

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

Resubmission date: 18 August 2017

Word count: 9.914 excluding tables and figures.

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

27 As children grow up, executive functions (EF) and attentional control (AC) become
28 increasingly important for children's successful navigation in their educational environment
29 and daily functioning at home (Best, Miller, & Jones, 2009; Diamond, 2013; Garon, Bryson,
30 & Smith, 2008). Executive functions are adaptive effortful mental processes that enable us to
31 plan, guide and control goal-oriented behavior and are especially critical when solving novel
32 problems (Best et al., 2009; Garon et al., 2008). There is general agreement that three core EF
33 can be defined, namely inhibition, working memory and cognitive flexibility (e.g. Miyake et
34 al., 2000). Miyake et al. (2000) argued that these three EF components share a common
35 underlying mechanism, often referred to as effortful attentional control (AC) (Garon et al.,
36 2008). AC is tightly intertwined with EF, both as a foundation on which EF components build
37 and as an ongoing process playing an important role during EF development (Garon et al.,
38 2008).

39 Inhibitory control is commonly described as the ability to suppress a dominant or
40 automatic response (Best et al., 2009; Diamond, 2013). Inhibitory control is often studied in
41 congruence with this definition of response inhibition, but it also encompasses an attentional
42 component known as interference control: the ability to selectively attend to certain stimuli
43 and ignore irrelevant stimuli (Diamond, 2013). Inhibitory control shows a rapid development
44 during the preschool years, but also improves between ages five and eight (Best et al., 2009).
45 Working memory (WM) refers to the ability to temporarily hold, manipulate and control
46 information in the mind (Garon et al., 2008). WM is commonly subdivided by content and
47 conceptualized as verbal WM and visual-spatial WM (Diamond, 2013). WM emerges during
48 the preschool years and shows a linear development between ages four and fifteen, though the
49 development of visual-spatial WM seems to reach its peak around age eleven (Best et al.,
50 2009; Davidson, Amso, Anderson, & Diamond, 2006). The final core EF component is
51 cognitive flexibility, the ability to shift between mental sets or tasks and adapt to changing

52 situations (Best et al., 2009). Cognitive flexibility builds on both WM and inhibition, and
53 shows a longer developmental trajectory, at least until early adolescence (Davidson et al.,
54 2006). Research on AC differentiates between focused and sustained attention as underlying
55 processes. Focused attention refers to being able to actively focus on one thing without being
56 distracted by other stimuli and sustained attention can be defined as the ability to maintain
57 concentrated attention over prolonged periods of time (Cohen, 2014). Early AC development
58 peaks during the preschool years, though continues to develop during the primary school
59 period, alongside the emergence of the core EF components (Garon et al., 2008).

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

77 Carlson, 2015; Mileva-Seitz et al., 2015; Rochette & Bernier, 2016; Yu & Smith, 2016). The
78 current study addresses an older age group of 4- to 8-year-olds and focuses on aspects of (i)
79 sensitivity and (ii) verbal scaffolding in relation to child AC and EF.

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

101 finding, though based on younger children than the current sample, also suggests that age may
102 moderate the association between parental support and child AC.

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

116 Verbal scaffolding can be subdivided into directive (i.e. telling the child what to do)
117 versus elaborative verbalizations (i.e. comment on the child's own course of action), in which
118 directive verbalizations leave little room for the child to reflect on the problem on his own,
119 while elaborative verbalizations evoke self-guided exploration and conceptual thinking,
120 allowing the child to practice self-regulatory skills such as EF (Bibok et al., 2009; Bonawitz et
121 al., 2011). Self-guided exploration without adequate guidance is not effective (Alfieri,
122 Brooks, Aldrich, & Tenenbaum, 2011; Kirschner, Sweller, & Clark, 2006; Mayer, 2004). A
123 specific scaffolding strategy to enhance self-guided exploration is the use of open-ended and
124 metacognitive questioning when asking for explanations, such as "Why do you think that?"
125 (Hmelo-Silver & Barrows, 2006). Indeed, it has been shown that parents who are less

126 directive and who instead ask more questions and engage their child in problem-solving
127 discussions may enhance the development of self-regulation in preschoolers (Eisenberg et al.,
128 2010; Mathis & Bierman, 2015; Neitzel & Stright, 2003). For instance, Landry and colleagues
129 (2000) showed that up to toddlerhood, parental directiveness had a positive effect on
130 cognitive development, but that this effect reversed after age four, in line with their child's
131 diminished need for structure. In contrast, elaborative parental utterances have been found to
132 predict child EF independent of age (Bibok et al., 2009; Landry et al., 2000; Smith, Landry, &
133 Swank, 2000), suggesting that parents should reduce directive scaffolding in favor of
134 elaborative scaffolding when their child becomes more independent.

