



Universiteit
Leiden
The Netherlands

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

Spruijt, A.M.

Citation

Spruijt, A. M. (2019, September 25). *Curious minds: stimulating parent-child interaction to foster neurocognitive functioning in four- to eight-year-olds*. Retrieved from <https://hdl.handle.net/1887/77911>

Version: Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/77911>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The following handle holds various files of this Leiden University dissertation:
<http://hdl.handle.net/1887/77911>

Author: Spruijt, A.M.

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

Issue Date: 2019-09-25



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 than 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 neurocognitive 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 generalizable 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.

REFERENCES

- Ailincăi, R., & Weil-Barais, A. (2013). Parenting Education: Which Intervention Model to Use? *Procedia - Social and Behavioral Sciences*, *106*, 2008-2021. doi: 10.1016/j.sbspro.2013.12.229
- Attili, G., Vermigli, P., & Roazzi, A. (2010). Children's Social Competence, Peer Status, and the Quality of Mother-Child and Father-Child Relationships. *European Psychologist*, *15*(1), 23-33. doi: 10.1027/1016-9040/a000002
- Aznar, A., & Tenenbaum, H. R. (2013). Spanish parents' emotion talk and their children's understanding of emotion. *Frontiers in Psychology*, *4*, 670. doi: 10.3389/fpsyg.2013.00670
- Aznar, A., & Tenenbaum, H. R. (2015). Gender and age differences in parent-child emotion talk. *British Journal of Developmental Psychology*, *33*(1), 148-155. doi: 10.1111/bjdp.12069
- Baron-Cohen, S., Ring, H. A., Wheelwright, S., Bullmore, E. T., Brammer, M. J., Simmons, A., & Williams, S. C. (1999). Social intelligence in the normal and autistic brain: an fMRI study. *European Journal of Neuroscience*, *11*(6), 1891-1898.
- Beauchamp, M. H., & Anderson, V. (2010). SOCIAL: an integrative framework for the development of social skills. *Psychological Bulletin*, *136*(1), 39-64. doi: 10.1037/a0017768
- Belsky, J., Fearon, P. R. M., & Bell, B. (2007). Parenting, attention and externalizing problems: testing mediation longitudinally, repeatedly and reciprocally. *Journal of Child Psychology and Psychiatry*, *48*(12), 1233-1242. doi: 10.1111/j.1469-7610.2007.01807
- Bennett, S., Farrington, D. P., & Huesmann, L. R. (2005). Explaining gender differences in crime and violence: The importance of social cognitive skills. *Aggression and Violent Behavior*, *10*(3), 263-288. doi: 10.1016/j.avb.2004.07.001
- Bergman Nutley, S., Soderqvist, S., Bryde, S., Thorell, L. B., Humphreys, K., & Klingberg, T. (2011). Gains in fluid intelligence after training non-verbal reasoning in 4-year-old children: a controlled, randomized study. *Developmental Science*, *14*(3), 591-601. doi: 10.1111/j.1467-7687.2010.01022
- Bernier, Carlson, S. M., Deschenes, M., & Matte-Gagne, C. (2012). Social factors in the development of early executive functioning: a closer look at the caregiving environment. *Developmental Science*, *15*(1), 12-24. doi: 10.1111/j.1467-7687.2011.01093
- Best, J. R., & Miller, P. H. (2010). A Developmental Perspective on Executive Function. *Child Development*, *81*(6), 1641-1660. doi: 10.1111/j.1467-8624.2010.01499
- Best, J. R., Miller, P. H., & Jones, L. L. (2009). Executive functions after age 5: Changes and correlates. *Developmental Review*, *29*(3), 180-200. doi: 10.1016/j.dr.2009.05.002
- Bierman, K. L., & Torres, M. (2016). Promoting the Development of Executive Functions through Early Education and Prevention Programs. In J. A. Griffin, L. S. Freund, & P. McCardle (Eds.), *Executive function in preschool age children: Integrating measurement, neurodevelopment and translational research*. (pp. 299-326). Washington, D.C: American Psychological Association.
- Bjorklund, D. F. (2018). A Metatheory for Cognitive Development (or "Piaget is Dead" Revisited). *Child Development*, n/a-n/a. doi: 10.1111/cdev.13019

