. The predicted R^2 value of each model was reasonably close to the corresponding adjusted R^2 values, indicating that overfitting was not an issue.

Parental sensitivity

Social behavioral competence at school

Models 2 to 5 were no significant improvement over Model 1 (all $p_{F\ \Delta R2} > .05$), suggesting that neither gender nor age significantly moderated the association between SP or intrusiveness and social behavioral competence at school. A main effect of intrusiveness was found. Higher intrusiveness was significantly related to fewer social behavioral skills at school in the whole sample (β = -.24, p = .01). The threshold for statistical significance was not achieved for the association between SP and social behavioral skills at school (β = .17, p = .07). However, this trend suggests that parents who are more supportive tend to have children who have slightly better social behavioral skills at school.

Social behavioral competence at home

Models 2 to 5 were no significant improvement over Model 1 (all $p_{F\ \Delta R2} > .05$), suggesting that neither gender nor age significantly moderated the association between SP or intrusiveness and social behavioral competence at home. Nor were there any significant associations between SP or intrusiveness and social behavioral competence at home.

Social cognition

A significant age interaction effect was found for the association between intrusiveness and social cognition. The relation between intrusiveness and social cognition was best described by including age as a moderator (Model 4 $p_{F\ \Delta R2}$ = .03, BF_{10} = 3.08; see also Figure 2). Bayesian analyses indicated substantial evidence for an age interaction effect. Post hoc probing showed that a lower level of intrusiveness was significantly associated with better social cognitive skills in older children (+2 *SD* β = .46, $p < .01$; +1 *SD* β = .29, $p < .01$), but not in younger children ($p > .05$). Gender did not significantly moderate the relation between SP or intrusiveness and social cognition. A main effect of SP was found. Higher SP was related to better social cognition in the whole age-range and this relation was similar for boys and girls (β = .16, $p = .03$).

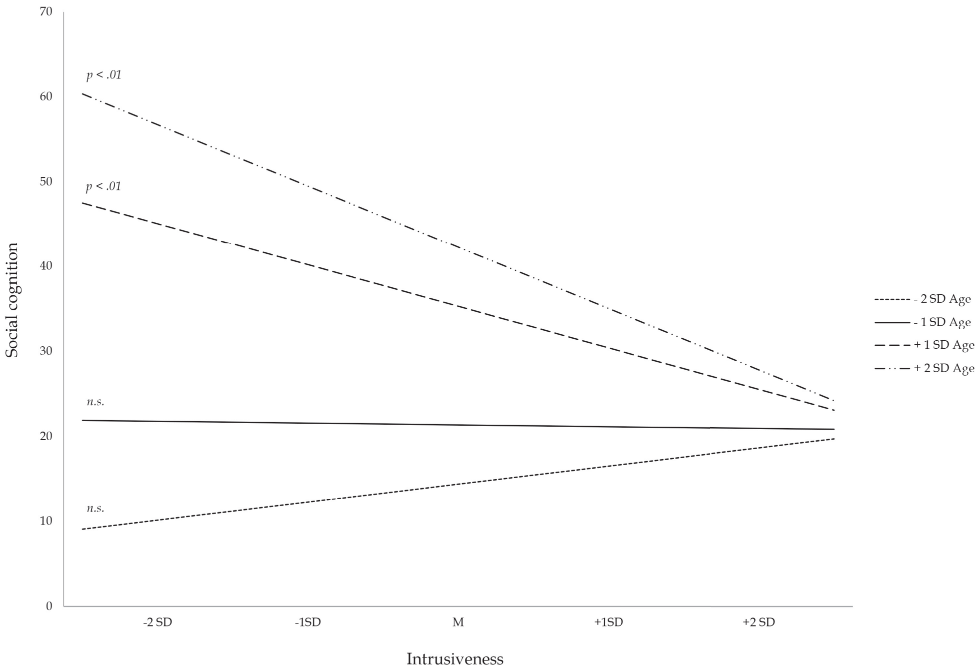


Figure 2. Moderation effect of age on the relation between parental intrusiveness and social cognitive competence.

Parental questioning style

Social behavioral competence at school

Models 2 to 5 were no significant improvement over Model 1 (all $p_{F\ \Delta R2} > .05$), suggesting that neither gender nor age significantly moderated the association between parental questioning style and social behavioral competence at school. Nor were there any significant main effects between parental questioning style and social behavioral competence at school.

Social behavioral competence at home

A significant three-way interaction was found for total questions when considering gender and age (Model 5 $p_{F\ \Delta R2}$ = .04, BF_{10} = 2.43). Bayesian analyses indicated anecdotal evidence for a gender by age interaction effect, but no substantial evidence for the absence of such an effect. Post hoc probing (see Figure 3) showed that only in younger girls, was having a parent who asks more questions related to better social behavioral skills at home (β = .60, p < .01). The lower-bound RoS was below -2 *SD* on questions (RoS = 3.06 – 0.52; see shaded region only at the high end of total questions in Figure 3), suggesting only the "for-better" side of the differential susceptibility model is supported; the exact opposite of the diathesis-stress model. No significant associations between social behavioral skills at home and open- versus closed- ended questions ratio score were found.

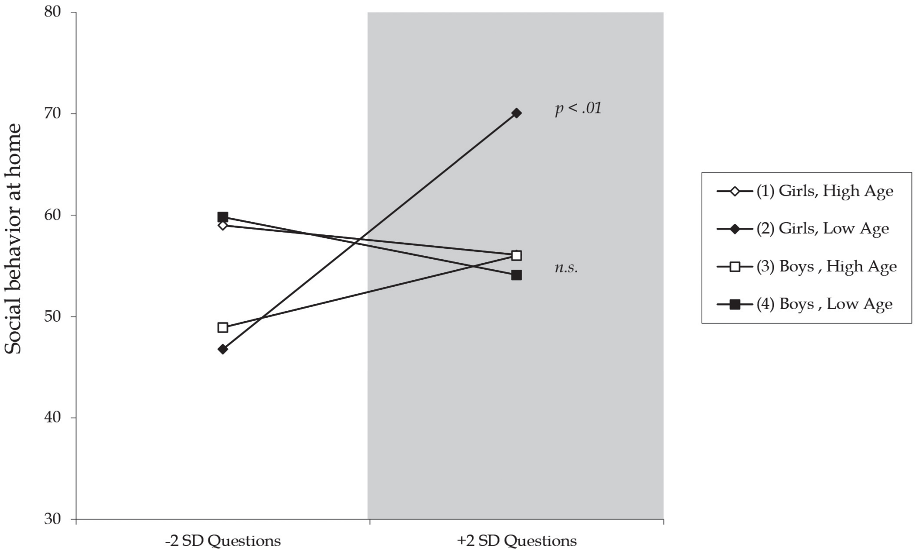


Figure 3. Three-way gender by age interaction effect on the relation between total questions asked and social behavioral competence at home. Gray shaded area denotes region where the lines significantly differ.

Social cognition

A significant gender interaction effect was found for total questions. The relation between the total amount of questions asked by parents and social cognition was best described by including gender as a moderator (Model 3 $p_{F\ \Delta R2}$ = .04, BF_{10} = 6.18). Bayesian analyses indicated substantial evidence for a gender interaction effect. Post hoc probing (see Figure 2) showed that asking fewer questions was only significantly related to poorer social cognition in boys (β = .29, p = .01). The upper-bound RoS was above +2 *SD* on questions (RoS = -0.17 – 16.93; see shaded region only at the low end of total questions in Figure 4), suggesting these results are consistent with the diathesis stress model. No significant associations between social cognition and open- versus closed-ended questions ratio score were found.

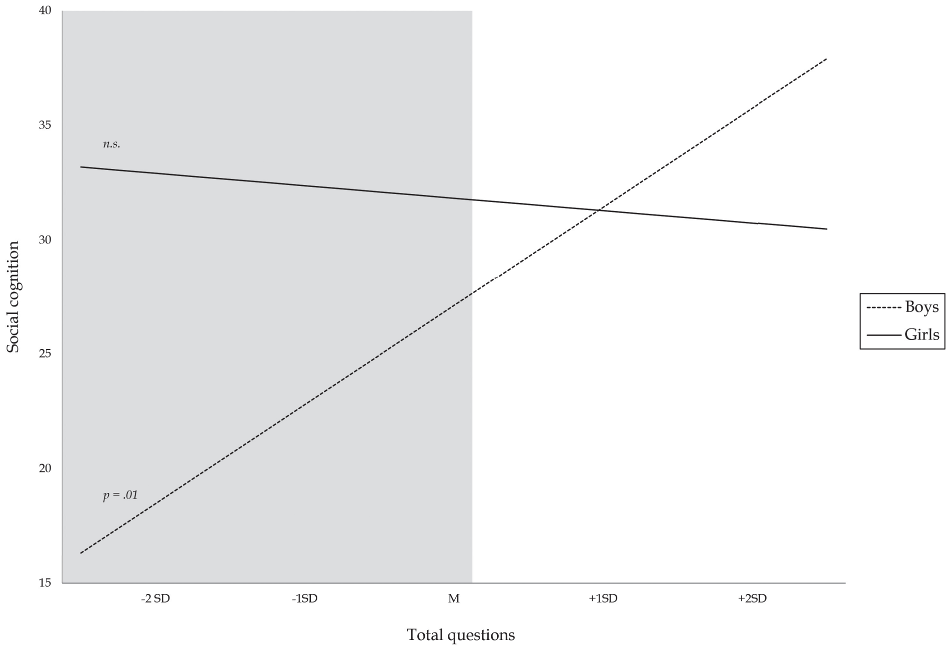


Figure 4. Moderation effect of gender on the relation between total questions asked and social cognitive competence. Gray shaded area denotes region where the two lines significantly differ.

Table 3. *Hierarchical regression analysis results of most parsimonious models for parental supportive presence and intrusiveness with aspects of child social competence.*

		Social Behavior						Social Cognition		
		School (n=89)			Home (n=91)			SCST total (n= 98)		
Independent variables		b (SE)	95% CI		b (SE)	95% CI		b (SE)	95% CI	
Supportive Presence			low	up		low	up		low	up
Intercept		41.53 (1.32)	38.83	44.16	53.03 (1.32)	50.42	55.69	27.14 (1.47)	24.26	29.94
M1	SP	1.92 (1.08)†	-.04	3.93	0.06 (1.13)	-1.95	2.17	2.51 (1.20)*	.38	4.59
	Age	-1.63 (1.17)	-4.17	.72	-1.44 (1.25)	-3.61	1.11	4.63 (1.32)***	1.96	7.29
	Gender	7.61 (2.00)***	3.76	11.26	4.82 (2.04)*	.81	8.50	3.72 (2.22)†	-.74	8.32
	Verbal ability	0.39 (0.13)**	.15	.64	0.24 (0.13)†	-.05	.50	0.48 (0.14)**	.18	.77
Adj. R^2 / Pred. R^2		.21 / .17			.06 / .02			.46 / .42		
ΔR^2 / $F \Delta R^2$		25 / 6.87***			.10 / 2.32†			.48 / 21.22***		
Intrusiveness										
Intercept		41.76 (1.30)	39.12	44.40	53.01 (1.31)	50.13	55.81	28.33 (1.83)	24.62	32.03
M1	I	-2.64 (1.08)*	-4.95	-.50	-0.80 (1.16)	-3.48	1.69	-2.84 (1.63)†	-6.05	.06
	Age	-1.24 (1.17)	-3.67	1.09	-1.34 (1.25)	-3.61	1.32	5.76 (1.38)***	2.56	8.53
	Gender	7.32 (1.96)***	3.49	10.97	4.82 (2.03)*	.72	8.62	3.43 (2.19)	-1.00	7.82
	Verbal ability	0.36 (0.12)**	.12	.60	0.24 (0.13)†	-.03	1.69	0.36 (0.15)*	.06	.71
M2	I^2							-0.74 (1.38)	-3.17	1.83
M3	I x Gender							1.92 (2.49)	-2.61	6.45
M4	I x Age							-2.15 (1.03)*	-3.87	-.52
Adj. R^2 / Pred. R^2		.24 / .19			.06 / .02			-.47 / .43		
ΔR^2 / $F \Delta R^2$		27 / 7.76***			10 / 2.45†			.02 / 4.39*		

Note Table 3. M1: first model with linear independent variable, age, gender and receptive verbal ability; M2: second model quadratic independent variable added; M3: third model adding linear interaction with gender; M4: fourth model adding linear interaction with age; M5: fifth model adding linear interaction age by gender and three-way interaction with age by gender. Variables marked with superscript 2s are curvilinear variables. Adjusted R_2 and predicted R_2 of the most parsimonious model is reported. ΔR_2: Change in R_2 in comparison with the previous model. $F \Delta R_2$: F for change in R_2 in comparison with the previous model. B: Unstandardized coefficient. SE: Standard error.
†p<.10; *p<.05; **p<.01;***p<.001.

Table 4. *Hierarchical regression analysis results of most parsimonious models for parental questioning style with aspects of child social competence.*

		Social Behavior						Social Cognition		
		School (n=89)			Home (n=91)			SCST total (n= 98)		
Independent variables		b (SE)	95% CI		b (SE)	95% CI		b (SE)	95% CI	
Total questions			low	up		low	up		low	up
Intercept		41.60 (1.34)	38.81	44.46	54.72 (1.51)	51.64	58.13	28.14 (1.68)	24.63	31.41
M1	Questions	-1.16 (1.35)	-3.58	1.66	0.20 (2.03)	-3.93	7.91	4.93 (2.07)*	.97	9.15
	Age	-1.86 (1.20)	-4.62	.76	-1.89 (1.47)	-4.39	.89	5.11 (1.36)***	1.90	8.38
	Gender	7.21 (2.02)***	3.21	11.06	3.24 (2.15)	-1.29	7.52	3.56 (2.07)	-.88	7.86
	Verbal ability	0.35 (0.13)**	.11	.60	0.27 (0.13)*	-.04	.53	0.49 (0.15)**	.20	.79
M2	Q^2				-1.29 (1.33)	-4.37	.40	-1.19 (1.11)	-3.38	1.27
M3	Q x Gender				2.75 (2.72)	-3.93	7.91	-5.55 (2.68)*	-10.70	-1.33
M4	Q x Age				1.55 (1.81)	-1.61	4.33			
M5	Age x Gender				1.55 (1.86)	-2.13	4.51			
	Q x Age x Gender				-4.72 (2.12)*	-8.92	-.93			
Adj. R^2 / Pred. R^2		.19 / .14			.13 / .07			45 / .41		
ΔR^2 / $F \Delta R^2$		.23 / 6.09***			.06 / 3.21*			.02 / 4.28*		

3

Table 4. Continued

		Social Behavior						Social Cognition		
		School (n=89)			Home (n=91)			SCST total (n= 98)		
Ratio open-closed										
Intercept		41.64 (1.35)	38.84	44.46	53.00 (1.30)	50.27	55.61	27.22 (1.50)	24.27	30.04
M1	Ratio	-0.14 (1.12)	-2.48	2.15	1.43 (1.10)	-.53	3.31	0.42 (1.24)	-2.05	2.71
	Age	-1.71 (1.20)	-4.43	.78	-1.43 (1.23)	-3.63	1.07	4.55 (1.35)**	1.65	7.61
	Gender	7.28 (2.03)***	3.42	10.98	4.80 (2.02)*	.60	8.64	3.51 (2.27)	-1.05	8.32
	Verbal ability	0.38 (0.13)**	.13	.64	0.24 (0.13)†	-.03	.48	0.45 (0.15)**	.13	.76
Adj. R^2 */ Pred.* R^2		.18 / .13			.07 / .04			.43 / .39		
ΔR^2 / $F \Delta R^2$		.22 / 5.86***			.12 / 2.79*			.45 / 19.27***		

Note. M1: first model with linear independent variable, age, gender and receptive verbal ability; M2: second model quadratic independent variable added; M3: third model adding linear interaction with gender; M4: fourth model adding linear interaction with age; M5: fifth model adding linear interaction age by gender and three-way interaction with age by gender. Variables marked with superscript 2s are curvilinear variables. Adjusted R^2 and predicted R^2 of the most parsimonious model is reported. ΔR^2: Change in R^2 in comparison with the previous model. $F \Delta R^2$: F for change in R^2 in comparison with the previous model. B: Unstandardized coefficient. SE: Standard error.
†$p<.10$; *$p<.05$; **$p<.01$;***$p<.001$.

DISCUSSION

The aim of the current study was to investigate whether aspects of parenting strategies, i.e. supportive presence, intrusiveness and questioning style, are associated with child social competence during the early school years and to what extent (1) these parental strategies mediate the relation between gender and social competence, in line with a differential socialization model; and (2) whether gender and age moderate the relation between parenting strategies and social competence, distinguishing between the differential susceptibility and diathesis stress models. This study showed that parenting strategies did not mediate the relation between gender and social competence, suggesting gender differences in social behavioral competence could not be explained by differential socialization of boys and girls. Social behavioral competence at school was related to intrusiveness and social cognition was related to supportive presence, while controlling for verbal ability. Gender moderated the association between the amount of questions asked by parents and children's social cognition. Only boys of parents who asked fewer questions showed lower levels of social cognition, in line with the diathesis-stress model. Furthermore, only in older children, lower levels of intrusiveness were related to better social cognition, and only in younger girls, having a parent who asks more questions was related to better social skills at home.

Differential socialization

The gender differences in social behavioral competence could not be explained by parental differential socialization as far as parental sensitivity or questioning style are concerned. Parents did not interact with their sons and daughters in a different way. It was expected that gender-differentiated parenting would only be true for some, but not all parenting strategies that have been associated with social competence. In particular, we hypothesized that parents would ask more questions to their daughters than to their sons, in line with the meta-analysis by Leaper et al. (1998), which we could not confirm. Even though differential socialization of sons and daughters has not been consistently found in meta-analyses, all concluded that gender differences in parenting decrease with age (Endendijk et al., 2016; Leaper et al., 1998; Lytton & Romney, 1991). For instance, differential verbal socialization was especially apparent in mothers of toddlers, compared to mothers of school-aged children (Leaper et al., 1998). Similarly, differential socialization in emotion talk was only found in four-year-olds and not six-year-olds (Aznar & Tenenbaum, 2015), suggesting differential socialization by parents may change with age. In this study, a somewhat older age-range of four- to eight-year-old children was studied. Even though differential socialization may influence social competence during early childhood, based on this study we might conclude that after age four, gender differentiated parenting appears to diminish with respect to sensitivity and questioning style.