135 At different developmental stages, children need customized stimulation and guidance
136 adapted to the situation, their needs, and the task at hand (Bradley, Pennar, & Iida, 2015). A
137 recent study in 4- to 11-year-olds demonstrated that the relationship between parenting
138 behaviors and child agency shifts with age (Bradley et al., 2015), in line with the findings of
139 Landry and colleagues (2000), Cuevas and colleagues (2014), and Mathis and Bierman
140 (2015). Since AC and EF skills are considered crucial in goal-directed behavior (Giesbrecht et
141 al., 2010) and rapid improvements in AC and EF skills occur between the ages four and eight
142 (Best & Miller, 2010), this raises the question whether key aspects of parenting strategies are
143 related to AC and EF, and to what extent age moderates this relationship in 4- to 8-year-olds.

144 In the current study, we aim to investigate whether parental supportive presence and
145 intrusiveness and aspects of verbal scaffolding are associated with child AC and EF skills
146 during the early school years and to what extent age moderates these relations. We
147 hypothesize that supportive and non-intrusive parents have children who show better AC and
148 EF skills. As both self-guided exploration without adequate guidance and too much
149 directiveness are not expected to be effective in stimulating self-regulation, we assume that
150 the relation of AC and EF with level of parental intrusiveness and the amount of closed-ended

151 questions parents ask, will be curvilinear. Furthermore, we hypothesize that in older children
152 AC and EF are more negatively associated with higher levels of intrusiveness and more
153 closed-ended questions. In addition, it is hypothesized that parents who are supportive and
154 who scaffold the interaction with their child by asking more open-ended and elaborative
155 questions, have children who show better AC and EF skills.

156 **Method**

157 *Participants*

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

165 Parents of 138 4- to 8-year-old children from the lowest four grades of two Dutch
166 primary schools (pre-school to second grade in USA school system), from towns that are part
167 of the urban agglomeration of Rotterdam and the conurbation of The Hague, agreed to
168 participate in this study, and signed an informed consent letter. The current study used child
169 computer-based neurocognitive measures of AC and EF and observational data of parents'
170 interactive behavior with their child collected during a home visit. Parents of 99 out of 138
171 children agreed to a home visit (response = 71.7%, 10.1% fathers). Participants who agreed to
172 a home visit did not significantly (all $p > .05$) differ on age, gender, school, grade, single
173 parenthood status, parental education or prevalence of referral to mental health care in the past
174 year from those who did not agree to a home visit. One child refused to complete the
175 neurocognitive assessments and was excluded from analyses (Final $N = 98$). Children ranged

176 in age from 4 to 8 years ($M = 6.2$ years, $SD = 1.2$) and 56.1% were male. No parents or
177 children were excluded because of problems with oral or written proficiency in Dutch. For
178 detailed sample characteristics, see Table 1.

179 *Procedure*

180 Computer-based performance tasks were administered during an individual test session
181 (approximately 60 minutes) in a separate room at the child's school. Tests were administered
182 by two trained master students or by one of the main investigators (AMS, MCD). After the
183 session the children could choose a small present as a token of appreciation. All home visits
184 were conducted by master student pairs. Data were collected in the period between November
185 2013 and February 2014 (school 1) and between May and June 2014 (school 2).

186 *Measures*

187 *Demographic characteristics*

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

200 *Parenting strategies*

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

216 *Aspects of parental sensitivity.* Parental supportive presence and intrusiveness were
217 coded using the revised Erickson 7-point scale for Supportive Presence (SP) and Intrusiveness
218 (Egeland, Erickson, Clemenhagen-Moon, Hiester, & Korfmacher, 1990). A parent scoring
219 high on SP shows emotional support to the child and is reassuring when the child is having
220 difficulty with the task. A parent scoring high on Intrusiveness lacks respect for the child's
221 autonomy and does not acknowledge the child's intentions or desires. The subscales SP and
222 Intrusiveness were coded for each joint activity task by three coders who were blind to other
223 data concerning the child or the parent. For each parent-child dyad, the combining task and