- Bjorklund, D. F., Periss, V., & Causey, K. (2009). The benefits of youth. *European Journal of Developmental Psychology*, 6(1), 120-137. doi: 10.1080/17405620802602334
- Bodrova, E., & Leong, D. J. (2007). Tools of the mind. *Columbus, OH: Pearson*.
- Bradley, R. H., Pennar, A., & Iida, M. (2015). Ebb and Flow in Parent-Child Interactions: Shifts from Early through Middle Childhood. *Parenting*, 15(4), 295-320. doi: 10.1080/15295192.2015.1065120
- Casey, B. J., Tottenham, N., Liston, C., & Durston, S. (2005). Imaging the developing brain: what have we learned about cognitive development? *Trends in Cognitive Sciences*, 9(3), 104-110. doi: 10.1016/j.tics.2005.01.011
- Cohen, R. A. (2014). Focused and Sustained Attention *The Neuropsychology of Attention* (pp. 89-112). Boston, MA: Springer US.
- Conner, D. B., & Cross, D. R. (2003). Longitudinal analysis of the presence, efficacy and stability of maternal scaffolding during informal problem-solving interactions. *British Journal of Developmental Psychology*, 21(3), 315-334. doi:10.1348/026151003322277720
- Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, 44(11), 2037-2078. doi: 10.1016/j.neuropsychologia.2006.02.006
- Diamond, A. (2013). Executive Functions. *Annual Review of Psychology*, 64(1), 135-168. doi: 10.1146/annurev-psych-113011-143750
- Diamond, A., Barnett, W. S., Thomas, J., & Munro, S. (2007). Preschool Program Improves Cognitive Control. *Science (New York, N.Y.)*, 318(5855), 1387-1388. doi: 10.1126/science.1151148
- Diamond, A., & Lee, K. (2011). Interventions shown to Aid Executive Function Development in Children 4–12 Years Old. *Science (New York, N.Y.)*, 333(6045), 959-964. doi: 10.1126/science.1204529
- Diamond, A., & Ling, D. S. (2016). Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not. *Developmental Cognitive Neuroscience*, 18(Supplement C), 34-48. doi: 10.1016/j.dcn.2015.11.005
- Dias, N. M., & Seabra, A. G. (2017). Intervention for executive functions development in early elementary school children: effects on learning and behaviour, and follow-up maintenance. *Educational Psychology*, 37(4), 468-486. doi: 10.1080/01443410.2016.1214686
- Dieterich, S. E., Assel, M. A., Swank, P., Smith, K. E., & Landry, S. H. (2006). The impact of early maternal verbal scaffolding and child language abilities on later decoding and reading comprehension skills. *Journal of School Psychology*, 43(6), 481-494. doi: 10.1016/j.jsp.2005.10.003
- Dotterer, A. M., Iruka, I. U., & Pungello, E. (2012). Parenting, Race, and Socioeconomic Status: Links to School Readiness. *Family Relations*, 61(4), 657-670. doi: 10.1111/j.1741-3729.2012.00716
- Dubas, J. S. (2009). Integrating childhood in the family context: Commentary on Bjorklund, Periss and Causey. *European Journal of Developmental Psychology*, 6(1), 138-145. doi: 10.1080/17405620802602367
- Eisenberg, N., Taylor, Z. E., Widaman, K. F., & Spinrad, T. L. (2015). Externalizing symptoms, effortful control, and intrusive parenting: A test of bidirectional longitudinal relations during early childhood. *Developmental Psychopathology*, 27(4 Pt 1), 953-968. doi: 10.1017/s0954579415000620