Diathesis-stress or differential susceptibility

Higher levels of parental support were significantly related to better social cognitive skills in their children and tended to relate to better social behavioral skills at school. Higher levels of parental intrusiveness were significantly related to worse social behavioral skills at school in their children. These findings are in line with previous studies, suggesting that parental sensitivity is linked to the development of social competence (e.g. Barnett et al., 2012; Lengua et al., 2007; Spinrad et al., 2007). It was hypothesized that the relative influence of parenting on social competence would decrease with age, in line with the diminished need for structure as children start school, which we could not confirm. Surprisingly, lower levels of intrusiveness were only related to better social cognition in older children, suggesting that how intrusiveness matters in relation to social cognition varies with age. This is consistent with the findings of Landry and colleagues (2000) in a slightly younger sample, who showed that parents providing verbal structure had a positive effect on cognitive and social development, but that this effect reversed after age four. Perhaps children still require some structure from their parents with regard to more sophisticated developmental tasks, such as self- and third party perspective taking, even after they have started school. As such, higher levels of intrusiveness may be an appropriate parenting strategy with regard to social cognition in younger children, while lower levels of intrusiveness become more adaptive as children age. In contrast with our hypothesis, these associations were not stronger for boys. Studies reporting stronger associations between parental sensitivity and social competence in boys generally focus on the early childhood years (for a review, see Bornstein, 2005). As the relation between parenting and child behavior changes with age (Bradley et al., 2015) and individual differences in environmental susceptibility may vary with age (Ellis et al., 2011), this finding may be due to the somewhat older four- to eight-year-old age range in the current study. Rather, our data suggest that during the early school years, parental sensitivity may be related to child social competence irrespective of gender.

In line with a diathesis-stress model, worse social cognitive skills in boys were related to parents asking fewer questions. This is consistent with research on the development of child behavioral problems, suggesting boys are more vulnerable to adverse parenting effects than girls (e.g. Barnett & Scaramella, 2013; Calkins, 2002; Crick & Zahn-Waxler, 2003). Surprisingly, the gender by age interaction effect found in this study was only partially consistent with the differential susceptibility model and the exact opposite of the diathesis stress model. Only in younger girls was having a parent who asks more questions related to better social skills at home. In other words, only the "for-better" side of the differential susceptibility model was supported. Rather than parental questioning style protecting young girls from showing worse social behavioral skills, this suggests that girls functioned better than younger boys when parents asked more questions. This opposite of vulnerability has been described as vantage sensitivity (Manuck, 2011), suggesting girls may have an advantage to thrive under optimal parenting conditions compared to boys. However, Bayesian analyses did not indicate clear evidence for a gender by age interaction effect nor for the absence of such an effect, which suggests that longitudinal studies are better equipped to disentangle these associations. Parents asking more questions to their children may represent an overall better parental verbal ability, an increased awareness of the importance of having rich verbal communication with their child, or more encouragement of their children's learning. Even though parental questioning style was not significantly associated with parents' educational level in this study, parents were less likely to have a low educational attainment. Based on our study we cannot conclude with any certainty the rationale behind parents' questioning style and believe this to be a potential avenue for further research.

Even though the gender by age interaction effect seems counterintuitive, as relations were expected to be stronger for boys (Leaper, 2002), they may be explained by a transactional model of parent-child interaction, indicating a reciprocal relation between child behavior and parenting strategies (Sameroff, 2009). Parental questioning style may stimulate the development of social competence, but more socially competent children, and in particular girls, may also evoke more questions from parents because they are more responsive and cooperative (Barnett et al., 2012). Due to the cross-sectional nature of the current study, no definite answer on causality in these associations can be given. Perhaps parents who perceive their daughters as more social ask them more questions than they ask their sons, as overall parents rated their daughters as more social than their sons. This would be substantiated by the finding in this study that teachers also rated girls as being more socially competent, but that there were no gender differences in the association between parental questioning style and social behavior at school. Although speculative, this would suggest the nature of this relation relies more on how parents perceive their daughters than on how their questioning style influences their child's social behavior.

Nonetheless, these findings support the idea that only some aspects of parenting strategies have a differential effect on the development of social competence of boys and girls. More specifically, only parents' questioning style and not aspects of parental sensitivity seems to have gender-differentiated associations with social competence in young school-aged children. Furthermore, these findings underscore the importance of formally testing moderation effects when distinguishing the differential susceptibility model from the diathesis-stress model (Roisman et al., 2012). Drawing conclusions based on visual inspection of the interaction plots may have led to the false assumption that data were consistent with the differential susceptibility model.

Strengths and limitations

Several limitations of the current study need to be acknowledged. Parents may have acted differently than their usual self during the joint-activity tasks as a consequence of being videotaped. However, due to the relatively natural observation conditions in the home, it is unlikely that the nature of the interactions was considerably misrepresented (Gardner, 2000). Secondly, in the current study it was impossible to differentiate between fathers' and mothers' interactive style due to low occurrence of participating fathers (10%), possibly obscuring parental gender effects on differential socialization. Thirdly, children from only two Dutch schools in the same provincial region participated in this study, which may limit the generalizability of our findings. In addition, the current sample did not accurately represent families from a lower educational background, as the number of parents with a low educational level was underrepresented (7.5% compared to expected 33.6 % in Dutch 25-45-year-olds; Central Bureau for Statistics [CBS], 2013). Fourthly, several relatively complex analyses were conducted using a modest sample size. However, cross-validation by examining confidence intervals based on 5000 bias-corrected bootstraps, comparing predicted R^2 values with adjusted R^2 values to avoid overfitted models, and Bayesian analyses raised no major concerns. Finally, the current study assessed associations between parental strategies and child social competence cross-sectionally, and no inferences concerning developmental changes within children or causality can be made.

Strengths of this study include the use of multiple well-validated social competence measures and the use of different informants. Moderation effects were thoroughly investigated and controlled for nonlinearity of effects as recommended by Roisman et al. (2012). Verbal ability was also controlled for in this study, indicating our findings are not due to gender differences in language skills. Furthermore, observed parenting behaviors were coded objectively and included aspects of parental sensitivity as well as parent-child verbal interaction.

In sum, our results indicate that parent-child questioning style and not aspects of parental sensitivity seems to have gender-differentiated associations with social competence in school-aged children, while parents do not treat their sons and daughters differently at this age. In boys, asking fewer questions was associated with worse social cognitive skills, in line with a diathesis-stress model. These findings suggest opportunities to educate parents to be more supportive in general, become less intrusive as their children mature and to ask more questions, especially to their sons, which may enhance social competence. Furthermore, our findings underscore the importance of formally testing moderation effects as well as testing for nonlinearity to avoid misleading interactions (Ganzach, 1997; Holmbeck, 2002; Roisman et al., 2012). For instance, drawing conclusions based on visual inspection of the interaction plots instead of probing interaction effects may lead to false assumptions which may seriously hinder the interpretation of study results. Future studies assessing moderation effects should also consider curvilinear effects and post hoc probing before interpreting their results.

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APPENDIX

Bootstrapping analyses

Table 1. *Bootstrapping analyses results with parenting strategies as a mediator in the relation between gender and social competence.*

	Social behavior at school (n=89)			Social behavior at home (n=91)			Social cognition (N=98)		
		95% CI			95% CI			95% CI	
Mediator	*b (SE)*	Lower	Upper	*b (SE)*	Lower	Upper	*b (SE)*	Lower	Upper
Total effect	7.28 (2.02)***	3.26	11.29	4.81 (2.02)*	.79	8.84	3.47 (2.26)	-1.01	7.95
Age	-1.71 (1.19)	-4.07	.65	-1.44 (1.24)	-3.90	1.02	4.57 (1.34)**	1.90	7.24
Verbal ability	.38 (.13)**	.13	.63	.24 (.13)	-.02	.50	.45 (.14)**	.16	.74
Supportive presence (SP)									
Direct effect Gender - SP	-.17 (.20)	-.57	.23	-.07 (.19)	-.46	.32	-.10 (.19)	-.48	.28
Direct effect Gender - SC	7.61 (2.00)***	3.63	11.59	4.82 (2.04)*	.77	8.89	3.72 (2.22)	-.69	8.13
Indirect effect (mediation)	-.34 (.48)	-1.88	.27	< -.01 (.23)	-.60	.42	-.25 (.54)	-1.84	.52
Intrusiveness (I)									
Direct effect gender - I	.01 (.20)	-.38	.41	<.01 (.19)	-.37	.38	.02 (.18)	-.34	.38
Direct effect gender - SC	7.32 (1.96)***	3.41	11.22	4.82 (2.03)*	.78	8.85	3.52 (2.22)	-.89	7.92
Indirect effect (mediation)	-.04 (.56)	-1.28	1.08	< -.01 (.27)	-.61	.55	-.05 (.50)	-1.13	.95
Total questions (TQ)									
Direct effect gender - TQ	-.06 (.16)	-.39	.26	-.05 (.17)	-.37	.28	-.05 (.16)	-.37	.27
Direct effect gender - SC	7.21 (2.02)***	3.26	11.29	4.87 (2.03)*	.83	8.90	3.56 (2.25)	-.91	8.03
Indirect effect (mediation)	.07 (.30)	-.28	1.12	-.05 (.33)	-1.07	.40	-.08 (.36)	-1.15	.44
Ratio questions (RQ)									
Direct effect gender - RQ	<.01 (.20)	-.39	.39	<.01 (.20)	-.38	.40	-.08 (.19)	-.46	.29
Direct effect gender	7.28 (2.03)***	3.24	11.32	4.80 (2.02)*	.80	8.81	3.51 (2.27)	-1.00	7.95
Indirect effect (mediation)	<.01 (.24)	-.53	.55	.01 (.35)	-.67	.81	-.04 (.26)	-.82	.30

Note. Results based on 5000 bootstrapped samples. SC = Social competence (dependent variable). 95% CI = bias-corrected and accelerated confidence intervals, with **p* <.05 when range lower-upper CI does not include zero.

CHAPTER 4

Educating parents to improve parent-child interactions: Fostering the development of attentional control and executive functioning

Based on Andrea M. Spruijt, Marielle C. Dekker, Tim B. Ziermans & Hanna Swaab

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ABSTRACT

Parent child interaction is essential in the development of attentional control (AC) and executive functioning (EF). Educating parents in AC and EF development may help them to respond more adaptively to their child's developmental needs. The aim of this study is to investigate whether parents can be educated to improve interactions with their child through a compact psycho-educational program that focuses on fostering the development of AC and EF. Parents and their children in a low-risk sample of four- to eight-year-olds were randomly assigned to either the educational program condition (N = 34) or the control condition (N = 36). Parental supportive presence and intrusiveness were observed during home visits and children's performance-based AC and EF were assessed before and after the four-session educational program. Parents in the educational program improved significantly in supportive presence (ηp^2 = .19) and intrusiveness (ηp^2 = .09) compared to controls. There was no short-term educational program mediation effect on child AC and EF through parental support and intrusiveness. This study showed, however, that only within the educational program condition, supportive presence and intrusiveness were significantly associated with AC and EF at post-test. Furthermore, parents who improved on support after the educational program had children who improved on AC and EF. Parental supportive presence and intrusiveness can be enhanced by using a compact educational program. Future studies should aim at examining variations in educational program responsiveness and assessing the associations between these parenting strategies and AC and EF over time.

Keywords: Parent educational program; Supportive presence; Intrusiveness; Attentional control; Executive functioning; School-aged children

The manner in which parents interact with their children influences their development and their school success (e.g. Englund, Luckner, Whaley, & Egeland, 2004; Trivette, Dunst, & Hamby, 2010). Parenting educational programs initially focused mainly on high-risk families, but more recently, programs also aim to optimize conditions for child development through the involvement of parents regardless of risk status (Ailincai & Weil-Barais, 2013). The educational challenge of these kind of programs is to make parents aware of their own behavior and help them realize their influence on the behavior of their children. The aim of the current study is to investigate whether parents can be educated to improve the interactions with their child through a compact psycho-educational program that focuses on fostering the development of executive functions (EF) and attentional control (AC).

Fostering the development of EF and AC in young children has received increasing attention in recent years (Bierman & Torres, 2016). EF are adaptive neurocognitive processes fundamental to problem-solving that enable us to plan, guide and control goal-oriented behavior (Best, Miller, & Jones, 2009; Garon, Bryson, & Smith, 2008). There is general agreement that the three core EF components inhibition, working memory and cognitive flexibility are interrelated, but can be distinguished reliably (e.g. Miyake et al., 2000). These core EFs share a common underlying mechanism, often referred to as effortful attentional control. AC is intertwined with EF as an ongoing process essential for EF development (Garon et al., 2008). AC entails both the ability to actively focus on one thing without being distracted, known as focused attention, and the ability to maintain attention over prolonged periods of time, or sustained attention (Cohen, 2014). As both AC and EF have repeatedly been linked to the quality of development and the functioning in many important aspects of life, such as school performance, health, and job success (For a review, see Diamond, 2013), policy makers and practitioners recognize the relevance of preventive interventions targeting AC and EF development.

During the transition from dependence to greater autonomy, young children's AC and EF development is influenced by the relationship with their parents and the conditions in their caregiving environment (Bernier et al., 2012; Diamond, 2013; Fox & Calkins, 2003). Parent-child interaction is essential in the development of AC and EF, as adequate parenting provides support and external regulation in order for children to practice and internalize self-regulatory skills (Fox & Calkins, 2003; Giesbrecht, Muller, & Miller, 2010; Kopp, 1982; Sigel, 2002). As children grow up and increasingly seek out greater autonomy, many parent-child interactions can be marked as either supportive or controlling (Fox & Calkins, 2003). Supportive parenting requires parental understanding of these changing developmental needs during the preschool years (Landry et al., 2008). However, achieving this understanding may be a difficult process for some parents. For instance, in one study only 25% of mothers from a low socio-economic background showed relatively stable high levels of sensitive responsiveness to their child's signals and another 25% even decreased dramatically between infancy and the preschool period (Landry, Smith, Swank, Assel, & Vellet, 2001).

Adequate parenting strategies, characterized by parents' ability to perceive and respond to their children's signals including attempts to support their child's need for independence, may foster the development of self-regulation. Indeed, parental support and intrusiveness have repeatedly been linked to the development of AC and EF in young children (e.g. Bernier, Carlson, & Whipple, 2010; Clark & Woodward, 2015; Cuevas et al., 2014; Fay-Stammbach, Hawes, & Meredith, 2014; Gaertner, Spinrad, & Eisenberg, 2008; Kraybill & Bell, 2013; Mathis & Bierman, 2015; Spruijt, Dekker, Ziermans, & Swaab, 2018; Sulik et al., 2015). Parental support refers to reassuring and supportive caregiving, while intrusiveness refers to lack of autonomy support or negative and controlling parenting (Dotterer, Iruka, & Pungello, 2012). While parent interventions aimed to improve school readiness (e.g. social cooperation, vocabulary) often include promoting supportive and non-intrusive parenting (For a review, see Welsh, Bierman, & Mathis, 2014), the effects of this type of intervention on child AC and EF development have not yet been examined.

Based on a growing body of neurodevelopmental research suggesting that self-regulation skills develop rapidly between ages four and eight (Best & Miller, 2010), a wide variety of preventive child interventions promoting AC and EF skills in young children has emerged over the last decade that show somewhat encouraging results. However, transfer to academic learning is often absent (e.g. Bergman Nutley et al., 2011; Dowsett & Livesey, 2000; Thorell, Lindqvist, Bergman Nutley, Bohlin, & Klingberg, 2009). Programs aimed at improving classroom quality and teacher-child relationships have shown more promising results, including positive effects on academic learning and AC and EF skills (e.g. Dias & Seabra, 2017; Raver et al., 2011). For instance, in a study by Raver and colleagues (2008), teachers in the intervention condition scored higher on sensitivity and showed higher levels of positive classroom climate than controls, suggesting that improving teacher-child interactions can promote self-regulation skills and academic performance in young children. These kinds of programs are often aimed at high-risk low-income samples, and therefore we do not yet know whether the effects are also generalizable to low-risk samples. Nonetheless, these findings are in line with the notion that high quality caregiving promotes the development of AC and EF skills in young children (Bernier, Carlson, Deschenes, & Matte-Gagne, 2012). As such, it is surprising that hardly any parenting programs aimed at improving AC and EF development have been explored.

Whether and how much parents can facilitate the development of self-regulation in their children warrants further study (Bierman & Torres, 2016; Diamond, 2013). Regardless of the type of intervention, repetition appears to be essential for the best results (For a review, see Diamond, 2013). For instance, school curricula successful in promoting self-regulatory skills, involved repeated practice throughout the day and not just during one module (e.g. Diamond, Barnett, Thomas, & Munro, 2007; Raver et al., 2008; Riggs, Greenberg, Kusché, & Pentz, 2006). This suggests that educating parents to implement self-regulatory skills practice during daily routines outside the school setting, could be a valuable asset in promoting the development of AC and EF on a more regular basis. Interventions have shown the best results when self-regulatory skills were continually challenged with increasing demands, adaptive to the child's age and ability (e.g. Bergman Nutley et al., 2011; Holmes, Gathercole, & Dunning, 2009). Parents may become more involved in their children's learning when they are educated about how their child reasons and learns (Gleason & Schauble, 1999). In this sense, parents educated in AC and EF development may be better equipped to recognize their child's level of competence and facilitate AC and EF development by adaptively challenging their child's self-regulatory skills. With this increased parental understanding of their child's developmental needs, parents may thus be better able to perceive and supportively respond to their child's signals.

The Curious Minds parent educational program focuses on educating parents on how to support and scaffold the development of cognitive, social-emotional and self-regulatory skills necessary for adaptive behavior and learning while interacting with their child. The aim of the program is twofold: (1) to educate parents about their child's AC and EF developmental needs; and (2) to educate parents through home-assignments how they can stimulate AC and EF development as well as explorative behavior and reasoning abilities through interaction that is sensitive to their child's developmental needs. A major objective of this study is to examine whether the Curious Minds parent educational program is able to improve parental support and intrusiveness, which have been shown to have a positive impact on children's AC and EF. We hypothesized that parents in the educational program condition would show greater improvements in parental support and intrusiveness than controls. We expected associations between parenting strategies and child AC and EF to increase after the educational program, as parents will have become more aware of their own behavior and have tuned their strategies to their child's needs. Additionally, we investigated whether parental support and intrusiveness would mediate the association between the educational program condition and the children's AC and EF performance after finishing the program, and hypothesized a significant mediation effect. Furthermore, we hypothesized that parents within the educational program condition whose interaction with their child improved most, had children who also improved most on AC and EF.

METHOD

Participants

The current study is embedded within the Curious Minds program: a longitudinal program investigating the development of executive and social functioning in primary school-aged children in the Netherlands and evaluating the effects of a parent and a teacher educational program (approved by the Ethical Board of the department of Education and Child Studies at Leiden University (ECPW-2010016)).

Parents of 138 4- to 8-year-old children (M = 6.26 years, SD = 1.19, 55.1% male) from the lowest four grades of two Dutch primary schools (pre-school to second grade in USA school system), from towns that are part of the Rotterdam-The Hague Metropolitan Area were eligible for this particular study and signed an informed consent letter. The current study uses observational data of parents' interactive behavior with their child collected during a home visit and child, computer-based neurocognitive measures of AC and EF. Children were randomly assigned to either the parent educational program condition (EPC) or the control condition (CC). Participants were included in analyses when their parents had agreed to home visits, when parents attended at least two group sessions (EPC only), and when complete pre- and post-test data were available.