224 sorting task were coded independently and by different coders. All coders completed an
225 extensive training, consisting of several practice and feedback sessions supervised by an
226 expert coder. Reliability of the coders (intraclass correlation (ICC)) was assessed directly after
227 completion of the training and at the end of the coding process to detect possible rater drift.
228 ICCs between coders directly after training were .92 for the SP scale ($N = 12$) and .81 for the
229 Intrusiveness scale ($N = 12$). At the end of the coding process, ICCs were .91 for the SP scale
230 ($N = 12$) and .92 for the Intrusiveness scale ($N = 12$), suggesting no significant rater drift.
231 Whenever interactions were difficult to score due to an ambiguous interaction ($N = 14$),
232 consensus was sought after a discussion with all coders. Although parent-child dyads were
233 randomly assigned to either joint task battery A or B, each task battery may have elicited a
234 somewhat different interaction between parent and child. Therefore, level of SP and
235 Intrusiveness was computed by standardizing each task version score (A or B) within each
236 task (sorting or combining), followed by averaging these Z-scores over both joint activity
237 tasks.

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

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

265 *Self-regulation*

266 We assessed aspects of attentional control and executive functions as measures of self-
267 regulation with several neuropsychological tasks from the Amsterdam Neuropsychological
268 Tasks (ANT, version 2.0), a well-validated computerized test battery (De Sonneville, 2005;
269 2014). The ANT has been used extensively in both clinical and non-clinical populations and
270 contains widely used paradigms such as the Go/No-Go paradigm, with adequate test-retest
271 stability and discriminant validity in children (Kindlon, Mezzacappa, & Earls, 1995). The
272 ANT test battery requires a processor supporting Windows XP or higher and can be obtained

273 via www.sonares.nl, including a demo-version. All computer tasks were preceded by
274 instructions and practice trials.

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

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

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

307 ***Inhibitory control.*** Inhibitory control was measured with the ANT Go-NoGo (GNG)
308 task and the ANT Response Organization Objects (ROO) task. As suggested by Friedman &
309 Miyake (2004), we used multiple measures of the inhibition related process as a practical
310 solution to issues related to task impurity and low reliability. In the GNG task, either a square
311 with a gap (Go-signal) or without one (NoGo-signal) is presented centered on the computer
312 screen. Participants are instructed to click the mouse button when the Go-signal is displayed,
313 but withhold this response whenever the NoGo-signal is displayed. In total, 56 Go-signals
314 (75%) and 18 NoGo-signals (25%) are evaluated. The number of false alarms on this task was
315 used as a measure of level of response inhibition, as well as the number of missed Go-signals.
316 A higher amount of false alarms (e.g. the participant clicks when the target signal is not
317 presented) indicates that a child is less able to inhibit a prepotent response. A lower amount of
318 missed target signals (e.g. the participant does not click when the target signal is presented)
319 indicates better interference control (i.e. selectively attending to the target signal and ignoring
320 irrelevant targets).

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

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

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

346 ***Data analyses***

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

371 effect, a positive beta coefficient corresponds with a concave association and a negative beta
372 coefficient corresponds with a convex association. Alpha for significant effects was set at
373 $p < .05$.

374 **Results**

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

394

395

[INSERT TABLE 1 ABOUT HERE]

396 Table 1.

397 Participant characteristics and descriptive statistics variables of interest.

	Total (<i>N</i> =98)	M (SD) ^b	Range ^b
	%		
Age in months (<i>M</i> (<i>SD</i>))		74.30 (14.56)	49-101
Sex (male)	56.12		
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

398 ^aBackground information was missing for *N*=4 children due to non-response on parental
399 questionnaires. ^bOriginal values before transformation and standardization.