- Engelmann, K., Neuhaus, B. J., & Fischer, F. (2016). Fostering scientific reasoning in education – meta-analytic evidence from intervention studies. *Educational Research and Evaluation*, 22(5-6), 333-349. doi: 10.1080/13803611.2016.1240089
- Englund, M. M., Luckner, A. E., Whaley, G. J. L., & Egeland, B. (2004). Children's Achievement in Early Elementary School: Longitudinal Effects of Parental Involvement, Expectations, and Quality of Assistance. *Journal of Educational Psychology*, 96(4), 723-730. doi: 10.1037/0022-0663.96.4.723
- Fay-Stammbach, T., Hawes, D. J., & Meredith, P. (2014). Parenting Influences on Executive Function in Early Childhood: A Review. *Child Development Perspectives*, 8(4), 258-264. doi: 10.1111/cdep.12095
- Fivush, R., Brotman, M. A., Buckner, J. P., & Goodman, S. H. (2000). Gender Differences in Parent-Child Emotion Narratives. *Sex Roles*, 42(3), 233-253. doi: 10.1023/a:1007091207068
- Flook, L., Smalley, S. L., Kitil, M. J., Galla, B. M., Kaiser-Greenland, S., Locke, J., . . . Kasari, C. (2010). Effects of Mindful Awareness Practices on Executive Functions in Elementary School Children. *Journal of Applied School Psychology*, 26(1), 70-95. doi: 10.1080/15377900903379125
- Fox, N. A., & Calkins, S. D. (2003). The Development of Self-Control of Emotion: Intrinsic and Extrinsic Influences. *Motivation and Emotion*, 27(1), 7-26. doi: 10.1023/a:1023622324898
- Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, 134(1), 31-60. doi: 10.1037/0033-2909.134.1.31
- Gartner, K. A., Vetter, V. C., Schaferling, M., Reuner, G., & Hertel, S. (2018). Training of parental scaffolding in high-socio-economic status families: How do parents of full- and preterm-born toddlers benefit? *British Journal of Educational Psychology*, 88(2), 300-322. doi: 10.1111/bjep.12218
- Giesbrecht, G. F., Muller, U., & Miller, M. R. (2010). Psychological distancing in the development of executive function and emotion regulation. In B. W. Sokel, U. Muller, J. Carpendale, A. Young, & G. Iarocci (Eds.), *Self- and social-regulation: The development of social interaction, social understanding, and executive functions* (pp. 337-357). New York: Oxford University Press.
- Gleason, M. E., & Schauble, L. (1999). Parents' Assistance of Their Children's Scientific Reasoning. *Cognition and Instruction*, 17(4), 343-378. doi: 10.1207/S1532690XCI1704_1
- Gopnik, A. (2016). *The Gardener and the Carpenter: What the New Science of Child Development Tells Us About the Relationship Between Parents and Children*: Random House.
- Green, C. T., Bunge, S. A., Briones Chiongbian, V., Barrow, M., & Ferrer, E. (2017). Fluid reasoning predicts future mathematical performance among children and adolescents. *Journal of Experimental Child Psychology*, 157(Supplement C), 125-143. doi: 10.1016/j.jecp.2016.12.005
- Hofmann, S., Doan, S. N., Sprung, M., Wilson, A., Ebesutani, C., Andrews, L., . . . Harris, P. L. (2016). Training children's theory-of-mind: A meta-analysis of controlled studies. *Cognition*, 150, 200-212. doi: 10.1016/j.cognition.2016.01.006
- Holmes, J., Gathercole, S. E., & Dunning, D. L. (2009). Adaptive training leads to sustained enhancement of poor working memory in children. *Developmental Science*, 12(4), F9-15. doi: 10.1111/j.1467-7687.2009.00848
- Karbach, J., & Kray, J. (2009). How useful is executive control training? Age differences in near and far transfer of task-switching training. *Developmental Science*, 12(6), 978-990. doi: 10.1111/j.1467-7687.2009.00846