Parents of 99 out of the 138 eligible children agreed to both home visits (response = 71.7%). Participants whose parents agreed to home visits did not significantly differ from those who did not agree to home visits on the background variables: age, gender, school, grade, or prevalence of referral to mental health care in the past year; nor did their parents significantly differ on single parenthood status or parental education (all p > .05). Participants in the EPC who missed all (N = 18) or three out of four (N = 5) sessions were excluded from analyses and also did not significantly differ from those who remained in the EPC on any of the background variables (all p > .05). The final sample size for analysis (*N* = 70) consisted of 34 children in the EPC and 36 in the CC. For detailed sample characteristics, see Table 1.

Table 1. *Participant characteristics and descriptive statistics variables of interest.*

Educational program analysis	Total (*n*=70)	EPC (*n*=34)	CC (*n*=36)	*p*
Age in months at T1 (*M* (*SD*))	76.25 (14.49)	76.56 (14.89)	75.97 (14.32)	.87
Sex (%male)	55.71	47.06	63.88	.16
Parental education[b]				.91
High (%)	44.77	43.75	45.71	
Medium (%)	47.76	50.00	45.71	
Low (%)	7.46	6.25	8.57	
Single parenthood (%)	4.48	6.25	2.86	.60
Referral to mental health care past year (%)	7.46	6.25	8.57	.72
Parental sensitivity T1[c]				
Supportive presence (*M* (*SD*))	3.94 (1.52)	3.88 (1.61)	4.00 (1.44)	.61
Intrusiveness (*M* (*SD*))	3.73 (1.44)	3.62 (1.41)	3.83 (1.47)	.73
Child factors T1				
Attentional control (*M* (*SD*))	.28 (2.22)	.37 (2.47)	.20 (1.98)	.76
Executive functioning (M (SD))	.31 (1.91)	.38 (1.80)	.25 (2.04)	.78
Principal component analysis[d]	**Total (*n*=225)**			
Age in months at T1 (*M* (*SD*))	73.53 (14.65)			
Sex (% male)	54.22			
Parental education[a]				
High (%)	49.04			
Medium (%)	46.15			
Low (%)	4.81			
Single parenthood (%)	5.30			
Referral to mental health care past year (%)	7.96			

[a]Background information was missing for *N*=17 children due to non-response on parent questionnaires. [b]Background information was missing for *N*=3 children due to non-response on parent questionnaires. [c]Original values before standardization. [d]See Appendix. EPC=Educational program condition; CC=Control condition.

Procedure

Pre-test baseline data were collected in the period between November 2013 and February 2014 (school 1) and between May and June 2014 (school 2). Post-test data were collected in the period between June and July 2014 (school 1) and between January and February 2015 (school 2). Computer-based performance tasks were administered during an individual test session of approximately 60 minutes in a separate quiet room at the child's school. Tests were administered by two trained junior investigators or by one of the senior investigators. Children were rewarded for participation with a small token of appreciation after the test session.

Curious Minds educational program

The content of the educational program was inspired by the Vygotskian principles of the Tools of the Mind curriculum for pre-school children (Bodrova & Leong, 2007; Diamond et al., 2007), which focuses on supporting and scaffolding the development of cognitive, social-emotional and self-regulatory skills necessary for adaptive behavior and learning using a familiar adult in a real-life setting as a change agent. The program was provided by a skilled clinical neuropsychologist specialized in child and adolescent neurodevelopment after all baseline assessments were completed, and consisted of four, monthly group sessions of approximately two hours each at the child's school. The caregiver of each child who also participated in the home visits was asked to attend the group sessions.

During each session, the focus was on a specific (neuro)cognitive mechanism, for which parents received basic information about the brain-behaviour developmental course at specific ages, using everyday examples of parent-child interaction. Parents also received a workbook summarizing information about development, as well as matching home assignments following each session to enhance the learning experience of parents. These home assignments were discussed during the following session, allowing parents to learn from the educator's feedback and each other's day-to-day experiences. For a more detailed description per session, see Table 2.

Measures

Demographic characteristics

Parents filled out a complementary background information questionnaire, using the online survey software Qualtrics (http://www.qualtrics.com/). The highest completed level of education was used as an indicator of educational attainment according to the Dutch Standard Classification of Education (SOI) which is based on UNESCO's International

Table 2. *Description of the discussed topics and home assignments per session of the Curious Minds educational program.*

Session	***Main theme***	***Home assignments***
Session 1	How children learn and process new information, how this is regulated through AC and EF and how parents can help their child explore new topics in more depth by being more supportive, less intrusive and by asking questions.	e.g.: - Do science experiments with soap bubbles - Think outside the box by imagining as many different uses for a paperclip as possible. - Play sensory games, such as touching and tasting different types of food while blindfolded.
Session 2	Teaching parents how to stimulate specific aspects of AC and EF while interacting with their child. Discussion of home assignments session 1.	e.g.: - Tell two different stories to your child simultaneously, while your child focuses on one of the stories, and ask questions afterwards about its content (targeting ***attention***). - Play the game ***Yes and no are forbidden***: trick your child into answering questions with 'yes' or 'no (targeting ***inhibition***). - Play the ***Going on a trip*** game: alternately add an item to the sentence 'I am going on a trip and I am going to pack…', after recalling all items that have been mentioned (targeting ***working memory***). - Let your child come up with alternative plans when a playdate is suddenly cancelled, and observe whether your child is able to flexibly change plans (targeting ***cognitive flexibility***).
Session 3	Teaching parents how to stimulate emotion regulation and social cognition while interacting with their child. Discussion of home assignments session 2.	e.g.: - Practice and discuss a range of facial emotion expressions in front of the mirror. - Observe and address your child's emotional reactions during daily interaction and describe the reactions. - Discuss several short, illustrated stories (e.g. ***How does Billy feel when he's not allowed to play with the other kids? How do you know?***) - In a naturally occurring situation, explain why it is important to place yourself in someone else's shoes (i.e. perspective taking), using questions.
Session 4	Recap of sessions 1 through 3; parents were free to discuss what they had learned and ask additional questions. Discussion of home assignments session 3.	There were no home assignments following session 4.

Standard Classification of Education (ISCED) ("SOI 2003 (Issue 2006/'07),"): 1. primary education (SOI level 1 to 3; at most vocational training); 2. Secondary education (level 4 of SOI); and higher education (level 5 to 7 of SOI; bachelor's degree or higher). Single parenthood status was defined by not having the child's other parent or a new caregiver living in the same household. Mental health care referral was assessed by asking parents whether their child had been referred, examined or treated for emotional and behavioral problems in the past year.

Parental support and intrusiveness

The parent's interactive behavior with the child was videotaped at pre- and post-test home visits during two joint activity tasks. These tasks consisted of a combining task and a sorting task of approximately five to ten minutes each, both based on tasks designed by Utrecht University (Corvers, Feijs, Munk, & Uittenbogaard, 2012). The videotapes were coded afterwards for level of parental supportive presence and intrusiveness using the revised Erickson 7-point scale for Supportive Presence and Intrusiveness (Egeland, Erickson, Clemenhagen-Moon, Hiester, & Korfmacher, 1990). A parent scoring high on Supportive Presence is reassuring when the child is experiencing difficulty with the task and gives emotional support to the child. A parent scoring high on Intrusiveness lacks respect for the child's autonomy and does not acknowledge the child's intentions or desires (For detailed task and coding descriptions, see Spruijt et al., 2018)).

Attentional control and Executive Functioning

AC and EF were measured with several neuropsychological tasks from the Amsterdam Neuropsychological Tasks (ANT, version 2.0), assessing focused and sustained attention, inhibition, working memory and cognitive flexibility. The ANT is a well-validated computerized test battery (De Sonneville, 2005; 2014). The ANT has been used extensively in both clinical and non-clinical populations and contains widely used paradigms such as the Go/No-Go paradigm, that has shown good test and test-rest reliability (r =0.84) in adults (Wostmann et al., 2013) and comparable paradigms have also shown adequate test-retest stability in children (Kindlon, Mezzacappa, & Earls, 1995), as well as the Hearts and Flowers paradigm which has been validated for children as young as four years old (Davidson, Amso, Anderson, & Diamond, 2006; Diamond et al., 2007). All computer tasks were preceded by instructions and practice trials (For detailed task descriptions, see Appendix, Table 1 and Spruijt et al., 2018)).

Data analyses

Data were analyzed using IBM SPSS version 23. Demographic characteristics for both schools and conditions were compared with chi-square tests, independent t-tests and Fisher exact tests. Principal component analysis was conducted on the pre-test ANT data of the larger Curious Minds sample (N = 225) to form coherent and relatively independent subsets of variables to reduce the number of observed ANT variables to a smaller number of components (see Appendix).

The educational program effect on post-test parental support and intrusiveness was assessed using ANCOVA controlling for their corresponding pre-test values. Partial correlations were calculated to explore whether the associations between parenting strategies and AC and EF components differed for the EPC and CC and whether these associations changed after the educational program. The educational program effect on AC and EF components through mediation by supportive presence and intrusiveness was assessed using bootstrapping, a nonparametric resampling procedure (Hayes, 2009). Bootstrapping with 5000 resamples was done to test for significant indirect effects using the SPSS macro developed by Preacher and Hayes (2009). Pre-test values and age were controlled for in all analyses. Post hoc regression analyses with sensitivity change scores within the EPC were conducted to assess whether especially those parents who improved after the program on supportive presence and intrusiveness had children who improved on AC and EF. Change scores were calculated by subtracting pre-test from post-test scores and reversing the intrusiveness change score. For all significant effects, partial η^2 addressed effect size (0.04 = small effect; 0.25 = moderate effect; 0.64 = strong effect (Ferguson, 2009). Alpha for significant effects was set at $p \leq .05$.

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RESULTS

Sample characteristics and descriptive statistics for the variables of interest are displayed in Table 1. Participants in the EPC did not significantly differ in age, gender, school, grade, single parenthood status, parental education or prevalence of referral to mental health care in the past year from those in the CC. Neither did they differ on level of *AC* or *EF* at pre-test (all p > .05).

Curious Minds educational program effects

Parent-child interaction

At post-test, parents in the EPC scored significantly higher on support (η_p^2 = .19), showing a small to moderate effect size, and lower on intrusiveness (η_p^2 = .09), a small effect, than parents in the CC, while controlling for pre-test parenting scores (see Table 3 and Figure 1).

Table 3. *Analysis of covariance (ANCOVA) results comparing educational program and control condition on parenting strategies at posttest, controlling for corresponding pre-test score.*

	EPC *M (SD)*	CC *M (SD)*	*F (df)*	η_p^2	*p*
Parenting strategies					
Supportive presence	.26 (.94)	-.32 (.92)	15.87 (67)	.19	<.001
Intrusiveness	-.24 (.87)	.28 (.96)	6.42 (67)	.09	.01

Note. M: Mean. ***SD:*** Standard deviation. η_p^2: Partial eta squared. EPC=Educational program condition; CC=Control condition.

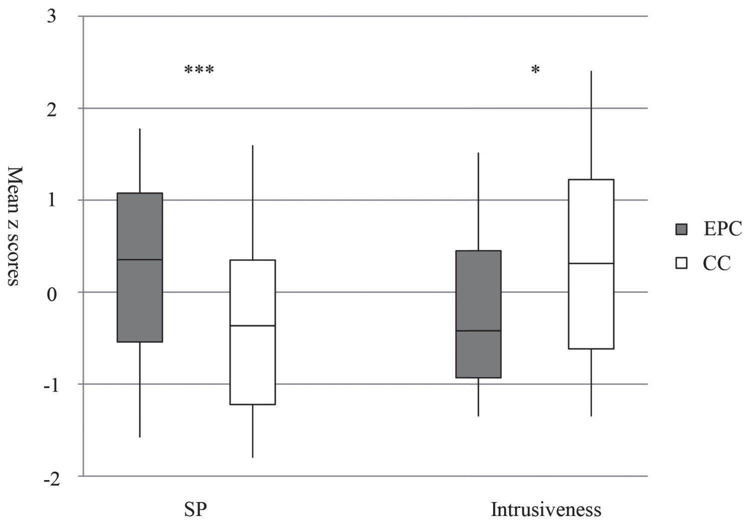

Figure 1. Educational program effect at post-test on parental supportive presence and intrusiveness for the Educational program condition (EPC) and Control condition (CC), controlled for pre-test values.

Parent-child interaction with AC and EF: differential associations between conditions

We explored whether the associations between parenting strategies and AC and EF components differed for the EPC and CC and whether these associations changed after the educational program. At pre-test, parental support and intrusiveness were not associated with child *AC* and *EF* components (see Table 4). At post-test however, support and intrusiveness of parents in the EPC were significantly associated with child *AC* and *EF* components. No such associations were found in the CC.

Mediating effect of parent-child interaction on AC and EF

Next, we investigated whether the educational program produced a short term effect on child *AC* and *EF*, mediated by support and intrusiveness. Even though regression coefficients between EPC and both parental support and intrusiveness were significant, standardized indirect effects for *AC* and *EF* were non-significant (see Table 5). This indicates that support and intrusiveness did not act as a significant mediator between EPC and *AC* and *EF.*

Differential effects within the educational program

Within the EPC, regression analyses showed that a higher change score for supportive presence at post-test was significantly associated with better *AC* (β = .21, *p* = .03) and better *EF* (β = .30, *p* = .05) at post-test, controlled for pretest values of *AC* and *EF* and age. A higher change score for intrusiveness was marginally associated with better *AC* (β = .20, ***p*** = .06), but not *EF* (β = .05, *p* = .74) at post-test. No such associations were found in the CC.

Table 4. *Partial correlations for the educational and control condition among observed parenting behaviors and child AC and EF, controlled for age.*

	Educational condition (*N*=34)				Control condition (*N*=36)			
Child components	**SP T1**	**I T1**	**SP T2**	**I T2**	**SP T1**	**I T1**	**SP T2**	**I T2**
1. ***AC*** T1	.29	-.18			-.06	-.09		
2. ***EF*** T1	.11	-.05			.23	-.27		
2. ***AC*** T2			.49**	-.53**			.19	-.13
4. ***EF*** T2			.34†	-.38*			-.11	.01

†***p*** <.10; *****p*** <.05***;*** *****p*** <.01. SP=Supportive Presence; I=Intrusiveness.

Table 5. *Bootstrapping analyses results with parenting as a mediator in the relation between educational program condition and AC and EF.*

				AC			*EF*		
	Direct effect	**95% CI**			**95% CI**			**95% CI**	
Mediator	**program - parenting**	**Low**	**Up**	***b (SE)***	**Low**	**Up**	***b (SE)***	**Low**	**Up**
Total effect program				.34 (.32)	-.31	1.00	.31 (.32)	-.33	.95
Covariate age				.09 (.01)***	.06	.12	.01 (.01)	-.01	.03
Covariate T1 *AC/EF*				.19 (.10)†	-.01	.40	.55 (.10)***	.35	.75
Supportive presence	.65 (.16)***	.31	.98						
Direct effect program – *AC/EF*				.10 (.35)	-.62	.81	.20 (.35)	-.51	.91
Indirect effect (mediation)				.25 (.17)	<-.01	.68	.11 (.16)	-.19	.46
Intrusiveness	-.46 (.19)*	-.84	-.07						
Direct effect program – *AC/EF*				.22 (.33)	-.45	.90	.26 (.33)	-.41	.92
Indirect effect (mediation)				.13 (.13)	-.04	.51	.06 (.10)	-.11	.31

Note. Results based on 5000 bootstrapped samples. 95% CI = bias-corrected and accelerated confidence intervals, with *p* <.05 when range lower-upper CI does not include zero. Covariate T1 *AC/EF* refers to corresponding pretest component.

DISCUSSION

The aim of the current study was to investigate whether parents can be educated to improve interactions with their child through a compact psycho-educational program with home-assignments. Focusing on parenting strategies that have been shown to have positive impact on children's attentional control (AC) and executive functioning (EF), this study showed in a low-risk sample of four- to eight-year-olds that parents in the educational program condition scored significantly higher on supportive presence and lower on intrusiveness than controls. Though parenting strategies did not act as a mediator between educational condition and child AC and EF, children of those parents who improved after the educational program showed enhanced AC and EF performance.

At post-test, parents in the Curious Minds educational condition were more supportive and less intrusive towards their child during joint activity problem-solving tasks than controls were. This is in line with the positive results regarding programs aimed at improving teacher-child relationships in order to promote self-regulatory skills (e.g. Raver et al., 2008). Our study results suggest that certain aspects of parental sensitivity can indeed be improved using a compact educational program teaching parents about how their child reasons and learns, and how to implement self-regulatory skills practices during daily routines. Potential benefits of this educational group program in comparison to for instance home visiting programs targeting school readiness (For a review, see Welsh et al., 2014), include its high cost-effectiveness and wide employability.

Adequate parenting strategies, characterized by attempts to support the child's need for independence, have already repeatedly been linked to child AC and EF (e.g. Bernier et al., 2010; Clark & Woodward, 2015; Cuevas et al., 2014; Fay-Stammbach et al., 2014; Gaertner et al., 2008; Kraybill & Bell, 2013; Mathis & Bierman, 2015; Spruijt et al., 2018; Sulik et al., 2015). This suggests that educating parents may be a valuable asset in promoting the development of AC and EF, as they can implement self-regulatory skills practice during natural daily routines at home (Bierman & Torres, 2016). However, in the current study it was found that the Curious Minds educational condition did not lead to an overall improved AC and EF at post-test through changes in parental support and intrusiveness.

Several aspects that may explain this lack of effect on child outcomes have to be considered. First of all, previous studies have shown that greater benefits in AC and EF skills can be achieved in children who have larger initial deficits (Diamond & Lee, 2011; Diamond & Ling, 2016; Flook et al., 2010; Karbach & Kray, 2009; Tominey & McClelland, 2011). Self-regulatory skills are often delayed in children growing up in a low-income household with parents with low educational backgrounds (Noble, McCandliss, & Farah, 2007). As the current sample consists of low-risk children with parents who were less likely to have low levels of education (Central Bureau for Statistics [CBS], 2013), this may help explain why no detectable effect on child AC and EF was yet discernable after about a half year.

Second, due to restrictions related to school logistics, post-test data had to be assembled directly after completion of the educational program. Perhaps parents need more time implementing what they have learned before measurable improvements in AC and EF development can be observed. Programs that have improved teacher-child relationships (e.g. Raver et al., 2008), and which have shown to positively impact child self-regulatory skills (e.g. Raver et al., 2011) included at least two months of implementation time after the final session before posttest data were collected. Therefore, effects on child AC and EF may become apparent with time. This is in line with the findings of Dias and Seabra (2017), who have shown that EF gains after a teacher program were amplified at a one-year follow-up compared to direct posttest measurements, suggesting that some effects may indeed be larger later than directly after completing the program (Diamond & Ling, 2016). These conclusions imply a need for longitudinal studies with multiple post-test measurements to disentangle whether an educational program can achieve generalized and sustained effects on AC and EF development.