400

401

402

403

[INSERT TABLE 2 ABOUT HERE]

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

404 *Parenting strategies and AC*

405 *SP and Intrusiveness*

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

411 **[INSERT FIGURE 1 ABOUT HERE]**

412 **[INSERT TABLE 3 ABOUT HERE]**

413 *Verbal scaffolding*

414 No significant associations were found between child AC and open- or closed-ended
415 questions, nor between child AC and leading observational questions. A significant
416 interaction effect for procedural questions with age was found both for focused attention
417 ($\beta = .20, p = .03, \text{adjusted } R^2 = .28$) and sustained attention ($\beta = .17, p = .04, \text{adjusted}$
418 $R^2 = .42$). Post hoc probing, however, showed that amount of procedural questions was not
419 significantly related (all $p > .05$) in either age group to the reaction time on the focused
420 ($\beta_{\text{young}} = -.22; \beta_{\text{old}} = .22$) and the sustained attention task ($\beta_{\text{young}} = -.17; \beta_{\text{old}} = .18$). Explanatory
421 questions showed a curvilinear relation that was positively accelerated with reaction time on
422 the focused attention task ($\beta = .21, p = .04, \text{adjusted } R^2 = .28$). This convex relation indicated
423 that children of parents who asked relatively more explanatory questions had a shorter
424 reaction time, but only up to a certain point (inflection point = $.67, < 1 \text{ SD}$ above the mean;
425 see Figure 2a). Beyond the inflection point asking more explanatory questions was associated
426 with worse focused attention task performance.