- Kiel, E. J., Premo, J. E., & Buss, K. A. (2016). Maternal Encouragement to Approach Novelty: A Curvilinear Relation to Change in Anxiety for Inhibited Toddlers. *Journal of Abnormal Child Psychology*, *44*(3), 433-444. doi: 10.1007/s10802-015-0038-3
- Kolb, B., & Gibb, R. (2011). Brain Plasticity and Behaviour in the Developing Brain. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, *20*(4), 265-276.
- Korkman, M., Kemp, S. L., & Kirk, U. (2001). Effects of Age on Neurocognitive Measures of Children Ages 5 to 12: A Cross-Sectional Study on 800 Children From the United States. *Developmental Neuropsychology*, *20*(1), 331-354. doi: 10.1207/S15326942DN2001_2
- Korkman, M., Lahti-Nuuttila, P., Laasonen, M., Kemp, S. L., & Holdnack, J. (2013). Neurocognitive development in 5- to 16-year-old North American children: A cross-sectional study. *Child Neuropsychology*, *19*(5), 516-539. doi: 10.1080/09297049.2012.705822
- Kuhn, D. (2010). What is Scientific Thinking and How Does it Develop? *The Wiley-Blackwell Handbook of Childhood Cognitive Development* (pp. 497-523): Wiley-Blackwell.
- Landry, S. H., Smith, K. E., Swank, P. R., Assel, M. A., & Vellet, S. (2001). Does early responsive parenting have a special importance for children's development or is consistency across early childhood necessary? *Developmental Psychology*, *37*(3), 387-403.
- Landry, S. H., Smith, K. E., Swank, P. R., & Guttentag, C. (2008). A Responsive Parenting Intervention: The Optimal Timing Across Early Childhood For Impacting Maternal Behaviors And Child Outcomes. *Developmental Psychology*, *44*(5), 1335-1353. doi: 10.1037/a0013030
- Landry, S. H., Smith, K. E., Swank, P. R., & Miller-Loncar, C. L. (2000). Early maternal and child influences on children's later independent cognitive and social functioning. *Child Development*, *71*(2), 358-375.
- Leaper, C., Anderson, K. J., & Sanders, P. (1998). *Moderators of gender effects on parents' talk to their children: a meta-analysis*: American Psychological Association.
- Lengua, L. J., Honorado, E., & Bush, N. R. (2007). Contextual risk and parenting as predictors of effortful control and social competence in preschool children. *Journal of Applied Developmental Psychology*, *28*(1), 40-55. doi: 10.1016/j.appdev.2006.10.001
- Lewis, C., & Carpendale, J. I. M. (2009). Introduction: Links between social interaction and executive function. *New Directions for Child and Adolescent Development*, *2009*(123), 1-15. doi: 10.1002/cd.232
- Lytton, H., & Romney, D. M. (1991). Parents' differential socialization of boys and girls: A meta-analysis. *Psychological Bulletin*, *109*(2), 267-296. doi: 10.1037/0033-2909.109.2.267
- Mermelshtine, R. (2017). Parent-child learning interactions: A review of the literature on scaffolding. *British Journal of Educational Psychology*, *87*(2), 241-254. doi: 10.1111/bjep.12147
- Miller Singley, A. T., & Bunge, S. A. (2014). Neurodevelopment of relational reasoning: Implications for mathematical pedagogy. *Trends in Neuroscience and Education*, *3*(2), 33-37. doi: 10.1016/j.tine.2014.03.001
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: a latent variable analysis. *Cognitive Psychology*, *41*(1), 49-100. doi: 10.1006/cogp.1999.0734
- Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., . . . Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, *108*(7), 2693-2698. doi: 10.1073/pnas.1010076108