Third, the educational program consisted of four sessions, which may have been too few to result in discernable improvements in AC and EF development. Interestingly however, post hoc analyses showed that especially those parents who participated in the program and who showed increased supportive presence at post-test, had children who also showed improved AC and EF skills at post-test. As this association was not found in the control condition, this may indicate that parents who benefitted from the program did not only improve in supportive presence and intrusiveness but also altered their scaffolding in interaction with their children to be more beneficial to their child's AC and EF development. Future research needs to focus on this and other aspects of parent-child interaction that might enhance AC and EF development, and needs to find factors that will help explain why some parents benefit from an educational program, while others do not. Little is known about variations in educational program responsiveness and possible moderators affecting program success on stimulating child development. Future studies might include moderating variables that are, for instance, found in meta-analytical studies focusing on child externalizing behavioral problems. These studies showed that program success was moderated by economic disadvantage, severity of initial problem behavior, parental educational level and parental psychopathology (Lundahl, Risser, & Lovejoy, 2006; Reyno & McGrath, 2006). Nonetheless, even small improvements in self-regulatory skills may result in large benefits regarding outcomes in later life (Moffitt et al., 2011), suggesting even small effects may become more and more prominent with time.

Fourth, as the opportunity to practice self-regulatory skills in a natural setting with a familiar adult may be the most promising approach to achieve generalized gains (Bierman & Torres, 2016) and repetition of self-regulatory skills practice throughout the day is essential for success (Diamond, 2013), educational program effects on child outcomes may become more feasible when the school environment is also targeted. As such, greater benefits in child AC and EF may be observed when using a more integral approach, targeting both the school and the home environment. Future studies should aim to disentangle the effects of approaches aimed at parents as the sole recipient and more integral approaches, targeting the home and school environment both separately and complementarily.

Several limitations need to be acknowledged. Parents may have acted differently during home visits than usual due to the somewhat contrived joint-activity tasks. However, it should be noted that observing parent-child interaction under these relatively more natural conditions in the home environment is not expected to distort the nature of interaction much (Gardner, 2000). Secondly, our coding system focused on parenting behaviors. Consequently, real-time bidirectional relations between parenting strategies and child behavior were not investigated. Thirdly, children from only two Dutch schools in the same provincial region were included in this study, which limits the generalizability of our findings. Fourth, not all parents who were assigned to the educational condition participated or completed all sessions, which may have biased our results due to selective drop-out. However, parents who were excluded from analyses did not significantly differ from those who remained in the educational condition, suggesting no attrition bias. Fifth, during the Curious Minds educational program, the home assignments were not checked or monitored. Unfortunately, we do not have detailed information on the amount and quality of practice for each parent. Nonetheless, home assignments were discussed freely every following session, possibly generating cohesiveness and social pressure to complete the assignments.

This study is among the first few to examine manners in which parents can be educated to facilitate the development of self-regulation in their children by using a compact educational program. Strengths of this study include randomizing to condition within each school rather than assigning schools to different conditions, limiting classroom effects. Furthermore, observed parenting behaviors were coded objectively with high interrater reliability and well-validated age-appropriate neuropsychological tasks were used to assess child AC and EF. In sum, the current study showed that the Curious Minds educational program had the expected impact on the quality of parent-child interactions by improving parental support and intrusiveness compared to controls. Though no short-term mediation effects were found on child AC and EF through parental support and intrusiveness, we are reluctant to draw firm conclusions on these results alone, and tentative results suggested that especially parents in the educational condition who improved on parental support had children with better AC and EF skills. Future studies should aim at examining variations in educational program responsiveness and assessing these relations over time. In addition, combining parent- and teacher programs may have the greatest potential for enhancing development.

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APPENDIX

Principal Component Analysis

Preliminary tests indicated that the data were suitable for principal component analysis, with Kaiser Meyer Olkin measure = .81 and Bartlett's test of Sphericity = 573.53, $p < .001$. Results of the Scree-Test showed that a two-component solution fit the data best. Results of the Oblimin rotation showed substantive loadings (i.e. > .30) on Component 1 (eigenvalue = 3.45) and Component 2 (eigenvalue = 1.07; see Table 1). We labeled the extracted components *Attentional control (AC) and Executive functioning (EF). AC* and *EF* pre- and post-test component scores were computed using the component loadings, including lower (<.30) loadings. Composite scores were reversed, with higher scores indicating better performance on *AC* and *EF*. The Pearson ***r*** correlation coefficient between the *AC* and *EF* component was .43. With a mean time of 6.23 months (*SD* = 1.00) in between measurements, stability between pre-test and post-test in the control group (*N* = 57) for the *AC* component (***r*** = .70) and the *EF* component (***r*** = .69) was high.

4

Table 1. *Principal component analysis results[a] for attentional control and executive functioning variables of the Amsterdam Neuropsychological Tasks (ANT; N=225).*

	Component loading	
Measures	C_1	C_2
%variance explained	49.24	15.28
Focused attention (FAO2)	**.97**	-.17
Sustained attention (SAO2)	**.89**	.01
Interference control (GNG misses)	**.60**	**.31**
Working memory (STS)	**-.53**	**-.42**
Inhibitory control – no response (GNG false alarms)	-.05	**.65**
Inhibitory control – different response (ROO 2)	.02	**.82**
Cognitive flexibility (ROO 3)	-.03	**.71**

Note: [a] Two component solution (Pattern matrix), Oblimin rotation. Component loadings ≥.30 are displayed in bold. FAO2=Focused Attention Objects – 2 keys; SAO2=Sustained Attention Objects -2 keys; GNG=Go-NoGo; STS=Spatial Temporal Span; ROO=Response Organization Objects.

CHAPTER 5

Educating parents to enhance reasoning abilities in children: A focus on verbal scaffolding

Based on Andrea M. Spruijt, Tim B. Ziermans, Marielle C. Dekker & Hanna Swaab

In revision

ABSTRACT

This study investigated whether parents can be educated to improve parent-child interactions and whether this can improve children's reasoning abilities. Parents of four- to eight-year-olds were randomly assigned to a compact psycho-educational program (*N*=34) or control condition (*N*=36). Parental questioning style was observed during problem-solving interactions at home and children's scientific and social reasoning were assessed using performance-based tasks. Parents in the educational condition asked significantly more open-ended, observational and explanatory questions at post-test than controls did. More open-ended questions resulted in improved scientific reasoning in their children and more explanatory questions resulted in improved social reasoning. Educating parents to adaptively modify their parent-child interactions can positively influence their questioning style, which in turn may benefit their child's reasoning abilities.

Keywords: Parent-child interaction; parent educational program; verbal scaffolding; social reasoning; scientific reasoning

Parent-child interaction is essential in the development of children's learning and problem-solving skills. By using nondirective instructional techniques, parents can help their child engage in complex problem-solving by scaffolding the task either verbally (e.g., asking questions) or nonverbally (e.g., attention redirection behaviors) (Lewis & Carpendale, 2009). Scaffolding can be defined as the parental input during parent-child interaction promoting independent problem-solving and learning (Dieterich et al., 2006; Mermelshtine, 2017). Parents may become more involved in their children's learning when they are educated about how their child reasons and learns (Gleason & Schauble, 1999). In this sense, parents educated in reasoning development may be better equipped to recognize their child's level of competence and facilitate development by adaptively challenging their child's skills. With this increased parental understanding of their child's developmental needs, parents may thus be better able to adaptively scaffold problem-solving and thereby challenge their child's reasoning abilities.

Fluid reasoning abilities reflect the ability to think logically, detect patterns and relations, form concepts, and solve problems in novel situations (Cattell, 1987; Schneider & McGrew, 2012). Cattel (1987) conceptualized reasoning abilities as a scaffold for learning, serving as a foundation to acquire other cognitive skills. These reasoning abilities have repeatedly been shown to be predictive of school performance, especially math achievement (e.g. Floyd, Evans, & McGrew, 2003; Green, Bunge, Briones Chiongbian, Barrow, & Ferrer, 2017; Hale, Fiorello, Kavanagh, Holdnack, & Aloe, 2007; Miller Singley & Bunge, 2014). Reasoning is traditionally considered a relatively stable trait of an individual, and resistant to change through training (e.g. Carroll, 1993). However, more recently this notion has been called into question (Flynn, 2007; Nisbett et al., 2012). Specifically, reasoning abilities have been shown to be influenced by environmental factors and to be improvable (e.g. Mackey, Hill, Stone, & Bunge, 2011; Nisbett et al., 2012). Given that young children spend a substantial amount of time with their parents, this raises the question whether parents can be educated to support the early development of reasoning abilities through scaffolding.

Kuhn (2010) posited that practicing reasoning abilities in the real-life social context may be especially promising. In order to solve problems using skilled reasoning, children need to learn strategies to achieve their goals. A way to learn new strategies is through social interaction, either by being instructed specifically, by imitating others, or by collaborating. Caregivers can use verbal scaffolding such as asking questions to provide structure during a complex problem-solving task, enabling a child to gain control over his or her cognitive performance and behavior (Lewis & Carpendale, 2009). During verbal scaffolding parents provide their children with age-appropriate contingent responses (i.e. they follow the child's conversational lead), respecting the child's autonomy and stimulating explorative behavior. A specific verbal scaffolding strategy is the use of open-ended and metacognitive questioning when asking for explanations, such as "Why do you think that?" and "How are you going to figure that out?" (Hmelo-Silver & Barrows, 2006). With scaffolding, metacognitive processes involved in reasoning become externalized and available to children who are not yet able to monitor these processes on their own, in line with Vygotsky's (1978) zone of proximal development. With time, this scaffolding becomes internalized speech, which allows children to monitor their reasoning on their own (Wertsch, 1998).

A distinction in children's reasoning abilities can be discerned based on the domain of the problem that has to be unraveled, in particular problems with social content versus more logical or scientific problems (Marini & Case, 1994). Even though there is compelling evidence relating parental scaffolding to children's cognitive abilities and school achievement, studies focusing on the association between scaffolding and socio-emotional development are scarce (For a review, see Mermelshtine, 2017). The development of social understanding can be described by five successive social cognitive stages and largely takes place between preschool age and adolescence (Selman, 1980, 2003). At the first stage or egocentric level (around four years of age), children are only able to understand social interactions from their own perspective. At approximately six years of age, children are able to understand that someone else's perspective is distinct from their own (the subjective level). When children reach the self-reflective level (between eight and ten years of age) they are able to understand how someone else may view their own perspective. Around twelve years of age children are able to understand someone else's view of shared perspectives at the mutual level and adolescents are able to understand their own perspective in the context of multiple perspectives at the generalized level. These social cognitive skills are essential in understanding others during social interactions, both at the individual and the group level (Frith & Blakemore, 2006).

Around the age of four children also start developing an increasing awareness of how people obtain knowledge and begin to differentiate between assertions and reality (For reviews, see Kuhn, 2000, 2010). Furthermore, children begin to realize that perceptual information has to be correct and not just present to generate knowledge (Flavell, 2004). For instance, Flavell and colleagues (1986) showed that while three-year-olds are not yet able to make the distinction between the true color of a glass of milk and its appearance when a red filter is wrapped around it, most four-year-olds can correctly distinguish that the milk looks red but really is white. This metacognitive awareness is considered the origin of scientific thinking, as it allows children to see evidence as a source of support for a theory (Bullock, Sodian, & Koerber, 2009; Kuhn, 2010). Before the age of four, children think that mental representations are merely copies of reality, which makes it impossible for them to understand falsifiable theories, central to scientific reasoning. However, according to the ***Theory theory*** (Gopnik & Wellman, 1994), children begin to consciously revise their theories by the age of four, as they are confronted with evidence that does not match their current naïve theory. The social context plays a formative role in this conceptual change, as social experiences influence children to revise and improve their theories and conceptions of others (Hughes & Leekam, 2004).

Despite the early emergence of the metacognitive precursors of reasoning abilities, the developmental trajectory of these abilities is prolonged and requires adequate support and practice (Morris, Croker, Masnick, & Zimmerman, 2012). Even in typically developing children, considerable inter-individual differences in social understanding occurs (Repacholi & Slaughter, 2004) and differences in scientific reasoning abilities already appear during primary school (Bullock et al., 2009). As children reach primary school age, they become more active participants in interactions, which leads to parents systematically increasing their contingent instructions during parent-child interaction (Conner & Cross, 2003). Furthermore, the influence of reasoning abilities on later achievement is considered to be the strongest between ages five and ten (Ferrer & McArdle, 2004), suggesting this is an optimal age-range to stimulate the development of reasoning abilities through scaffolding. Interventions that include social interactive components aimed at supporting the development of aspects of social understanding such as theory of mind (For a meta-analysis, see Hofmann et al., 2016) or the development of scientific reasoning abilities (For a meta-analysis, see Engelmann, Neuhaus, & Fischer, 2016) have proven to be successful. Parents may be a valuable asset in supporting the early development of reasoning abilities through scaffolding. For instance, parents who ask their children questions during problem-solving help them to structure the task; a strategy which is often spontaneously imitated by children (For a review, see Morris et al., 2012). Butler and Markman (2014) showed that four-year-olds were more likely to display deeper categorization reasoning abilities when an adult was deliberately scaffolding the task, in comparison to an accidental demonstration of the task.

Parents may play an important role in supporting the development of early reasoning abilities and parent-child interaction has already been associated with reasoning abilities in kindergartners (Stright, Herr, & Neitzel, 2009) and ten- and eleven-year-old children

(Chng, Wild, Hollmann, & Otterpohl, 2014). Furthermore, parent training has been shown to be successful in improving parents' beliefs about scaffolding and the promotion of learning (Gartner, Vetter, Schaferling, Reuner, & Hertel, 2018). Nonetheless, the number of studies evaluating programs aimed at promoting parental scaffolding is still limited.

The Curious Minds parent educational program focuses on educating parents on how to support and scaffold the development of cognitive, social-emotional and self-regulatory skills necessary for adaptive behavior and learning. The aim of the educational program is twofold: (1) to educate parents about their child's developmental needs; and (2) to educate parents through home-assignments how they can stimulate self-regulation as well as explorative behavior and reasoning abilities through scaffolding that is sensitive to their child's developmental needs. A major objective of this study is to examine whether the Curious Minds parent educational program is able to improve parental questioning style in a low-risk sample of four- to eight-year-olds, and whether this can positively impact their child's social and scientific reasoning abilities. We hypothesized that parents in the educational program condition would ask more open- than closed-ended questions and more elaborative questions than parents in the control condition. Additionally, we hypothesized that parental questioning style would mediate the association between educational program condition and children's reasoning abilities.

METHOD

Participants

The current study is embedded within the Curious Minds program: a longitudinal program investigating the development of executive and social functioning in primary school-aged children in the Netherlands, and evaluating the effects of a parent and a teacher educational program (approved by the Ethical Board of the department of Education and Child Studies at Leiden University (ECPW-2010016)).

Parents of 138 4- to 8-year-old children (*M* = 6.26 years, *SD* = 1.19, 55.1% male) from the lowest four grades of two Dutch primary schools (pre-school to second grade in USA school system), from towns that are part of the Rotterdam-The Hague metropolitan area were eligible for this study and signed an informed consent letter. Children were randomly assigned to either the parent educational program condition (*N* = 69) or the control condition (*N* = 69) by drawing participant numbers from a jar. Participants were included in the analyses when their parents agreed to both home visits, when parents attended at least two sessions (educational program condition only), and when complete pre- and post-test data were available. Parents of 99 out of the 138 eligible children agreed to the home visits (response = 71.7%). To check for potential attrition bias participants whose parents agreed to the home visits were compared to those who did not agree on background variables. Groups did not significantly differ on: age, sex, school, grade, or prevalence of referral to mental health care in the past year, nor did their parents significantly differ on single parenthood status or parental education (all $p > .05$). Participants in the educational program condition who missed all ($N = 18$) or three out of four ($N = 5$) sessions were excluded from analyses and also did not significantly differ from those who remained in the educational program condition on any of the background variables (all $p > .05$). The final sample size for analysis ($N = 70$) consisted of 34 children in the educational condition and 36 in the control condition. For detailed sample characteristics, see Table 1.

Procedure

The current study uses observational data of parents' interactive behavior with their child collected during problem-solving interactions during a home visit, and child paper-and-pencil and hands-on tests to assess level of social and scientific reasoning abilities. Pre-test baseline data were collected in the period between November 2013 and February 2014 (school 1) and between May and June 2014 (school 2). Post-test data were collected in the period between June and July 2014 (school 1) and between January and February 2015 (school 2). Paper-and-pencil and hands-on performance tasks were administered in a separate room at the child's school, during two individual test sessions of approximately 60 minutes. Tests were administered by two trained junior investigators or by one of the senior investigators (AMS, MCD). All home visits were conducted by two trained junior investigators. Children were rewarded with a small token of appreciation for participation after the test session.

Curious Minds parent educational program

The content of the parent educational program was inspired by the Vygotskian principles of the Tools of the Mind curriculum for pre-school children (Bodrova & Leong, 2007; Diamond, Barnett, Thomas, & Munro, 2007), which focuses on supporting and scaffolding the development of cognitive, social-emotional and self-regulatory skills necessary for adaptive behavior and learning by using a familiar adult in a real-life setting as a change agent. The program took place at their children's school and was initiated after all baseline assessments with participating parents and children were completed. The program was provided by a skilled clinical neuropsychologist specialized in child and adolescent neurodevelopment, and consisted of four, monthly group sessions of approximately two hours each. The caregiver of each child who also participated in the home visits was asked to attend the sessions.

Table 1. *Participant characteristics and descriptive statistics (M (SD)) variables of interest at pretest.*

	EPC (*n* = 34)	CC (*n* = 36)	*p*
Age in months at T1	76.56 (14.89)	75.97 (14.32)	.87
Sex (% male)	47.06	63.88	.16
Parental education[a]			.91
High (%)	43.75	45.71	
Medium (%)	50.00	45.71	
Low (%)	6.25	8.57	
Single parenthood (%)	6.25	2.86	.60
Referral to mental health care past year (%)	6.25	8.57	.72
Number of questions per minute T1[b]			
Total questions	4.24 (1.69)	4.06 (1.87)	.68
Ratio open/closed questions	-.11 (1.10)	-.41 (1.05)	.24
Observational leading questions	.67 (.46)	.56 (.51)	.37
Procedural questions	.18 (.18)	.12 (.18)	.17
Explanatory questions	.18 (.20)	.15 (.18)	.52
Social reasoning ability T1			
Total social reasoning proficiency	32.35 (12.96)	31.97 (15.44)	.91
Identifying	7.15 (1.79)	7.36 (1.94)	.63
Discriminating	5.26 (2.11)	5.17 (2.27)	.85
Differentiating	5.59 (2.49)	4.61 (3.30)	.17
Comparing	4.21 (2.43)	4.56 (2.98)	.59
Perspective taking	3.24 (2.70)	3.33 (2.73)	.88
Scientific reasoning ability T1			
Conservation proficiency	35.50 (12.35)	36.44 (13.60)	.76
Proportional proficiency[b]	4.76 (1.26)	4.42 (1.25)	.25
Proportional complexity[b]	1.40 (.35)	1.28 (.45)	.21

[a] Background information was missing for *N* = 3 children due to non-response on parent questionnaire. [b] Original values before standardization. EPC = Educational program condition; CC = Control condition.