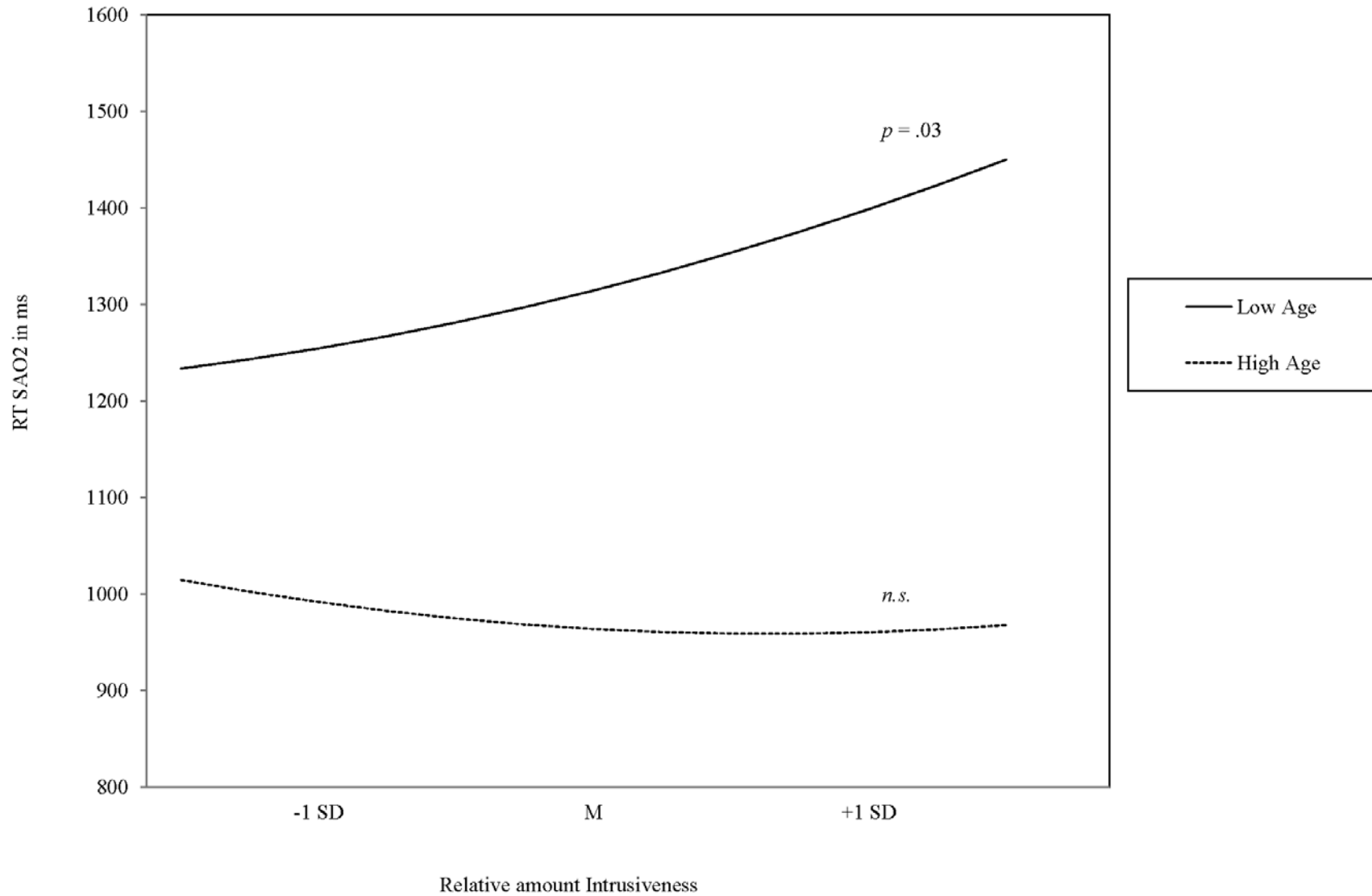


Figure 1. Moderation effect of age on the relation between parental intrusiveness and reaction time sustained attention task (RT SAO2).

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

	Attentional control			Executive functions			
	Focused RT	Sustained RT	Interference control GNG misses	Inhibitory control	Prepotent ROO part 2	Working memory	Cognitive flexibility
				Prepotent GNG FA		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)**
<i>Adj. R² / Pred. R²</i>	.25 / .22	.39 / .37	.49 / .47	.06 / .03	.16 / .13	.41 / .39	.09 / .06
$\Delta R^2 / F \Delta R^2$	.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)*					
<i>Adj. R² / Pred. R²</i>	.24 / .22	.41 / .39	.47 / .45	.05 / .03	.17 / .13	.41 / .38	.08 / .05
$\Delta R^2 / F \Delta R^2$	.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 * $p < .05$; ** $p < .01$; *** $p < .0001$.

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

	Attentional control		Executive functions				
	Focused RT	Sustained RT	Inhibitory control		Working memory	Cognitive flexibility	
			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 Closed ²			.16 (.07)*	.18 (.07)*	.30 (.11)**		
<i>Adj. R² / Pred. R²</i>	.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)**
<i>Adj. R² / Pred. R²</i>	.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)**
<i>Adj. R² / Pred. R²</i>	.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			
	Focused RT	Sustained RT	Interference control GNG misses	Inhibitory control		Working memory	Cognitive flexibility
				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
$\Delta R^2 / F \Delta R^2$	.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
$\Delta R^2 / F \Delta R^2$	.03 / 4.54*	.02 / 3.96*	.40 / 32.00***	.09 / 4.70*	.16 / 9.01***	.42 / 33.87***	.12 / 6.52**
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
$\Delta R^2 / F \Delta R^2$	.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 R² and predicted R² of the most parsimonious model are reported. ΔR^2 : Change in R² in comparison with the previous model. $F \Delta R^2$: F for change in R² in comparison with the previous model, with * $p < .05$; ** $p < .01$; *** $p < .0001$.

427 [INSERT TABLE 4 ABOUT HERE]

428 [INSERT TABLE 5 ABOUT HERE]

429 *Parenting strategies and EF*

430 *SP and Intrusiveness*

431 Higher supportive presence was associated with fewer misses on the GNG task ($\beta = -.32$,
432 $p < .001$, adjusted $R^2 = .49$) and fewer errors on the ROO-2 task ($\beta = -.20$, $p = .04$, adjusted
433 $R^2 = .16$), both tasks assessing aspects of inhibitory control. Higher intrusiveness was related
434 to more misses on the GNG inhibition task ($\beta = .29$, $p < .001$, adjusted $R^2 = .47$) and more
435 errors on the ROO-2 inhibition task ($\beta = .22$, $p = .02$, adjusted $R^2 = .17$) too. No significant
436 association of parental support and intrusiveness with working memory or with cognitive
437 flexibility was found.

438 *Verbal scaffolding*

439 The relative amount of closed-ended questions asked by parents had a positively accelerated
440 curvilinear relation with number of false alarms ($\beta = .26$, $p = .01$, adjusted $R^2 = .10$) and
441 number of misses ($\beta = .20$, $p = .02$, adjusted $R^2 = .42$) on the GNG task, as well as with
442 number of errors on the ROO-2 task ($\beta = .26$, $p < .01$, adjusted $R^2 = .20$), all assessing
443 inhibitory control. These convex relations indicate that initially, parents who ask relatively
444 more closed-ended questions have children who do better on these inhibition tasks, but only
445 until a certain point. After this inflection point, asking more closed-ended questions is
446 increasingly associated with inhibition errors (both GNG inflection points = $.19$, $< 1 SD$ above
447 the mean; ROO inflection point = $-.25$, $< 1 SD$ below the mean; see Figure 2b). In addition,
448 children of parents who asked more closed-ended questions identified fewer targets on the
449 working memory task ($\beta = -.17$, $p = .04$, adjusted $R^2 = .43$). Asking more open-ended