- Newton, E. K., Laible, D., Carlo, G., Steele, J. S., & McGinley, M. (2014). Do sensitive parents foster kind children, or vice versa? Bidirectional influences between children's prosocial behavior and parental sensitivity. *Developmental Psychology, 50*(6), 1808-1816. doi: 10.1037/a0036495
- Noble, K. G., McCandliss, B. D., & Farah, M. J. (2007). Socioeconomic gradients predict individual differences in neurocognitive abilities. *Developmental Science, 10*(4), 464-480. doi: 10.1111/j.1467-7687.2007.00600
- Peterson, C. C., Wellman, H. M., & Slaughter, V. (2012). The Mind Behind the Message: Advancing Theory-of-Mind Scales for Typically Developing Children, and Those With Deafness, Autism, or Asperger Syndrome. *Child Development, 83*(2), 469-485. doi: 10.1111/j.1467-8624.2011.01728
- Raver, C. C., Jones, S. M., Li-Grining, C., Zhai, F., Bub, K., & Pressler, E. (2011). CSR's Impact on Low-Income Preschoolers' Preacademic Skills: Self-Regulation as a Mediating Mechanism. *Child Development, 82*(1), 362-378. doi: 10.1111/j.1467-8624.2010.01561
- Raver, C. C., Jones, S. M., Li-Grining, C. P., Metzger, M., Smallwood, K., & Sardin, L. (2008). Improving Preschool Classroom Processes: Preliminary Findings from a Randomized Trial Implemented in Head Start Settings. *Early Childhood Research Quarterly, 63*(3), 253-255. doi: 10.1016/j.ecresq.2007.09.001
- Romine, C. B., & Reynolds, C. R. (2005). A Model of the Development of Frontal Lobe Functioning: Findings From a Meta-Analysis. *Applied Neuropsychology, 12*(4), 190-201. doi: 10.1207/s15324826an1204_2
- Rutter, M., Caspi, A., & Moffitt, T. E. (2003). Using sex differences in psychopathology to study causal mechanisms: unifying issues and research strategies. *Journal of Child Psychology and Psychiatry, 44*(8), 1092-1115. doi: 10.1111/1469-7610.00194
- Sameroff, A. (2009). *The transactional model*: American Psychological Association.
- Selman, R. L. (1980). *The growth of interpersonal understanding*: Academic Press New York.
- Selman, R. L. (2003). *Promotion of Social Awareness: Powerful Lessons for the Partnership of Developmental Theory and*: Russell Sage Foundation.
- Shala, M. (2013). The impact of preschool social-emotional development on academic success of elementary school students. *Psychology, 4*(11), 787.
- Solomon, T., Plamondon, A., O'Hara, A., Finch, H., Goco, G., Chaban, P., . . . Tannock, R. (2018). A Cluster Randomized-Controlled Trial of the Impact of the Tools of the Mind Curriculum on Self-Regulation in Canadian Preschoolers. *Frontiers in Psychology, 8*, 2366-2366. doi: 10.3389/fpsyg.2017.02366
- Spinrad, T. L., Eisenberg, N., Gaertner, B., Popp, T., Smith, C. L., Kupfer, A., . . . Hofer, C. (2007). Relations of Maternal Socialization and Toddlers' Effortful Control to Children's Adjustment and Social Competence. *Developmental Psychology, 43*(5), 1170-1186. doi: 10.1037/0012-1649.43.5.1170
- Stright, A. D., Herr, M. Y., & Neitzel, C. (2009). Maternal scaffolding of children's problem solving and children's adjustment in kindergarten: Hmong families in the United States. *Journal of Educational Psychology, 101*(1), 207-218. doi: 10.1037/a0013154
- Thorell, L. B., Lindqvist, S., Bergman Nutley, S., Bohlin, G., & Klingberg, T. (2009). Training and transfer effects of executive functions in preschool children. *Developmental Science, 12*(1), 106-113. doi: 10.1111/j.1467-7687.2008.00745
- Tominey, S. L., & McClelland, M. M. (2011). Red Light, Purple Light: Findings From a Randomized Trial Using Circle Time Games to Improve Behavioral Self-Regulation in Preschool. *Early Education and Development, 22*(3), 489-519. doi: 10.1080/10409289.2011.574258

- Trivette, C. M., Dunst, C. J., & Hamby, D. W. (2010). Influences of Family-Systems Intervention Practices on Parent-Child Interactions and Child Development. *Topics in Early Childhood Special Education*, 30(1), 3-19. doi: 10.1177/0271121410364250
- Van Geert, P. (2011). *Talent for science and technology in children and their educators. Drawing the contours of the talent map.* Retrieved from http://www.fi.uu.nl/publicaties/literatuur/2011_talentenkaart.pdf
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Welsh, J. A., Bierman, K. L., & Mathis, E. T. (2014). Parenting programs that promote school readiness. . In B. M. & B. K. (Eds.), *Promoting School Readiness and Early Learning: The Implications of Developmental Research for Practice*. (pp. 253–278). New York, N.Y: Guilford Press.