During each session, the focus was on a specific (neuro)cognitive mechanism, for which parents first received basic information on typical developmental aspects. Information about the brain-behavior developmental course at specific ages was illustrated using everyday examples of parent-child interactions. Parents also received a workbook summarizing information about the development of cognitive, social-emotional and self-regulatory skills, as well as matching home assignments to practice with their child following each session to enhance the learning experience of parents. These home assignments were discussed during the following session, allowing parents to learn from the trainer's feedback and each other's day-to-day experiences. For a more detailed description per session, see Table 2.

Measures

Demographic characteristics

Parents filled out a complementary background information questionnaire, using the online survey software Qualtrics (http://www.qualtrics.com/). The highest completed level of education by the parent who participated in the home visit was used as an indicator of educational attainment according to the Dutch Standard Classification of Education (SOI) which is based on UNESCO's International Standard Classification of Education (ISCED) ("SOI 2003 (Issue 2006/'07),"): 1. primary education (SOI level 1 to 3; at most vocational training); 2. secondary education (level 4 of SOI); and 3. higher education (level 5 to 7 of SOI; bachelor's degree or higher). Single parenthood status was established for the parent who participated in the home visit, and was defined by not having the child's other parent or a new caregiver living in the same household. Mental health care referral was assessed by asking parents whether their child had been referred, examined or treated for emotional and behavioral problems in the past year.

Parental questioning style

The parent's interactive behavior with the child was videotaped at pre- and post-test home visits during two joint activity problem-solving tasks. These problem-solving tasks consisted of a combining task and a sorting task of approximately five to ten minutes each, both based on tasks designed by Utrecht University (Corvers, Feijs, Munk, & Uittenbogaard, 2012). Parent-child dyads were alternately assigned to either task version A (N = 32, 46%) or task version B of each joint activity task (N = 38, 54%) at pre-test, which were reversed at post-test to avoid test-retest learning effects. Version A consisted of combining four different eyes and four different mouths to form 16 unique smiley faces

Table 2. *Description of the discussed topics and home assignments per session of the Curious Minds educational program.*

Session	***Main theme***	***Home assignments***
Session 1	How children learn and process new information, and how parents can help their child to explore topics in more depth by encouraging reasoning through asking questions.	e.g.: - Do science experiments with soap bubbles - Think outside the box by imagining as many different uses for a paperclip as possible. - Play sensory games, such as touching and tasting different types of food while blindfolded.
Session 2	Teaching parents how to stimulate specific aspects of AC and EF while interacting with their child. Discussion of home assignments session 1.	e.g.: - Tell two different stories to your child simultaneously, while your child focuses on one of the stories, and ask questions afterwards about its content (targeting ***attention***). - Play the game ***Yes and no are forbidden***: trick your child into answering questions with 'yes' or 'no (targeting ***inhibition***). - Play the ***Going on a trip*** game: alternately add an item to the sentence 'I am going on a trip and I am going to pack…', after recalling all items that have been mentioned (targeting ***working memory***). - Let your child come up with alternative plans when a playdate is suddenly cancelled, and observe whether your child is able to flexibly change plans (targeting ***cognitive flexibility***).
Session 3	Teaching parents how to stimulate emotion regulation and social cognition while interacting with their child. Discussion of home assignments session 2.	e.g.: - Practice and discuss a range of facial emotion expressions in front of the mirror. - Observe and address your child's emotional reactions during daily interaction and describe the reactions. - Discuss several short, illustrated stories (e.g. ***How does Billy feel when he's not allowed to play with the other kids? How do you know?***) - In a naturally occurring situation, explain why it is important to place yourself in someone else's shoes (i.e. perspective taking), using questions.
Session 4	Recap of sessions 1 through 3; parents were free to discuss what they had learned and ask additional questions. Discussion of home assignments session 3.	There were no home assignments following session 4.

and sorting different types of toy animals, and version B consisted of combining four different flower petals with four different disks to form 16 unique flowers and sorting different types of toy food. Parent-child dyads were free to sort and combine the items according to their own strategy, as long as all combinations in the combining task were different. Parents were instructed to support their child as they would normally do. The combining tasks consisted of more flower petals/disks and eyes/mouths than possible unique combinations, challenging parent-child dyads to reason about a strategy to form only unique combinations. The sorting tasks did not have a best solution, challenging parents to provide their child with age-appropriate contingent responses when they came up with a sorting rule. The videotapes were coded afterwards for parental questioning style.

The form and type of questions parents asked their children during the two joint activity problem-solving tasks were used as a measure of parental questioning style. All questions were coded from video-recordings using transcribed verbatim reports. Each question was first coded as being either (a) open-ended (e.g., ''How do you want to start?"), (b) multiple choice (e.g., ''Does a kangaroo live in the zoo or in the ocean?"), or (c) closed-ended (e.g., ''Is a cow a farm animal?"). Next, questions were coded in the following categories: (a) observational leading questions (e.g., ''What's the color of this food?", inquiring about observable aspects during the task), (b) procedural questions (e.g., ''How are you going to sort the animals?", inquiring about an action plan), and (c) explanatory questions (e.g., ''Why can the toad not be in the ocean group?", inquiring about the child's reasoning behind decisions). The form and category of each question were coded for both joint activity problem-solving tasks by three coders who were blind to other data concerning the child or the parent. All coders completed extensive training consisting of several practice and feedback sessions supervised by one of the investigators (AMS). Interrater reliability (Cohen's kappa) was large, with .84 on average for the sorting task ($N_{questions}$ = 122) and .87 on average for the combining task ($N_{questions}$ = 115). For each question form and category within each task, the number of questions per minute was calculated. Although parent–child dyads were randomly assigned to either joint Task Battery A or B, each task battery may have elicited a somewhat different interaction between parent and child. Therefore, we standardized the number of questions per minute within each task (sorting or combining) for each task version (A or B), followed by averaging these z-scores over the joint activity tasks.

Due to very low occurrence of multiple-choice questions (2.4%), this form was excluded from further analyses. The difference score between the standardized amounts of open- and closed-ended questions was calculated as a relative measure of question format preference during the tasks. A higher ratio score indicates that the parent asked more open-ended than closed-ended questions relative to the other parents.

Reasoning abilities

Scientific reasoning

Aspects of scientific reasoning ability, conservation and proportional reasoning, were measured with (i) the subtest Quantity of the Revised-Amsterdam Intelligence Test for children (Bleichroth, Drenth, Zaal, & Resing, 1987), a paper-and-pencil task to study conservation reasoning, and (ii) the balance scale task, a seminal task to study proportional reasoning.

Conservation reasoning

Conservation reasoning proficiency was assessed using the Quantity paper-and-pencil task that consists of 65 items (40 for four-year-olds) on relative length, weight, volume, amount, relative distance, surface area, and odds (e.g. which glass contains the most lemonade?; which rope is the longest?; which necklace has the most beads?; which cow has the most grass to eat?). Four consecutive incorrect answers resulted in aborting the task. Out of four pictures, children were asked to point to the picture with the right answer. The test-retest reliability (r = .76) and internal consistency (Cronbach's alpha = .91) of this subtask are considered sufficient (Bleichroth et al., 1987). The total number of correct answers was used in analyses as a measure of conservation reasoning proficiency.

Proportional reasoning

Proportional reasoning proficiency and complexity level were assessed using a balance scale task (utilizing a beam centered on a fixed balance point with ten hanging points on both sides, and a set of 30 weights of 10 gram each). The ten hanging positions were marked with different stickers (e.g. red star, yellow smiley), similar on each side. Two parallel versions of this task were used (version A and B), each consisting of eight similar situations of increasing difficulty. A standard set of two explanatory questions was asked for the eight different test situations, resulting in a total of 16 explanations. The children were first asked to predict the end position of the balance scale before it was manipulated (i.e. before a card was placed) and to explain why. After the balance scale had been manipulated, they were asked to explain why the balance scale was in a certain position. The first four test situations focused on weight, the fifth on distance and the last three test situations on both weight and distance. The children did not receive feedback or extra assistance during the task, other than additional questions such as “what do you mean?” and “could you tell me more about that?” to reach the optimal complexity level of explanation. Administration of the balance scale task took approximately 15 minutes.

Balance scale problem tasks have repeatedly been used to assess scientific reasoning (e.g. Halford, Andrews, Dalton, Boag, & Zielinski, 2002; Jansen & van der Maas, 2002; Meindertsma, Van Dijk, Steenbeek, & Van Geert, 2012; Philips & Tolmie, 2007). The administration of the Balance scale task was recorded on video and coded by junior investigators who received extensive training, resulting in a large inter-coder reliability of .86 (ranging from .81 to .90). Predictions of the eight end positions were coded as either correct (1) or incorrect (0). The overall proficiency on proportional reasoning was calculated by summing the eight predictions, standardized within each task version (A/B). The explanations of the participants were coded using the coding scheme of Meindertsma et al. (2012), which is based on the dynamic skill theory of Fischer (1980) and Fischer and Bidell (2007). The coding of the complexity level of proportional reasoning can be found in Table 3. The overall complexity level of proportional reasoning was calculated by averaging the sixteen explanations. Mean complexity level was standardized within each task version (A/B).

Table 3. *Coding scheme for the complexity level of proportional reasoning.*

Code	Level of complexity	Content of explanation	Example
4	Representational system level	All relevant parts of the explaining mechanism and the relationships between these parts	“There is a balance because the distance on the side with one card is twice as long as the distance on the side with two cards”
3	Representational mapping level	Two or more parts of the explaining mechanism	“Because there are two cards and here only one, and because the cards are not at the same spot”
2	Single representational level	One part of the explaining mechanism	“Because they have the same weight”
1	Sensorimotor system level	Relation between action and result or an observation of the situation	“Because the card was put there”
0	Not specified	Indicates not to know an explanation	“I don’t know”

Social reasoning

Proficiency on a social reasoning task was measured with two parallel versions (A or B) of the short form of the Social Cognitive Skill Test (SCST) (Van Manen, 2007). The SCST is a semi-structured interview, based on the structural developmental approach of social cognition as proposed by Selman and Byrne (1974). Participants completed either version A or B at pre-test, corresponding to their randomly assigned A or B condition during the home visit, which were reversed at post-test. Both versions consisted of three short stories with accompanying pictures depicting different social situations in which a child is confronted with a social problem. Administration time was approximately 20 minutes. Eight questions regarding emotion recognition and perspective taking, increasing in difficulty, were asked per story, which were afterwards coded to yield either: (i) 3 points; when the answer was correct straightaway; (ii) 1 point; when the answer was not completely correct, but after a supplementary question became correct; (iii) 0 points; when the answer was incorrect from the start or still not completely correct after a supplementary question. A story was aborted after two consecutive incorrect answers. Social cognitive scale scores were calculated by summing the corresponding questions: ***(i)*** identifying; ***(ii)*** discriminating; ***(iii)*** differentiating; ***(iv)*** comparing; and ***(v)*** perspective taking, (i.e. the first question per story corresponds to identifying, the second to discriminating, etc.) The correlation between version A and B has been shown to be .84 with test-retest reliability ranging from .77 for version A to .78 for version B (Van Manen, 2007). Summed total scores were used in the analyses, as well as the five scale scores corresponding to the social cognitive stages developing at this study's age-range of four- to eight-year-olds.

Verbal ability

To assess whether associations between parental questioning style and children's reasoning ability were independent of differences in children's language skills, children's verbal ability was controlled for using the Concepts and Following Directions task of the Clinical Evaluation of Language Fundamentals (CELF-4^{NL}) (Semel, Wiig, & Secord, 2010). This task gives an indication of the child's ability to interpret and act upon spoken directions of increasing length and complexity. Children are instructed to identify in correct order a set of images that were verbally presented using time ordered prepositions. Administration took approximately 20 minutes. The task contains 49 items of increasing length and complexity. Upon reaching item 19, the task was aborted after seven consecutive incorrect answers. Administered items were afterwards coded to yield either 0 points for an incorrect answer or 1 point for a correct answer. Summed raw scores were used as a covariate in the analyses. The test-retest reliability (r = .76) of this subtask is considered sufficient (Semel et al., 2010).

Data analyses

Data were analyzed using IBM SPSS version 23. Demographic characteristics for both schools and educational program conditions were compared with chi-square tests, independent t-tests and Fisher exact tests. The educational effect on parental questioning style was assessed using ANCOVA controlling for corresponding pre-test values, verbal ability and age. The educational effect on reasoning through mediation by parental questioning style was assessed using bootstrapping, a nonparametric resampling procedure (Hayes, 2009). Bootstrapping with 5000 resamples was done to test for significant indirect effects using the SPSS macro developed by Preacher and Hayes (2009). Only parental questioning style variables with a significant educational program effect were included in the mediation analyses. Due to a ceiling effect of the social cognitive skill 'Identifying' (77% had one error or fewer at T1 and 93% had one error or fewer at T2), it was not considered in the mediation analyses. Unstandardized residual scores were used for parental questioning style variables in the mediation analyses, in order to control for pre-test values. Verbal ability and age were centered and controlled for in all analyses. For all significant effects, partial η^2 addressed effect size (0.04 = small effect; 0.25 = moderate effect; 0.64 = strong effect (Ferguson, 2009). Alpha for significant effects was set at $p < .05$.

RESULTS

Sample characteristics and descriptive statistics for the variables of interest are displayed in Table 1. Children in the educational program condition did not significantly differ from those in the control condition for age, sex, school, grade, single parenthood status, parental education or prevalence of referral to mental health care in the past year. Neither did the participants in the educational program condition differ from those in the control condition on the scientific and social reasoning measures at pre-test (all $p > .05$).

Curious Minds parent educational program effect

Parental questioning style

Parents in the educational program condition asked significantly more open- than closed-ended questions (η_p^2 = .10), more observational leading questions (η_p^2 = .07) and more explanatory questions (η_p^2 = .13) at post-test than parents in the control condition, while controlling for pre-test questioning style, verbal ability and age (see Table 4). Parents in the educational program condition did not ask more total questions than parents in the control condition, nor did they ask more procedural questions at post-test.

Table 4. *Analysis of covariance (ANCOVA) results comparing educational and control condition on parental questioning style at posttest, controlling for corresponding pre-test score, age and verbal ability.*

Parental questioning style	EPC *M (SE)*	CC *M (SE)*	*F (df)*	η_p^2	*p*
Total questions	.12 (.14)	.05 (.13)	.15 (65)	<.01	.70
Ratio open/closed questions	.35 (.16)	-.25 (.15)	7.35 (65)	.10	<.01
Observational leading questions	.11 (.12)	-.27 (.12)	4.82 (65)	.07	.03
Procedural questions	.17 (.13)	-.05 (.13)	1.41 (65)	.02	.23
Explanatory questions	.34 (.12)	-.19 (.12)	9.93 (65)	.13	<.01

Note. M : Marginal means. ***SE:*** Standard error. η_p^2:Partial eta squared.

Mediating effect of questioning style on scientific reasoning ability

The association between educational program condition and scientific reasoning ability was significantly mediated by the ratio score of open- versus closed-ended questions (see Table 5). Though the total effect regression coefficient between educational program condition and scientific reasoning was only significant for complexity level (***b*** = .34, SE = .14, ***p*** =.01) and not for proficiency ($b_{conservation}$ = -2.32, SE = 2.13, ***p*** = .27; $b_{proportion}$ = .31, SE = .18, ***p*** = .08), standardized indirect effects were significant for both proportional reasoning complexity (***b*** = .09, SE = .05, 95% CI [.01, .23]; see Figure 1) and conservation reasoning proficiency (***b*** = 1.52, SE = .99, 95% CI [.14, 4.37]; see Figure 2). This indicates that compared to controls, parents in the educational program condition asked more open- than closed-ended questions, which resulted in enhanced scientific reasoning in their children.

Table 5. *Bootstrapping analyses results with parental questioning as a mediator in the relation between educational condition and scientific reasoning ability*

				Scientific reasoning ability (N = 70)								
				Conservation proficiency			Proportional proficiency			Proportional complexity		
	Direct effect	95% CI			95% CI			95% CI			95% CI	
Mediator	Program - Q	Low	Up	*b (SE)*	Low	Up	*b (SE)*	Low	Up	*b (SE)*	Low	Up
Total effect educational program				-2.32 (2.13)	-6.58	1.93	.31 (.18)	-.04	.67	.34 (.14)*	.06	.61
Covariate age				.37 (.11)*	.15	.60	.02 (.01)*	.01	.04	.01 (.01)	-.01	.02
Covariate verbal ability				.11 (.40)	-.68	.91	.03 (.03)	-.03	.10	-.01 (.03)	-.06	.05
Covariate T1 Reasoning				.48 (.13)*	.22	.74	.12 (.13)	-.13	.38	.55 (.11)*	.32	.78
Ratio questions (Ratio Q)	.55 (.21)*	.13	.98									
Direct effect program - Reasoning				-4.11 (2.21)	-8.52	.30	.29 (.19)	-.08	.67	.25 (.14)	-.04	.53
Indirect effect (mediation)				1.52 (.99)*	.13	4.18	.02 (.06)	-.09	.15	.09 (.06)*	.01	.24
Observational questions (Obs. Q)	.30 (.17)	-.05	.64									
Direct effect program - Reasoning				-2.43 (2.22)	-6.86	2.00	.33 (.18)	-.04	.70	.29 (.14)*	.01	.57
Indirect effect (mediation)				.09 (.65)	-.85	1.92	-.02 (.06)	-.18	.05	.04 (.04)	-.01	.17
Explanatory questions (Exp. Q)	.48 (.17)*	.13	.83									
Direct effect program - Reasoning				-2.76 (2.31)	-7.37	1.85	.25 (.19)	-.14	.64	.40 (.15)*	.10	.69
Indirect effect (mediation)				.39 (.99)	-1.30	2.87	.06 (.06)	-.04	.22	-.06 (.06)	-.23	.03

Note. Results based on 5000 bootstrapped samples. 95% CI = bias-corrected and accelerated confidence intervals, with p <.05 when range lower-upper CI does not include zero. Covariate T1 reasoning refers to corresponding pretest reasoning variable.

5

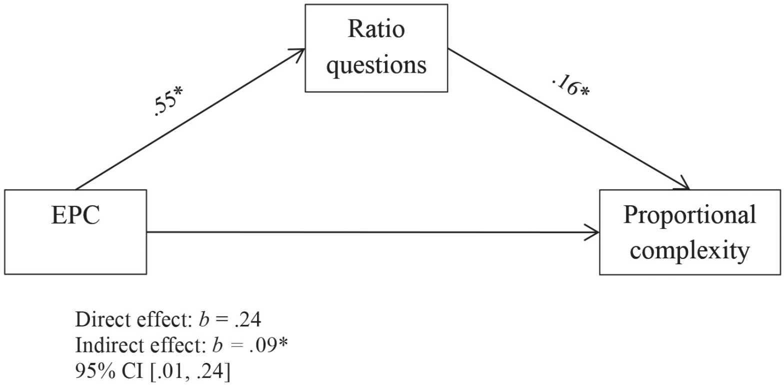

Figure 1. Unstandardized regression coefficients for the mediated association between educational condition and proportional reasoning complexity level (Balance Scale).