450 questions was linked to fewer misses on the GNG inhibition task ($\beta = -.17, p = .04$, adjusted
451 $R^2 = .42$). Furthermore, a higher open- versus closed-ended questions ratio score was
452 associated with fewer errors on the ROO-2 task ($\beta = -.20, p = .04$, adjusted $R^2 = .16$),
453 assessing inhibitory control, and on the ROO-3 task ($\beta = -.20, p = .04$, adjusted $R^2 = .12$),
454 assessing cognitive flexibility. In addition, children of parents with a higher open versus
455 closed-ended questions ratio score identified more targets on the working memory task
456 ($\beta = .16, p = .04$, adjusted $R^2 = .43$).

457 Observational leading questions showed a curvilinear relation that was positively
458 accelerated with number of misses on the GNG inhibition task ($\beta = .17, p = .04$, adjusted
459 $R^2 = .42$), and that was negatively accelerated with number of errors on the ROO-3 flexibility
460 task ($\beta = -.22, p = .03$, adjusted $R^2 = .11$) (see Figure 2c). The convex relation with number of
461 misses on the GNG indicated that more observational leading questions were associated with
462 fewer inhibitory control errors, but once the amount of questions reached a higher level
463 (inflection point = $.20, <1 SD$ above the mean), children of parents who asked relatively more
464 observational leading questions had more misses. In contrast, the concave relation with
465 cognitive flexibility indicated that more observational leading questions were associated with
466 increasingly fewer errors as the relative amount of questions reached a certain point
467 (inflection point = $-.21, <1 SD$ below the mean; see Figure 2c). In addition, a significant
468 interaction effect for explanatory questions with age was found for the number of false alarms
469 on the GNG inhibition task ($\beta = -.30, p < .01$, adjusted $R^2 = .11$) (See Figure 2d). Post hoc
470 probing showed that amount of explanatory questions was associated with more false alarms
471 in younger children ($\beta = .29, p = .03$, adjusted $R^2 = .12$), but with fewer false alarms in older
472 children ($\beta = -.28, p = .03$, adjusted $R^2 = .12$). No significant association between question
473 category and working memory was found.