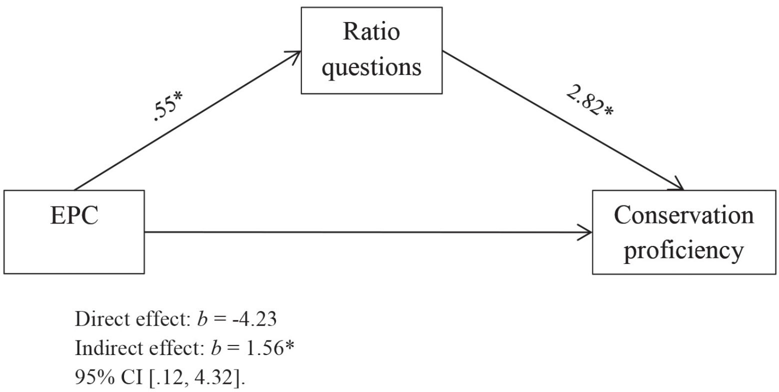

Figure 2. Unstandardized regression coefficients for the mediated association between educational condition and conservation reasoning proficiency level (Quantity task).

Mediating effect of questioning style on social reasoning ability

The association between educational program condition and social reasoning ability was significantly mediated by explanatory questions (see Table 6). The standardized indirect effect was significant for the social cognitive skill 'differentiating', corresponding to the subjective level (***b*** = .37, SE = .22, 95% CI [.06, .98]; see Figure 3). This indicates that compared to controls, parents in the educational program condition asked more explanatory questions, which resulted in enhanced differentiating skills in their children. Observational leading questions did not mediate the association between educational condition and reasoning abilities.

Table 6. *Bootstrapping analyses results with parental questioning as a mediator in the relation between educational condition and social reasoning ability.*

				Social reasoning ability (*N* = 69)														
				Egocentric level			**Subjective level**						**Self-reflective level**			**Total proficiency**		
				Discriminating			Differentiating			Comparing			Perspective taking					
	Direct effect	95% CI			95% CI			95% CI			95% CI			95% CI			95% CI	
Mediator	Program - Q	Low	Up	*b (SE)*	Low	Up	*b (SE)*	Low	Up	*b (SE)*	Low	Up	*b (SE)*	Low	Up	*b (SE)*	Low	Up
Total effect program				-.23 (.46)	-1.16	.69	.74 (.60)	-.46	1.94	.37 (.56)	-.75	1.49	-.12 (.54)	-1.20	.96	1.28 (2.22)	-3.17	5.72
Covariate age				<.01 (.02)	-.03	.04	.11 (.02)*	.06	.16	.07 (.02)*	.02	.12	.12 (.02)*	.07	.16	.54 (.10)*	.34	.73
Covariate verbal ability				-.02 (.09)	-.19	.15	.01 (.10)	-.19	.21	-.05 (.09)	-.24	.14	.09 (.09)	-.09	.28	.29 (.39)	-.48	1.06
Covariate T1 Reasoning				.14 (.12)	-.10	.38	-.09 (.11)	-.31	.12	.28 (.12)*	.04	.51	.13 (.13)	-.14	.40	.30 (.11)*	.09	.51
Ratio questions (Ratio Q)	.49 (.21)*	.08	.91															
Direct effect program-Reasoning				-.15 (.49)	-1.12	.83	.42 (.62)	-.82	1.65	.50 (.59)	-.68	1.67	.16 (.56)	-.95	1.27	1.16 (2.35)	-3.52	5.85
Indirect effect (mediation)				-.08 (.18)	-.51	.21	.30 (.23)	-.02	.91	-.12 (.23)	-.69	.26	-.26 (.21)	-.80	.04	.11 (1.00)	-1.35	2.66
Observational questions (Obs. Q)	.26 (.17)	-.09	.60															
Direct effect program-Reasoning				-.28 (.48)	-1.24	.67	.60 (.61)	-.62	1.82	.23 (.57)	-.92	1.38	-.08 (.56)	-1.19	1.04	.70 (2.28)	-3.84	5.25
Indirect effect (mediation)				.04 (.10)	-.08	.36	.13 (.17)	-.07	.65	.11 (.16)	-.06	.63	-.04 (.14)	-.46	.17	.48 (.60)	-.21	2.37
Explanatory questions (Exp. Q)	.46 (.18)*	.11	.81															
Direct effect program-Reasoning				-.32 (.49)	-1.31	.67	.37 (.62)	-.88	1.61	.23 (.60)	-.96	1.43	.10 (.57)	-1.05	1.25	.48 (2.37)	-4.25	5.22
Indirect effect (mediation)				.08 (.15)	-.18	.47	.37 (.22)*	.06	.98	.12 (.24)	-.18	.82	-.20 (.22)	-.79	.12	.73 (.87)	-.60	3.00

Note. Results based on 5000 bootstrapped samples. 95% CI = bias-corrected and accelerated confidence intervals, with $p < .05$ when range lower-upper CI does not include zero. Covariate T1 reasoning refers to corresponding pretest reasoning variable.

5

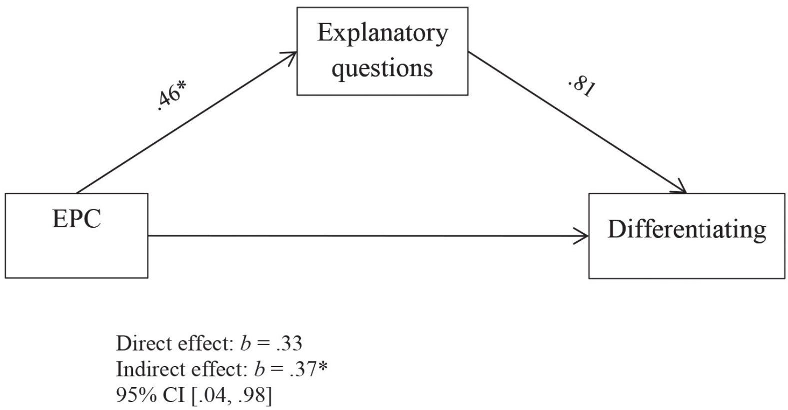

Figure 3. Unstandardized regression coefficients for the mediated association between educational condition and differentiating proficiency.

DISCUSSION

As children reach primary school age, they become more active participants in parent-child interactions, which leads to parents systematically increasing their contingent instructions to adaptively challenge their child's skills (Conner & Cross, 2003). Educating parents in reasoning development can better equip them to recognize their child's level of competence. With increased understanding of their child's reasoning and learning, parents may be better able to facilitate development through verbal scaffolding. The aim of the current study was to examine whether the Curious Minds parent educational program was able to improve parental questioning style in a low-risk sample of four- to eight-year-olds, which may positively impact their child's social and scientific reasoning abilities. The results show that parents in the educational program condition asked significantly more open-ended, observational and explanatory questions at post-test than controls did. More open-ended questions by parents in the educational program condition resulted in improved scientific reasoning in their children and more explanatory questions by parents in the educational program condition resulted in improved social reasoning.

This study has demonstrated that a compact psycho-educational parent program with home-assignments can be successful in improving parental verbal scaffolding through asking more open and elaborative questions. Our findings suggest that certain aspects of parental verbal scaffolding can indeed be improved using a compact educational program teaching parents about how their child reasons and learns, extending findings from previous studies shown to be successful in improving parents' beliefs about scaffolding and the promotion of learning (Gartner et al., 2018). Asking more open- than closed-ended questions mediated the association between educational program condition and aspects of scientific reasoning complexity and proficiency. This indicates that the enhanced scientific reasoning abilities of children with parents in the educational condition may be attributed to the improved verbal scaffolding by their parents. This is in line with the study by Butler and Markman (2014), who showed that four-year-olds were more likely to display deeper categorization reasoning abilities when an adult was scaffolding the task. However, where children showed improved reasoning ability while concurrently being scaffolded in the Butler and Markman study (2014), this study showed that children's reasoning ability was enhanced on other reasoning tasks which were not scaffolded directly. This may suggest that the scaffolded metacognitive processes involved in reasoning on these particular problem-solving tasks may have become internalized speech, allowing children to monitor their reasoning on their own (Wertsch, 1998).

Furthermore, asking more explanatory questions mediated the association between educational program condition and social reasoning proficiency, though not on all social cognitive skills. Interestingly, asking more explanatory questions only resulted in a higher proficiency on the social cognitive skill differentiating, corresponding to the subjective role taking level. This particular stage of social understanding develops between the ages six and eight and entails the ability to realize that someone else's perspective is distinct from your own or, in other words, the ability to think about others' thoughts. As parental questioning style only resulted in higher proficiency on differentiating, this may suggest that the children in our sample were in that particular developmental phase at that time. In that line of thought, the children in our sample may have already mastered the egocentric level, developing around four years of age, while the reflective level, developing between ages eight and ten, may still be a bridge too far (Selman, 1980, 2003). Tentatively, this might indicate that parental influence on the development of their children's early social reasoning abilities is subtle and depends on whether parental verbal scaffolding is adaptive to their child's developmental phase. This emphasizes the importance of an adaptive parental questioning style matching their child's zone of proximal development (Vygotsky, 1978).

In addition to reasoning proficiency, reasoning complexity level was also taken into account in this study. Research focusing on mathematical problem solving skills in preschoolers has shown that even though counting proficiency is necessary for problem solving success, especially the conceptual understanding of the counting process was predictive of math performance (Muldoon, Lewis, & Freeman, 2003). Perhaps children's reasoning complexity level reflects their conceptual understanding of reasoning, which might be more predictive of their school achievement than mere proficiency on a reasoning task. Given our findings on scientific reasoning complexity level, future studies are recommended to include complexity level when assessing children's developing reasoning ability and relating it to school achievement and social development.

As expected, educating parents to modify their daily parent-child interactions improved their questioning style and may have positively influenced the reasoning abilities of their child, which supports the notion that practicing reasoning abilities in the real-life social context using scaffolding is a promising approach to stimulate the development of early reasoning abilities (Kuhn, 2010). Our findings are in line with previous successful interventions that included social interactive components to stimulate the development of aspects of social understanding such as theory of mind (For a meta-analysis, see Hofmann et al., 2016) and the development of scientific reasoning abilities (For a meta-analysis, see Engelmann et al., 2016). Potential benefits of this compact parental group program in comparison to for instance home visiting programs targeting school readiness (For a review, see Welsh et al., 2014), include its wide employability and high cost-effectiveness.

Several limitations of the current study need to be acknowledged. Not all parents who were assigned to the educational condition participated in the program or completed all sessions, which may have biased our results due to selective drop-out. However, parents who were excluded from analyses did not significantly differ from those who remained in the educational program condition on parental education or single parenthood status, suggesting no attrition bias for these variables. Second, a no-contact control group was used, suggesting motivational issues may have arisen for parents in the control condition. However, parents in the control condition were invited to attend an informative workshop covering the topics discussed during the program after all the post-test assessments with participating parents and children were completed, possibly reducing motivational concerns. Third, during the Curious Minds program, the home assignments were not checked or monitored. Unfortunately, we do not have detailed information on the amount and quality of practice for each parent. Nonetheless, home assignments were discussed freely in each following session, possibly generating cohesiveness and social pressure to complete the assignments.

This study is among the first few to examine manners in which parents can be educated to facilitate the early development of social and scientific reasoning ability in their children through scaffolding by using a compact educational program. Strengths of this study include the objective coding with high interrater reliability of observed parental questioning style and the assessment of both reasoning proficiency and complexity level of scientific reasoning. Furthermore, parents were randomized to the educational program conditions within schools and within classes rather than assigning schools or total classes to different conditions, which limits classroom and school effects.

In sum, the current study showed that the Curious Minds parent educational program had a positive impact on the quality of parent-child interactions by improving parental questioning style compared to the control group, which may have enhanced aspects of reasoning complexity and proficiency in their children. Our findings are in line with the notion that the social environment can be an important asset in promoting early reasoning abilities (e.g. Mackey, Hill, Stone, & Bunge, 2011; Nisbett et al., 2012). Future studies should aim at examining variations in educational program responsiveness and assessing these relations over time. Furthermore, the possible moderating role of developmental phase on variations in program effects on children's reasoning ability and including reasoning complexity level when assessing long-term effects on school achievement are topics for further consideration in future studies.

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APPENDIX

Partial correlations

Table 1. *Partial correlations among observed parenting behaviors and child reasoning ability at pretest, controlled for verbal ability and age.*

	Parental questioning style				
Scientific reasoning	Total	Ratio	Observational	Procedural	Explanatory
1. Conservation proficiency	-.22†	-.09	-.09	-.06	.11
2. Proportional proficiency	-.12	-.01	-.11	-.08	-.06
3. Proportional complexity	-.03	.23†	.04	-.03	-.09
Social reasoning					
4. Discriminating	.27*	-.03	.21†	.15	.11
5. Differentiating	.07	.18	.10	.25*	-.03
6. Comparing	.07	-.09	-.04	.13	-.13
7. Perspective taking	.15	-.12	.05	.16	-.29*
8. Total proficiency	.15	.01	.09	.20	-.13

†*p* <.10; ***p* <.05*;* ***p* <.01.

CHAPTER 6

Summary and General discussion

During the transition from dependence to greater autonomy, young children's neurocognitive development is influenced by the relationship with their parents and the conditions in their caregiving environment (Bernier, Carlson, Deschenes, & Matte-Gagne, 2012; Diamond, 2013; Fox & Calkins, 2003). Children become more active participants in parent-child interactions by the time they reach primary school age, which leads to parents systematically increasing their contingent instructions (i.e. following the child's lead) to adaptively challenge their child's skills and foster development (Conner & Cross, 2003). Optimal development of neurocognitive functions like attentional control, executive functions and social cognition is essential for children's daily functioning at school and at home. These functions develop rapidly during the early school years and have been associated with quality of development and functioning in many important aspects of life, such as school performance, health, and job success (see Diamond, 2013). Good parenting strategies can shape children's attentional control, executive functioning, social cognitive development, and reasoning skills. Nevertheless, most studies in this field of research focus on infants and preschoolers and not the period thereafter. It is therefore important to also learn about the nature of these relations in school-aged children. Furthermore, parents require understanding of their children's changing developmental needs during the early school years to provide them with supportive, age-appropriate contingent responses (Landry et al., 2008). However, whether parents can be educated to alter their daily interactions with their children in order to provide a better learning environment that fosters the development of these skills, has also mainly been studied during infancy and preschool age or in high-risk families. To address whether educating parents to adapt parent-child interactions improves the interaction with their child and subsequently may benefit the development of the neurocognitive functions underlying children's goal-oriented and adaptive social behavior, this thesis had the following aims: (i) to explore the associations between parent-child interaction with attentional control, executive functioning and social cognition in four- to eight-year-old children (**Chapter 2 and 3**); (ii) to investigate the impact of age and gender on the associations between parent-child interaction and neurocognitive functioning in four-to eight-year-olds (**Chapter 2 and 3**); (iii) to explore to what extent parents can be educated to enhance their supportive presence, intrusiveness and questioning style in parent-child interaction (**Chapter 4 and 5**); and (iv) to explore whether improved parent-child interaction results in enhanced neurocognitive functioning (**Chapter 4**); and reasoning, as an important higher order executive functioning component (**Chapter 5**), in their four-to eight-year-old children. Below, the results of the four studies are summarized, followed by a general discussion of the main conclusions, implications for clinical practice, and directions for future research.

Summary of study results

The study described in **Chapter 2** revealed that aspects of attentional control and executive functioning were associated with specific elements of parenting behavior in four-to eight-year-olds. Children of parents who were more supportive and less intrusive displayed better inhibitory control, and children of parents who asked relatively more open-ended questions showed better performance on inhibition, working memory and cognitive flexibility tasks. Some of the associations between parenting strategies and child attentional control and executive functioning were curvilinear and some were moderated by age. More specifically, asking more closed-ended and elaborative questions was curvilinearly associated with inhibitory control. Elaborative questioning was also associated with attentional control and cognitive flexibility in a curvilinear manner. This indicates that more parental investment is not necessarily better; over- or underinvestment may become maladaptive, suggesting the dosage of parental questions should be adaptive to the child's needs. Furthermore, age was found to moderate some of the relations between parenting strategies and attentional control and executive functioning. Only in younger children, more intrusiveness was associated with worse attentional control and more frequent elaborative questioning was associated with decreased inhibitory control. No such negative associations were present in older children. Instead, asking more elaborative questions was associated with better inhibitory control in older children. This indicates that different types of parenting strategies may be either more or less adaptive at different ages. We did not, however, find age to act as a moderator in the relation between parental support and intrusiveness with executive functioning. Rather, our findings supported the presence of a robust relation between support and intrusiveness with inhibitory control, while no associations were found with working memory or cognitive flexibility. As both working memory and cognitive flexibility show a longer developmental trajectory (Best et al., 2009), the influence of parental support and intrusiveness on these executive functioning components might only be detectable at an older age. Our findings extend results from previous studies in younger age groups and suggest that parenting strategies adaptive to both the age and needs of children are associated with better attentional control and executive functioning during the early school years. **Chapter 3** reported on a study that examined gender differences in social cognitive and social behavioral competence and how these were related to specific elements of parenting behavior towards their children. Gender differences in social competence may occur due to exposure to different parenting strategies (differential socialization model) or due to a different impact of similar parenting strategies on boys and girls (differential susceptibility and diathesis-stress model). Parenting strategies did not mediate the relation between gender and social competence, indicating that parents did not treat their sons and daughters differently and that our findings did not support the differential socialization model. Gender differences in parenting might only be detectable at a younger age, as differential socialization has been found to decrease with age (Best & Miller, 2010; Leaper, Anderson, & Sanders, 1998; Lytton & Romney, 1991). It was concluded that parental supportive presence and intrusiveness were related to children's social cognitive and social behavioral competence irrespective of gender. In contrast, parental questioning style did show a gender-differentiated association with social competence. More specifically, asking fewer questions was associated with less optimal social cognitive skills in boys, supporting the diathesis-stress model. In line with chapter 2, some of the associations between parenting behavior and child social competence were moderated by age. Only in older children lower levels of intrusiveness were related to better social cognition, suggesting that how intrusiveness matters in relation to social cognition varies with age. Furthermore, our findings suggest that only parents' questioning style and not aspects of parental sensitivity seems to have a gender-differentiated association with social competence in school-aged children and that parents do not treat their sons and daughters differently at this age.

In **Chapter 4** and **Chapter 5** we investigated whether parents can be educated to shape their daily interactions with their child to provide an optimal learning environment, using the Curious Minds compact educational parent program. We explored whether parent-child interactions improved, and if so, whether this had an effect on the development of their child's attentional control, executive functioning, and reasoning directly after program cessation. Results showed that parents in the educational program condition significantly improved in supportive presence and intrusiveness during parent-child interaction compared to controls (**Chapter 4**). Furthermore, parents in the educational program condition asked significantly more open- than closed-ended questions and more elaborative questions than controls during parent-child interaction (**Chapter 5**). This is in line with the positive results regarding interventions aimed at improving teacher-child relationships in order to promote children's adaptive behavior (e.g. Raver et al., 2008). Parental support or intrusiveness did not act as a mediator between educational condition and child attentional control and executive functioning as reported in **Chapter 4**, suggesting the educational program did not have a short-term effect on children's attentional control and executive functioning development. This study showed, however, that parents within the educational program condition whose interaction with their child improved most on support, had children who performed better on attentional control and executive functioning. Furthermore, more open- than closed-ended questions by parents in the educational program condition resulted in improved scientific reasoning in their children and more elaborative questions resulted in improved social reasoning in **Chapter 5**. Our findings indicate that the parenting strategies observed in this thesis can be educated using a compact, psycho-educational parent program with home assignments. Enhanced reasoning and bigger improvements in attentional control and executive functioning were more common in those four-to-eight-year-old children of parents in the educational program who altered the interaction with their child, underscoring the need for studies assessing variations in educational program responsiveness.

Associations between parent-child interaction and neurocognitive functioning

The findings described in **Chapter 2** and **Chapter 3** suggest that young school-aged children could benefit from interacting with supportive, non-intrusive parents who ask challenging and relatively more open-ended questions. Though non-linear effects have been suggested as representing the best fit to depict parental influence on child development (Kiel et al., 2016) and overinvestment of parents may become maladaptive (Dubas, 2009), not all associations between children's neurocognitive functioning and parent-child interaction were curvilinear. In particular, only parental questioning style and not supportive presence or intrusiveness showed curvilinear associations with aspects of children's neurocognitive functioning. This assumes the presence of an optimal amount of questions by parents, i.e. not too few and not too many, which was linked to increased performance in their children. These associations indicate that an adequate parenting strategy requires more than merely asking more questions and that parental investment in itself does not define adaptive parenting behavior. However, for parental support and intrusiveness only linear associations were found with various aspects of children's neurocognitive functioning, suggesting there is no such thing as being, for example 'too supportive' or 'not intrusive enough'. This is in contrast with the findings from Kiel and colleagues (2016), who showed that child anxiety increased when mothers' intrusiveness was on either end of the continuum (i.e., high or low). This may suggest that the nature of the association (i.e. linear or curved) between parent-child interaction and child functioning differs per domain. For instance, parental intrusiveness may show a curvilinear association with child anxiety, while it relates in a more linear manner to children's executive functioning and social cognition. On the other hand, parents in our non-clinical sample may have shown less frequent intrusive parenting behaviors on either end of the continuum (3.6% of our sample scored on the low end and 2% scored on the high end of the intrusiveness scale), which may have obscured curvilinear associations with neurocognitive functioning.

In addition, the nature of these associations appears to differ per parenting domain, as parental questioning style was found to show both linear and curvilinear associations with children's neurocognitive functioning. For instance, better inhibitory control was more common in children with parents asking not too few and not too many closed-ended questions, while better working memory was associated with fewer closed-ended questions in general. Based on our studies, however, we cannot conclude with any certainty the rationale behind parents' questioning style. In the Curious Minds educational parent program, parents practice to ask more open-ended and elaborative questions to focus and maintain their child's attention, as well as to stimulate cognitive flexibility in problem-solving and reasoning. However, asking more questions may for instance also represent an overall better parental verbal ability or an increased awareness of the importance of having rich verbal communication.

Nonetheless, due to the cross-sectional nature of these studies, it is clear that no answer on causality in these associations can be given and a reversed relation might also be possible. It may be the case that parents, at least partially, adapt their behavior to their child's perceived needs at that particular moment in time. For instance, children's immature cognition may play a role in evoking more parental investment necessary for development, as adults have been shown to attribute positive affect more frequently to children expressing some forms of immature cognition compared to more mature children (see Bjorklund et al., 2009). Parenting strategies could therefore either be a cause or an effect of their child's functioning, or both when assuming a reciprocal relation (e.g. Belsky, Fearon, & Bell, 2007; Eisenberg, Taylor, Widaman, & Spinrad, 2015; Newton, Laible, Carlo, Steele, & McGinley, 2014; Sameroff, 2009). For instance, children with worse inhibitory control may evoke more intrusiveness in their parents in order to keep them focused and children with worse working memory and cognitive flexibility skills may evoke more closed- than open-ended questions in order to reduce the answering options to a clear single choice. Even if parenting strategies are evoked by their child's behavior, parents' choices are likely influenced by their own perceptions and expectations of their child. As parenting strategies and child behavior may reciprocally affect one another, certain parenting strategies may maintain immature cognition in their children. For instance, if a parent expects few inhibitory control skills from his or her child and therefore chooses to be more intrusive, he or she abstains the child from early learning opportunities to practice and internalize these skills. By analogy, if a parent is reluctant in letting go of a child learning to ride a bike, the parent 'abstains' the child from experiencing the balancing on his own, prolonging dependence on the parent. Similarly, parents provide their children with learning opportunities to practice and internalize functions that will help them to control their behavior, like attention, executive functions, and social cognition (e.g. Attili et al., 2010; Bennett et al., 2005; Diamond, 2013; Vygotsky, 1978). However, adaptive and supportive parenting in order to provide optimal learning opportunities requires parental understanding of changing developmental needs during the early school years (Landry et al., 2008). In other words, providing an optimal learning environment by adaptively challenging their child's attentional, executive functioning and social cognitive skills during daily interactions requires realistic parental expectations, in which parents neither over- nor underestimate their child.

Adaptive parenting: Considerations regarding gender and age

While the findings described in **Chapter 3** suggest that parental support and intrusiveness are related to child social competence irrespective of gender, parents' questioning style does seem to have a gender-differentiated association with social competence in young school-aged children. Fewer questions by parents were associated with immature social cognition in boys only, suggesting boys may either be more vulnerable to adverse parenting effects than girls or that immature social cognition in boys but not in girls evokes fewer questions. These findings are however, not compatible with the notion that immature cognition gives rise to more parental investment (i.e. more questions) because parents would find it endearing or are triggered to stimulate their child to catch up in development (Bjorklund et al., 2009). Even though girls were perceived by their parents as being more socially competent at home than boys, girls did not outperform boys on social cognitive skills. If some forms of immature cognition are endearing to adults, early socially competent behavior, in particular in girls, may also be considered endearing (Dubas, 2009). Perhaps, as parents perceive their sons as less socially competent at home regardless of their social cognitive skills, boys have a disadvantage in developing social cognitive skills compared to girls when facing less than optimal parenting conditions. Even though parents did not interact with their sons and daughters differently (i.e. they asked the same amount of questions to their sons as to their daughters), they may differentiate between their sons and their daughters regarding other parenting strategies than those studied. For instance, parents have been shown to talk more about emotions with their four-year-old daughters than with their sons (Aznar & Tenenbaum, 2015; Fivush, Brotman, Buckner, & Goodman, 2000) which predicts emotion understanding, an important aspect of social cognition (Aznar & Tenenbaum, 2013). Nonetheless, similar to our conclusions in **Chapter 2**, our findings indicate that children's social development could benefit from interacting with supportive, non-intrusive parents, irrespective of gender. Only parental questioning style appears to show a gender-differentiated association with children's social competence, suggesting especially boys' social cognitive skills may benefit from a more active questioning style by their parents.

Age mattered in the associations between children's neurocognitive functioning and parenting strategies. Parental intrusiveness and elaborative questioning style were not associated with child attentional control, executive functioning and social cognition across the entire age range in **Chapter 2** and **Chapter 3**. However, not for all parenting strategies age moderating effects were found. Especially parental support and asking open- or closed-ended questions were associated with neurocognitive functioning across the entire age range in this study. Furthermore, our findings suggest that not only the susceptibility to certain parenting strategies shifts with age, but also that how certain parenting strategies matter at different ages varies across different neurocognitive dimensions. For instance, higher levels of intrusiveness were associated with worse attentional control in younger children and with worse social cognitive skills in older children. Perhaps the timeframe of development of certain neurocognitive functions plays a role in how parenting strategies matter at different ages, illustrating the subtle nature of these associations. For instance, although attentional control continues to develop during the primary school period, its development is thought to have its peak during the preschool period (Garon et al., 2008), whereas the development of social cognitive reasoning and perspective taking largely takes place between four years of age and adolescence (Selman, 1980, 2003). This might suggest that as children become more independent (i.e. when children learning to ride a bike are at the stage of trying to balance on their own), they may require a somewhat different approach to achieve optimal development then when they are still completely dependent on parental guidance (i.e. still requiring the assistance of their parent to avoid falling over). However, the peak of development of these functions and thus the timing of becoming more independent does not take place simultaneously, suggesting that the influence of parenting strategies varies at different ages. For instance, children may still require some structure from their parents with regard to more sophisticated social cognitive developmental tasks, such as self- and third-party perspective taking, after they have started school. As such, somewhat higher levels of intrusiveness may still be an appropriate parenting strategy for younger children regarding social cognition, while lower levels of intrusiveness become more adaptive as children grow older and become more autonomous. This is consistent with findings in a slightly younger sample, where parents' verbal structuring had a positive effect on cognitive and social development, but that this effect reversed after age four (Landry, Smith, Swank, & Miller-Loncar, 2000). As parental support and asking open-ended questions do not interfere with the child's autonomy, higher levels of support or more open-ended questions remain an appropriate strategy even as children grow older. Age interaction effects were also found for more elaborative questioning in relation to children's neurocognitive functioning, possibly relating to the difficulty level of the questions parents ask. For instance, some elaborative questions may be too demanding for younger children, whereas they are likely to be stimulating for older children.

Our findings underscore the significant role parents play in stimulating neurocognitive functioning in their children and that age matters in these relations. Parents adjust or are best advised to adjust their parenting strategies to the age and needs of their school-aged children and to flexibly change the way they interact with their child over time. These adaptive parenting behaviors are expected to positively affect their child's attentional control, executive functioning and social cognitive development. However, adaptive and supportive parenting requires parental understanding of changing developmental needs (Landry et al., 2008) and parents may become more involved in their children's learning when they are educated about how their child reasons and learns and how neurocognitive functions develop (Gleason & Schauble, 1999).

Educating parents as change-agents

Educating parents about their children's neurocognitive development may result in them being better equipped to recognize their child's level of competence, allowing them to provide an optimal learning environment by adaptively challenging their child's skills during daily interactions. The opportunity to practice skills like attentional control, executive functioning and reasoning in a natural setting with a familiar adult may be a promising approach to achieve generalized gains (Bierman & Torres, 2016; Kuhn, 2010).

Children need customized stimulation and guidance adapted to the situation, their needs, and the task at hand (Bradley, Pennar, & Iida, 2015). Parents' behavior during parent-child interaction, however, is likely influenced by their own perceptions and expectations of their child, underscoring the influence of realistic parental expectations. Educating parents has been shown to be a successful approach in improving parents' beliefs about scaffolding and the promotion of learning (Gartner et al., 2018). With increased understanding about their child's neurocognitive development and learning, parents may be better able to perceive and to supportively and contingently respond to their child's signals. By educating parents about the development of neurocognitive functions, they are presumably better equipped to facilitate their children's development of attentional control, executive functioning and social cognitive skills through the way they interact with their child on a daily basis. The Curious Minds parent program is a compact educational program teaching parents about how their child reasons and learns, and how to implement neurocognitive functioning practices during daily routines. The program focuses on how to support and scaffold the development of cognitive, social-emotional and self-regulatory skills necessary for adaptive behavior and learning. The aim of the program is twofold: (1) to educate parents about their child's neurocognitive developmental needs; and (2) to educate parents through home-assignments how they can stimulate self-regulation as well as explorative behavior and reasoning abilities through interaction that is sensitive to their child's developmental needs.

The Curious Minds program proved to be successful in improving parental support, intrusiveness and questioning style in **Chapter 4** and **Chapter 5**. The majority of parenting programs targeting for instance school readiness (For a review, see Welsh et al., 2014), focus on enhancing parent-child interaction during infancy and the preschool age in high-risk families, even though the fostering influence of parents on neurocognitive development may be as important at later ages and in low-risk families. Though some of these programs have been shown to be successful in enhancing parental sensitivity and verbal scaffolding (e.g. PALS; Landry et al., 2008), they consist of multiple home-visits and require rather intensive coaching. Low-risk families (e.g. parents with a medium to high educational background with children without major learning or behavioral problems) may deem high intensity parenting programs unnecessary or too time-consuming, hindering efforts to retain parents' engagement in this type of intervention (Welsh, Bierman, & Mathis, 2014). Our study showed that a compact school-based group program for parents may already have a meaningful impact in promoting aspects of parent-child interaction that have been shown to be associated with children's neurocognitive development. Potential benefits of the Curious Minds educational parent program in comparison to for instance home visiting programs include its wide employability and high cost-effectiveness. Furthermore, implementation through the school allows for easy access to many parents of the target population and the compact nature of this four-session program may be more appealing to low-risk families. Despite the compact nature of our educational program, however, attrition in the educational program group was also a challenge in our study.

Providing optimal learning environments through parent-child interaction

Educational parenting programs that have improved parent-child interaction in younger children have predominantly shown small effects on children's functioning (For a review, see Welsh et al., 2014). Programs aimed at improving classroom quality and teacher-child relationships have also shown some promising results, including positive effects on academic learning and executive functioning skills (e.g. Dias & Seabra, 2017; Raver et al., 2011). However, these kinds of programs are often aimed at high-risk low-income samples, which limits generalizability to low-risk families. We explored whether improving parent-child interaction would result in enhanced neurocognitive functioning in a low-risk sample, but thus far, no educational effects were found on school-aged children's attentional control or executive functioning as reported in **Chapter 4**. Previous intervention studies have shown that greater benefits in attentional control and executive functioning can be achieved in children who have larger initial deficits (Diamond & Lee, 2011; Diamond & Ling, 2016; Flook et al., 2010; Karbach & Kray, 2009; Solomon et al., 2018; Tominey & McClelland, 2011). A large majority of parents who participated in this study had a medium to high educational background. Given that deficits are more common among children growing up in a low-income household with parents with low educational backgrounds (Noble, McCandliss, & Farah, 2007), this may explain why no short-term detectable educational program effect on attentional control and executive functioning through improved parent-child interaction was found in this study's sample.

Furthermore, this study assessed the effect of the educational program within a few weeks after the last group session. Perhaps parents need more time implementing what they have learned during daily interactions at home before detectable improvements can be observed. For example, some studies have shown that the effects of an intervention in the classroom context may be larger later (e.g. at a one-year follow-up) than directly after the teacher program (e.g. Dias & Seabra, 2017). In addition, more home assignments with increasing difficulty might be necessary to incite parents to regularly practice neurocognitive functions at home, as these functions need to be continually challenged to see improvements (Diamond & Ling, 2016). Nonetheless, even small improvements in neurocognitive skills may result in large benefits regarding outcomes in later life (Moffitt et al., 2011), suggesting that even small educational effects may become more and more prominent with enough exposure over time.

The Curious Minds educational program did show some positive educational effects regarding children's scientific and social reasoning in **Chapter 5**. This is in line with the conclusion by Diamond and Ling (2016) that intervention effects on children's executive functioning especially seem to appear when higher-order skills are challenged. Children's reasoning skills, an important higher order executive functioning component, may be optimally suited to tap early, subtle improvements in children's executive functioning. Educating parents to modify their questioning style positively influenced the reasoning abilities of their child, which supports the notion that practicing reasoning abilities in the real-life social context using questions to scaffold problem-solving is a promising approach (Kuhn, 2010). However, only the social reasoning skills of those children who were mastering subjective role taking, on average expected to develop between the ages of six and eight, benefitted from having parents who ask more elaborative questions. The majority of children in our sample were likely to be in that particular developmental phase at the time of the study. This emphasizes the importance of an adaptive parental questioning style matching their child's zone of proximal development in order to see improvements (Vygotsky, 1978). Parents in the educational program condition may have become more adaptive in this respect, as they were educated about how their child reasons and learns and practiced social cognitive skills such as perspective taking through home-assignments. How certain parenting strategies affect children's neurocognitive development at different ages appears to vary within the timeframe of development, in line with our findings described in **Chapter 2** and **Chapter 3**. Our findings underscore the importance of the social context of learning and our educational program supports parents to adaptively change the way they interact with their child over time in order to provide an optimal learning environment.

Limitations and directions for future research

Several limitations of the studies in this thesis need to be acknowledged. First, the issue of generalizability. Our sample consisted of children from two Dutch schools in the same provincial region. Furthermore, their parents were more likely to be medium to highly educated. Based on our studies we cannot conclude that our parent educational program is suitable for parents with a lower educational background. This needs to be further addressed in follow-up studies by including more schools representative for the Netherlands and by including parents with a lower educational background, using the educational program format described in this thesis.

Second, the number of repeated observations included in this study. Child neurocognitive functions and parenting strategies were measured at two time points. This limits the possibility to assess these subtle relations over time, as well as reciprocity between parenting and child functioning. Furthermore, some intervention effects may be larger later or require more time to be detected than directly after an educational program (Diamond & Ling, 2016; Dias & Seabra, 2017), or may not sustain. Our findings imply a need for longitudinal studies with multiple post-test measurements to disentangle whether the Curious Minds parent program can achieve generalized and sustained effects on child development, as well as to disentangle transactional processes in parent-child interaction.

Third, there were limitations in the parent-child interactions we observed during home visits. Our parent-child interaction coding system only focused on parenting behaviors. Consequently, real-time bidirectional relations between parenting strategies and child behavior were not investigated, impeding the possibility to investigate transactional processes in parent-child interaction.

Fourth, the cross-sectional character of some of the analyses in this study bring some limitations. As the age interaction effects described in our studies were assessed cross-sectionally, these effects may have been caused by differences between children instead of developmental differences within the same child, asking for studies examining intra-individual relations over time.

Fifth, limitations due to the modest sample size used in some of the analyses. Relatively complex analyses were conducted using a modest sample size. However, cross-validation by examining confidence intervals based on 5000 bias-corrected bootstraps, comparing predicted R^2 values with adjusted R^2 values to avoid overfitted models, and Bayesian analyses raised no major concerns.

Sixth, limitations due to attrition, because not all parents who were assigned to the educational program condition participated in the program or completed all sessions. This may have biased our results due to selective drop-out and prevents us from monitoring which aspects of the parent program work and what works for whom. Nonetheless, parents who were excluded from analyses did not differ from those who remained in the educational program condition.

Seventh, no data were available concerning parental compliance with for instance the home assignments. Home assignments were, however, discussed freely every following session which may have generated cohesiveness and social pressure. Future studies examining the effectiveness of educational parent programs should include measurements of parental compliance.

Finally, as the Leiden Curious Minds cohort only included a first pilot on teacher-educational program effects, it was impossible to investigate whether a more integral approach targeting both the school and the home environment would be more successful, i.e. educating parents and teachers of the same children. As practicing adaptive behavior in the real-life social context with familiar adults may be the most promising approach to achieve generalized gains (Bierman & Torres, 2016; Kuhn, 2010) and repeated practice throughout the day is essential for success (Diamond, 2013), intervention effects on child outcomes may become more feasible when the school environment is also targeted. Future studies should aim to disentangle the effects of intervention approaches aimed at parents as the sole recipient and more integral approaches, using randomized controlled trials targeting the home and school environment both separately and complementarily.