474 **[INSERT FIGURE 2 ABOUT HERE]**

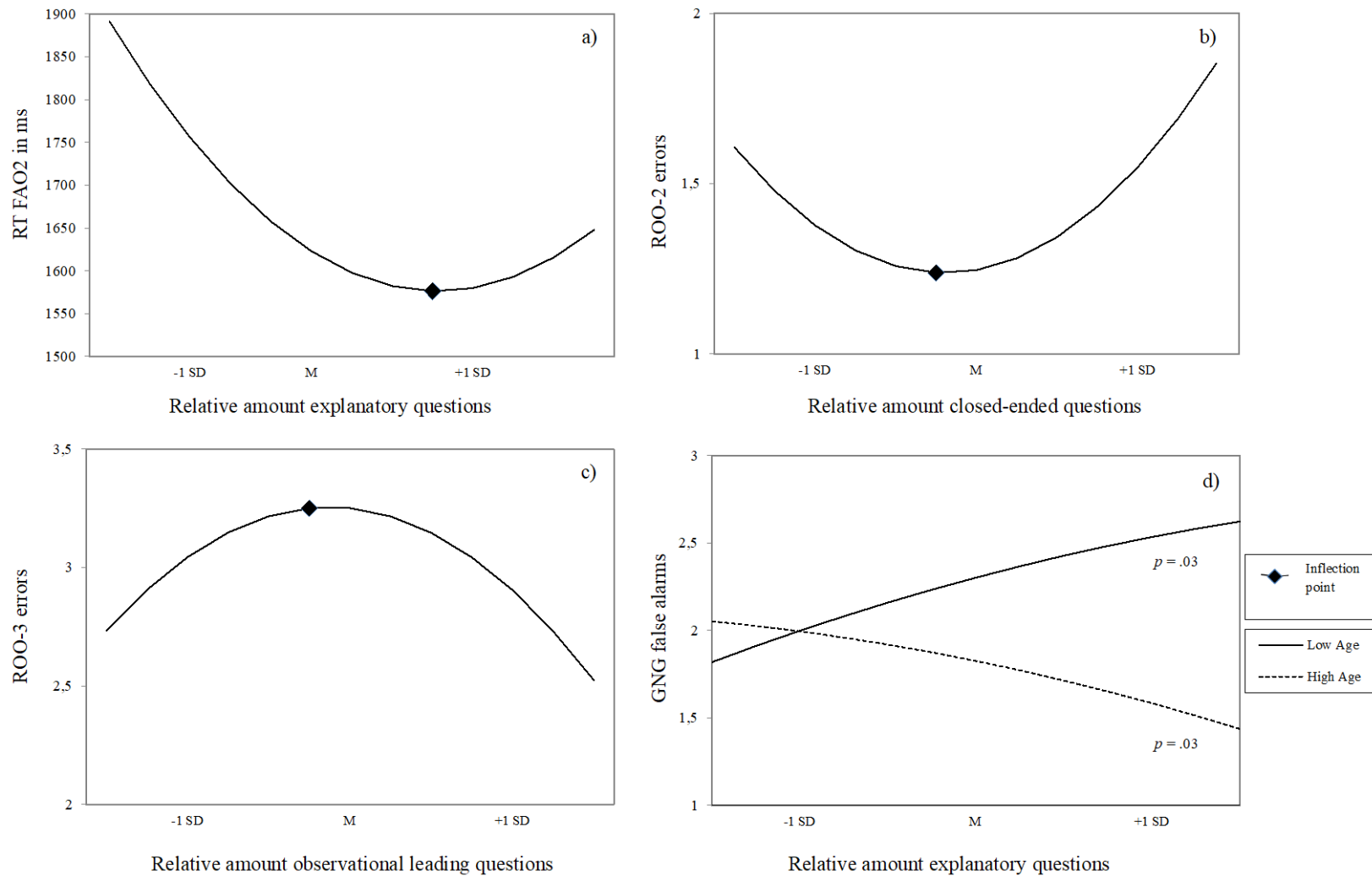


Figure 2. Convex relation between relative amount of explanatory questions and reaction time focused attention task (RT FAO2) (a). Convex relation between relative amount of closed-ended questions and number of errors inhibition task (ROO-2) (b). Concave relation between relative amount of observational 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).

475

Discussion

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

488 *Parenting strategies: relation with AC and EF*

489 Parents who were more supportive, less intrusive, and who asked more open-ended questions
490 had children with better inhibitory control. In addition, parents who asked relatively more
491 open-ended than closed-ended questions had children with better inhibitory control, working
492 memory skills and cognitive flexibility. This may suggest that parenting strategies can
493 influence their children's EF skills also during early school years, in line with Sigel's model
494 of psychological distancing (2002), and extending results from previous studies in younger
495 age groups (e.g. Bernier et al., 2010; Conway & Stifter, 2012; Eisenberg et al., 2010; Hughes
496 & Ensor, 2009; Kraybill & Bell, 2013; Matte-Gagné & Bernier, 2011; Neitzel & Stright,
497 2003; Sulik et al., 2015). Sigel's model entails that children learn self-regulation through
498 interacting with parents who are sensitive and able to adequately scaffold experiences,

499 building on earlier models emphasizing the importance of parent-child interaction in the
500 development of self-regulation (e.g. Vygotsky, 1978; Kopp, 1982; Calkins, 1994).
501 Nonetheless, the current study cannot give a definite answer on causality in this association. It
502 may also mean that parents are, at least partially, adapting their behavior in accordance with
503 their child's needs at that point in time. Certain parenting strategies could either be a cause or
504 an effect of their child's self-regulation skills, or both; suggesting a reciprocal relation
505 between parental strategies and children's functioning. For instance, Eisenberg and colleagues
506 (2010) concluded that individual differences in self-regulatory skills predicted maternal
507 scaffolding, suggesting that child skills may evoke specific parenting strategies. On the other
508 hand, in a more recent study, Eisenberg and colleagues (2015) reported a bidirectional
509 association between parental intrusiveness and child self-regulation, comparable to the
510 reciprocal associations reported by Belsky, Fearon and Bell (2007) between parental
511 sensitivity and child attentional control.