Clinical implications

"Even small changes in developmental timing can lead to big changes in who we become" (Gopnik, 2016, p. 208). Educating parents can benefit children's neurocognitive development and the aspects of parenting strategies investigated in this study could be useful objectives. Supportive and contingent parenting requires parental understanding of the changing developmental needs of their children (Landry et al., 2008) and achieving this understanding may be a difficult process for some parents. For instance, in one study only 25% of mothers from a lower socio-economic background showed relatively stable high levels of sensitive responsiveness to the child's signals and another 25% even decreased dramatically between infancy and the preschool period (Landry et al., 2001). This indicates that, at least for some parents, a compact educational parent program may provide them with the tools to interact with their children in a beneficial way to foster their neurocognitive development. It is important to aspire to develop an educational program that positively impacts all populations of learners. Important questions remain, however, what level of intensity and dosage of such an educational program is required to meaningfully impact neurcognitive development in young school-aged children, and what works for whom. Different families ideally ask for an adaptive approach, customized to their situation and specific parenting challenges. Pinpointing the effective components in customized educational parent programs such as the one described in this thesis, however, remains a difficult challenge for researchers. The demand for evidence-based practice is in stark contrast to the impopularity of replication studies, even though replication is crucial in order to determine whether program success is robust and not an anomaly and whether effects are generalizible to other populations.

Nonetheless, our study showed that a compact school-based group program for parents may already have a meaningful impact in promoting aspects of parent-child interaction that have been shown to be associated with children's neurocognitive development. Potential benefits of this school-based educational group program in comparison to more extensive parenting programs include its high cost-effectiveness and wide employability. Whether a large scale school-based implementation of an educational parent program such as the Curious Minds program is beneficial for children's neurocognitive development, regardless of the educational level of their parents or risk-status of their family is hard to foretell. Given the considerable benefits of optimal neurocognitive functioning development and its impact on many important aspects of life, however, the Curious Minds parent program may be a worthy investment. Provide a sapling with sufficient water and nutrition and it will grow, but provide optimal care adaptive to the individual tree and it will thrive. Educating parents to provide them with the tools to let their child thrive could bring us one step closer to an optimal learning environment for children's neurocognitive development.

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6

Nederlandse samenvatting
Dutch Summary

Naarmate kinderen in de schoolse leeftijd komen, maken zij een belangrijke verandering door van volledige afhankelijkheid van hun ouders naar steeds meer zelfstandigheid. De neurocognitieve ontwikkeling van kinderen wordt in belangrijke mate beïnvloed door de relatie met hun ouders en de omgeving waarin zij opgroeien (Bernier et al., 2012; Diamond, 2013; Fox & Calkins, 2003). Schoolkinderen worden in toenemende mate actieve deelnemers in ouder-kind interacties. Ouders passen gaandeweg hun manier van interacteren systematisch aan met hun kind als leidraad, om deze adaptief uit te dagen en ontwikkeling te stimuleren (Conner & Cross, 2003). Optimale ontwikkeling van neurocognitieve functies zoals aandacht, executieve functies en sociale cognitie is essentieel voor het dagelijks functioneren van kinderen, zowel op school als thuis. Deze functies maken een belangrijke ontwikkeling door tijdens de eerste schooljaren en worden geassocieerd met de kwaliteit van functioneren in een verscheidenheid aan belangrijke aspecten in het dagelijks leven, zoals schools functioneren, gezondheid en carrière (Diamond, 2013).

Passend ouderlijk gedrag tijdens ouder-kind interacties kan de ontwikkeling van aandacht, executieve functies, sociale cognitie en redeneervermogen vormgeven. Desondanks richten veel onderzoeken in dit vakgebied zich op kinderen in de baby- en peuterleeftijd en niet op de ontwikkelingsperiode die daarop volgt. Het is dan ook van belang om meer te weten te komen over de relatie tussen ouder-kind interactie en neurocognitieve ontwikkeling bij kinderen in de schoolse leeftijd. Daarnaast is het voor ouders van belang dat zij een duidelijk beeld hebben van de veranderende ontwikkelingsbehoeften van hun kind tegen de tijd dat deze naar school gaat, om zo op een ondersteunende en leeftijdsadequate manier op hem of haar te kunnen reageren (Landry et al., 2008). Dit roept de vraag op of ouders kunnen worden onderwezen om de dagelijkse interacties met hun kind op zo'n manier aan te passen dat ze een optimale leeromgeving voor neurocognitieve ontwikkeling creëren. Tot dusverre is er in dit thema echter voornamelijk onderzoek gedaan binnen hoog-risico gezinnen en gezinnen met jongere kinderen.

Dit promotieonderzoek was erop gericht om meer inzicht te krijgen in de aard van de relaties tussen ouder-kind interactie en de ontwikkeling van de neurocognitieve functies onderliggend aan doelgericht en sociaal adaptief gedrag bij vier- tot achtjarige kinderen. Daarnaast is onderzocht of een compact educatief ouderprogramma ertoe leidt dat ouders de interactie met hun kind aanpassen en of dit vervolgens van invloed is op de ontwikkeling van het neurocognitief functioneren bij hun kind. In **hoofdstuk 2** en **hoofdstuk 3** is er onderzoek gedaan naar de relaties tussen ouder-kind interactie (de mate van support, intrusiviteit en de manier van vragen stellen) met aandacht functies, executieve functies en sociale cognitie bij schoolkinderen, en welke rol hun leeftijd en geslacht spelen in deze relaties. In **hoofdstuk 4** en **hoofdstuk 5** is onderzocht in hoeverre een compact educatief ouderprogramma ertoe leidt dat ouders hun mate van support en intrusiviteit en hun manier van vragen stellen aanpassen tijdens ouder-kind interacties en of deze aangepaste interacties mogelijk leiden tot verbeterd neurocognitief functioneren van hun kinderen.

Samenvatting belangrijkste resultaten

In **hoofdstuk 2** is aangetoond dat aspecten van aandacht en executieve functies gerelateerd waren aan specifieke aspecten van ouderlijk gedrag tijdens ouder-kind interactie. Kinderen van ouders die een hogere mate van support lieten zien en in mindere mate intrusief waren tijdens ouder-kind interactie lieten betere inhibitievaardigheden zien. Daarnaast presteerden kinderen beter wat betreft inhibitie, werkgeheugen en cognitieve flexibiliteit wanneer hun ouders relatief meer open- dan gesloten vragen stelden. Interessant was dat een aantal van deze relaties curvilinear was (ofwel het beste kon worden weergegeven door een curve in plaats van een rechte lijn) en dat in sommige van deze relaties leeftijd een rol speelde. Het stellen van gesloten vragen en het stellen van onderzoekende vragen (***wat zie je***; ***waarom denk je dat***; ***hoe ga je het aanpakken***) kon in relatie met inhibitievaardigheden bij kinderen het beste worden weergegeven door een curve. Kinderen van ouders die niet teveel, maar ook niet te weinig gesloten- en onderzoekende vragen stelden, lieten een betere inhibitie zien. Aandacht en cognitieve flexibliteit bij kinderen kon in relatie met het stellen van onderzoekende vragen op een vergelijkbare manier het beste worden weergegeven door een curve. Deze bevindingen betekenen dat meer investering door ouders niet per definitie beter is; over- of onderinvestering kan maladaptief zijn, wat suggereert dat de hoeveelheid vragen die ouders aan hun kind stellen aangepast dient te zijn aan het niveau van hun kind. Daarnaast speelde leeftijd een rol in een aantal relaties tussen ouderlijk gedrag met aandacht en executief functioneren. Alleen bij relatief jongere kinderen was een hogere mate intrusiviteit gerelateerd aan zwakkere aandacht functies en was het stellen van meer onderzoekende vragen gerelateerd aan verminderde inhibitie. Bij relatief oudere kinderen was een omgekeerd verband zichtbaar: het stellen van meer onderzoekende vragen was gerelateerd aan verbeterde inhibitievaardigheden.

Deze bevindingen suggereren dat verschillende aspecten van ouderlijk gedrag ofwel meer of minder adaptief zijn tijdens ouder-kind interactie voor kinderen van verschillende leeftijden. Leeftijd speelde geen rol in het verband tussen de mate van ouderlijke support en intrusiviteit met het executief functioneren. Er was sprake van een robuuste relatie tussen de mate van support en intrusiviteit met inhibitie, terwijl er geen verbanden werden gevonden met werkgeheugen en cognitieve flexibiliteit. Kinderen van ouders die een hogere mate van support lieten zien en in mindere mate intrusief waren tijdens ouder-kind interactie, lieten betere inhibitievaardigheden zien, ongeacht de leeftijd van het kind. Aangezien zowel werkgeheugen als cognitieve flexibiliteit een langer ontwikkelingsverloop hebben (Best et al., 2009), is de invloed van de mate van ouderlijke support en intrusiviteit op deze componenten van executief functioneren mogelijk alleen waarneembaar op iets oudere leeftijd. Onze bevindingen zijn een aanvulling op onderzoek naar jongere leeftijdsgroepen en suggereren dat adaptief ouderlijk gedrag, zowel wat betreft de leeftijd als het niveau van het kind, gerelateerd is aan verbeterde aandacht en executief functioneren bij kinderen tijdens de eerste schooljaren.

In **hoofdstuk 3** zijn geslachtsverschillen in sociale cognitie en sociaal gedrag onderzocht en hoe deze vaardigheden gerelateerd zijn aan specifieke elementen van ouderlijk gedrag tijdens ouder-kind interactie. Geslachtsverschillen in sociale competentie zijn mogelijk een gevolg van blootstelling aan verschillend ouderlijk gedrag naar jongens en meisjes ***(differential socialization model)*** of een gevolg van vergelijkbaar ouderlijk gedrag met een verschillend effect op jongens en meisjes ***(differential susceptibility*** en ***diathesis-stress model).*** Deze studie toonde aan dat er geen sprake was van mediatie van ouderlijk gedrag tijdens ouder-kind interactie in de relatie tussen geslacht en sociale competentie. Dit houdt in dat ouders geen ander gedrag lieten zien naar hun zonen en dochters en dat het ***differential socialization model*** niet werd bevestigd. Verschillend ouderlijk gedrag naar jongens en meisjes is mogelijk alleen waarneembaar op iets jongere leeftijd, aangezien eerder onderzoek heeft aangetoond dat geslachtsverschillen in ouderlijk gedrag afnemen naarmate kinderen ouder worden (Endendijk et al., 2016; Leaper et al., 1998; Lytton & Romney, 1991). De mate van ouderlijke support en intrusiviteit tijdens ouder-kind interactie was gerelateerd aan sociale cognitie en sociaal gedrag bij kinderen ongeacht hun geslacht. De relatie tussen het stellen van vragen en sociale cognitie had echter wel een verschillend verband voor jongens en meisjes. Alleen bij jongens was het stellen van minder vragen gerelateerd aan een verminderde sociale cognitie, wat het ***diathesis-stress model*** ondersteunt. Vergelijkbaar met de conclusies in hoofdstuk 2, speelde leeftijd een rol in een aantal relaties tussen ouderlijk gedrag tijdens ouder-kind interactie en sociale competentie. Alleen in relatief oudere kinderen was een lagere mate van ouderlijke intrusiviteit tijdens ouder-kind interactie gerelateerd aan verbeterde sociale cognitie. Dit suggereert dat hoe ouderlijke intrusiviteit van belang is in relatie tot sociale cognitie, verandert met de leeftijd van hun kind. Onze bevindingen suggereren dat alleen de manier van vragenstellen en niet de mate van ouderlijke support of intrusiviteit tijdens ouder-kind interactie verschillende verbanden liet zien met sociale competentie voor jongens en meisjes en dat ouders hun zoons en dochters niet anders behandelen tijdens ouder-kind interactie op deze leeftijd.

In **hoofdstuk 4** en **hoofdstuk 5** is onderzocht of het Curious Minds compacte educatieve ouderprogramma ertoe leidt dat ouders de interactie met hun kind aanpassen om zo een optimale leeromgeving te creëren. Er is onderzocht of ouders hun mate van support en intrusiviteit en hun manier van vragen stellen veranderden en of deze aangepaste interactie mogelijk leidde tot verbeterde aandacht, executief functioneren en redeneervermogen direct na afloop van het ouderprogramma. Ouders die het ouderprogramma hadden gevolgd lieten een significante verbetering in de mate van support en intrusiviteit zien tijdens ouder-kind interactie in vergelijking met controles (**hoofdstuk 4**). Daarnaast stelden ouders die het ouderprogramma hadden gevolgd significant meer open- dan gesloten vragen en meer onderzoekende vragen tijdens ouder-kind interactie dan controles (**hoofdstuk 5**). Onze bevindingen zijn een aanvulling op de positieve resultaten die zijn gevonden in onderzoek naar het verbeteren van leerkracht-leerling relaties met als doel adaptief gedrag van kinderen te promoten (e.g. Raver et al., 2008). Er was geen sprake van mediatie door de mate van ouderlijke support of intrusiviteit tijdens ouder-kind interactie in de relatie tussen het educatieve programma met aandacht en executief functioneren zoals beschreven in **hoofdstuk 4**. Dit suggereert dat er geen korte termijn effect was van het programma op het neurocognitief functioneren. Deze studie toonde echter wel aan dat kinderen van ouders die na het volgen van het educatieve programma het sterkst waren verbeterd in de mate van support, beter presteerden op aandacht en executief functioneren.

Daarnaast resulteerde het stellen van meer open- dan gesloten vragen door ouders na het volgen van het educatieve programma in verbeterd wetenschappelijk redeneervermogen bij hun kinderen in **hoofdstuk 5**. Het stellen van meer onderzoekende vragen tijdens ouder-kind interactie leidde in hetzelfde hoofdstuk tot een verbeterd sociaal redeneervermogen. Onze bevindingen suggereren dat het ouderlijk gedrag tijdens ouder-kind interactie zoals geobserveerd in dit proefschrift kan worden onderwezen door middel van een compact educatief ouderprogramma met huiswerkopdrachten. Een verbeterd redeneervermogen en meer vooruitgang in aandacht en executief functioneren kwamen vaker voor bij kinderen van ouders die hun ouder-kind interacties aanpasten na het volgen van het educatieve programma, wat het belang van studies naar variaties in het effect van educatieve programma's benadrukt.

Klinische implicaties

"Even small changes in developmental timing can lead to big changes in who we become" (Gopnik, 2016, p. 208). Een educatief ouderprogramma kan ten gunste komen aan de neurocognitieve ontwikkeling van schoolkinderen en de aspecten van ouderlijk gedrag tijdens ouder-kind interactie die zijn onderzocht in dit proefschrift kunnen nuttige aanknopingspunten zijn. Om hun kinderen op een adaptieve manier te kunnen ondersteunen hebben ouders kennis nodig over de veranderende ontwikkelingsbehoeften van hun kind (Landry et al., 2008). Deze kennis hoeft echter niet voor alle ouders vanzelfsprekend te zijn. Een eerdere studie heeft bijvoorbeeld aangetoond dat slechts 25% van de moeders van een lagere sociaal-economische status relatief stabiel bleef in hun mate van sensitiviteit voor de signalen van hun kind en dat nog eens 25% zelfs sterk achteruitging in sensitiviteit tussen de baby- en peuterleeftijd (Landry et al., 2001). Dit houdt in dat, in ieder geval voor sommige ouders, een compact educatief ouderprogramma een uitkomst zou kunnen zijn door handvatten te geven om ouder-kind interacties vorm te geven en een optimale leeromgeving voor de neurocognitieve ontwikkeling te creëren.

Het is van belang ernaar te streven een educatief programma te ontwikkelen dat alle ouderpopulaties bereikt. Belangrijke vragen blijven dan echter hoe intensief het programma dient te zijn en hoeveel sessies een dergelijk programma nodig heeft om een betekenisvolle bijdrage te leveren, los van de vraag wat werkt voor wie. Idealiter vragen verschillende families om een benadering op maat, specifiek toegespitst op hun gezinssituatie en specifieke uitdagingen tijdens de opvoeding. Het uitlichten van de effectieve componenten in een interactief educatief ouderprogramma zoals beschreven in dit proefschrift, blijft echter een lastige uitdaging voor onderzoekers. De vraag naar evidence-based werken in de praktijk staat in schril contrast met de impopulariteit van replicatiestudies, ondanks dat replicatie van interventieonderzoek cruciaal is om te bepalen of een programma daadwerkelijk de gewenste resultaten oplevert en of de effecten generaliseerbaar zijn naar andere populaties.

Desondanks is in dit proefschrift aangetoond dat een compact educatief ouderprogramma dat wordt aangeboden via de school al een betekenisvolle rol kan spelen in het promoten van specifieke aspecten van de ouder-kind interactie, die gerelateerd zijn aan de neurocognitieve ontwikkeling van schoolkinderen. In vergelijking met meer intensieve ouderprogramma's heeft dit groepsprogramma dat kan worden aangeboden via de school een aantal potentiële voordelen, waaronder de brede inzetbaarheid en hoge kosteneffectiviteit. Het is moeilijk te voorspellen of het grootschalig implementeren van een educatief ouderprogramma zoals het Curious Minds programma op scholen effectief is voor de neurocognitieve ontwikkeling van kinderen ongeacht de achtergrond van hun ouders en eventuele problematiek binnen het gezin. Gezien het aanzienlijke belang van een optimale neurocognitieve ontwikkeling van kinderen en de impact hiervan op vele belangrijke aspecten in het leven, zou het Curious Minds programma een waardevolle investering kunnen zijn. Geef een jong plantje voldoende water en voeding en het zal groeien, maar geef het optimale zorg toegespitst op de specifieke plant en het zal het volledige potentieel waarmaken. Een educatief ouderprogramma waarin ouders handvatten krijgen om hun kind zijn of haar volledige potentieel te laten benutten kan ons een stapje dichter bij een optimale leeromgeving voor de neurocognitieve ontwikkeling van kinderen brengen.

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Work it harder
Make it better
Do it faster
Makes us stronger
More than ever
Hour after
Our work is
Never over | Daft Punk, 2001

Zo voelde het soms wel een beetje – maar nu is het toch echt 'over'! De hoogste tijd om in deze laatste woorden iedereen te bedanken die op enige manier heeft bijgedragen aan de totstandkoming van dit proefschrift.

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Andrea Spruijt was born on June 29, 1989 in Delft, the Netherlands. After completion of her secondary education at the Interconfessionele Scholengemeenschap Westland in Naaldwijk (2007) she studied Education and Child Studies at Leiden University, specializing in Clinical Child and Adolescent Studies. After obtaining her bachelor degree in 2010 she started the research master, Developmental Psychopathology in Education and Child Studies, which she finished in 2012. During this research master she did a clinical internship at the Leiden University Ambulatorium (Centre for Child and Adolescent Psychology), where she obtained the Certificate Psychodiagnostic assessment (NVO Basisaantekening Psychodiagnostiek). In 2013 she started her PhD research at the department of Clinical Neurodevelopmental Studies at Leiden University examining relations between parent-child interaction and neurocognitive functioning in four- to eight-year-olds. From May 2018 she works as a senior researcher at Yulius Academy.

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