512 An interesting finding was that some associations between parenting strategies and
513 child AC and EF were curvilinear. Children with better inhibitory control had parents who
514 asked more than just a few, but not too many closed-ended or observational leading questions
515 relative to other parents. Children with better AC had parents who asked relatively many
516 explanatory questions, though not too many. On the other hand, children with better cognitive
517 flexibility had parents who either asked a few or a lot of observational leading questions
518 compared to other parents. These curvilinear associations may indicate that an adequate
519 parenting strategy requires more than merely asking more questions and that asking questions
520 in itself does not define adaptive parenting behavior. A recent study focusing on the
521 association between child anxiety and parental intrusiveness also concluded that curvilinear
522 effects may be the best fitting to depict parental influence on child development, as anxiety

523 increased when mother's intrusiveness was on either end of the continuum (i.e. high or low)
524 (Kiel, Premo, & Buss, 2016).

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

529 *Age matters*

530 Not all aspects of parenting and child self-regulation were associated across the entire
531 age-range in this study. For instance, only younger children with parents who were less
532 intrusive had better AC. At the same time supportive parenting was not at all related to AC in
533 4- to 8-year-olds. These findings are in line with the study of Mathis and Bierman (2015),
534 who concluded that although parental intrusiveness was associated with low levels of child
535 AC in 4- to 5-year-olds, no relation was found for parental support. As it was hypothesized
536 that especially in older children parental intrusiveness would be negatively related to child
537 AC, the absence of this association in our study was surprising (Cuevas et al., 2014). Though
538 AC continues to develop during the primary school period, AC development is thought to
539 have its peak during the preschool period (Garon et al., 2008). This might suggest that AC
540 skills have mostly developed by the time children reach primary school age and parental
541 influence on AC development may be limited afterwards, though our finding of an association
542 between intrusiveness and AC in younger children suggests there may still be plasticity in AC
543 development around age four to five.

544 Within our sample of 4- to 8-year-olds, we did not find age to act as a moderator in the
545 relation between parental supportive presence or intrusiveness with EF development. Our
546 findings supported the presence of a robust relation between supportive presence and
547 intrusiveness with inhibitory control, but no association with working memory or cognitive

548 flexibility was detected. The influence of parental support and intrusiveness on EF might only
549 be detectable at an older age, as both working memory and cognitive flexibility show a longer
550 developmental trajectory than inhibitory control (Best et al., 2009). This is in agreement with
551 a recent study, showing parental sensitivity predicted inhibitory control but not working
552 memory in four year-olds (Mileva-Seitz et al., 2015). It should be noted, however, that
553 parental sensitivity may already be associated with neural development at an earlier age.
554 Even though brain activity may change dramatically, this does not always lead to improved
555 task performance (Johnstone et al., 2007) or these changes in neural activation may take time
556 to result in improved behavioral performance (Rueda, Rothbart, McCandliss, Saccomanno, &
557 Posner, 2005). However, Bernier and colleagues (2010; 2012) have linked autonomy support
558 (i.e. low intrusiveness) to an EF factor containing inhibitory control, working memory and
559 cognitive flexibility, already in early childhood. These findings, however, may be mainly
560 explained by the inclusion of inhibitory control in their EF factor. On the other hand, this
561 study's observation that verbal scaffolding was already associated with the more demanding
562 EF tasks assessing working memory and cognitive flexibility in 4- to 8-year-olds, might
563 suggest that scaffolding challenges children's self-regulation skills more than aspects of
564 parental sensitivity do. These tentative conclusions ask for longitudinal studies in large
565 samples to disentangle the role of specific aspects of parenting in EF development.

566 Age also mattered in the relation between certain aspects of verbal scaffolding and AC
567 and EF. Most interesting was the moderation effect of age on the association between
568 explanatory questions and inhibitory control. Parents of older children with better inhibitory
569 control asked relatively more explanatory questions, while this effect was reversed in younger
570 children. An explanation of this interaction effect might be related to the difficulty level of the
571 questions parents ask. According to Eshach and colleagues' (2014) taxonomy of question
572 difficulty, this study's explanatory questions would be identified as high-order questions. Our

573 finding may thus be due to the higher difficulty level of this question category in general.
574 Perhaps asking explanatory questions is too demanding for younger children, while it is likely
575 to be more adaptive for the older age group.

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

597 instead of developmental differences within the same child, asking for studies examining
598 these relations over time.

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

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622 **References**

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