### Relationships Between Maternal Autonomy Support and Children's Developing Self-

**Directed Executive Functions** 

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#### Abstract

Little is known about how environments might support or hinder children's developing ability to engage executive functions (EFs) in a self-directed way, without reminders from adults about what they should do, and when. Parents spend a great deal of time with their children early in development. One possibility is that specific parenting behaviors support children's autonomous decision making facilitating improvements in children's self-directed EF. To test this possibility, this study investigated the relationship between parenting behavior and children's self-directed EF using the Colorado Longitudinal Twin Sample. Maternal intrusiveness, detachment, and affective involvement were coded from a co-play construction task that mothers completed with their children at age 5. Selfdirected EF was measured when the same children were ages 4 and 7 via a semantic verbal fluency (VF) task. In this task, children attempt to generate examples of a category and can decide on their own when to switch from one subcategory to another. In a series of linear regression models, no significant relationships were observed between children's self-directed EF and maternal intrusiveness, detachment, or other affective behaviors. These null results are interpreted in light of questions related to construct validity for the present measures of maternal autonomy support. Future research addressing these complex questions regarding environmental influences on child selfdirectedness may benefit from attention to methodological and measurement development.

Keywords: Executive function, child development, maternal intrusiveness

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## **Directed Executive Functions**

Across development, children gradually develop the ability to accomplish goals even when they must break out of habits. For example, older children show increasing proficiency at self-directed forms of control, such as remembering to pack a bathing suit when they go on a trip without being reminded by a parent. Self-directed children think of a goal (swimming at the hotel's swimming pool), anticipate that they will need their bathing suit to meet this goal, and adjust their packing plans without additional prompts or reminders from adults.

To complete these types of tasks, children engage executive functions (EFs), the cognitive control processes that regulate thoughts and actions in support of goal-directed behavior (Miyake et al., 2000). Executive functions are important because they are predictive of a range of important life outcomes, including academic success, criminality, and planning behaviors toward retirement (Moffit et. al, 2011). Children begin developing executive functions around preschool (Snyder and Munakata 2010; Barker et, al, 2014; Carlson, Mandell, Williams, 2004; Diamond, Barnett, Thomas, & Munro, 2007), but these abilities do not reach maturity until early adulthood (Bernier, 2010, Best & Miller, 2010).

### **Development of Executive Function in Children**

Very young children can successfully engage EFs when they are provided with cues and reminders from adults (Snyder and Munakata, 2010; Barker et. al, 2014). These abilities are highlighted by children's performance in *externally-driven* EF tasks. For example, in the box-search task, children are asked to inhibit a pre-potent response to

reach for presented stimuli (Gerstadt et. al, 1994). A child is presented with a box that either has a triangle or a square on the top of it. They are taught that a triangle symbolizes there is no sticker in the box and the child should not open it. Three-year-olds are able to successfully complete this task when instructions and reminders are given immediately before they respond, but act impulsively otherwise (Barker et. al, 2015).

Across development, children progressively grow to rely on external cues less and become more endogenous (self-directed) in order to complete tasks and responsibilities. One task that has been used to investigate children's emerging ability to engage EFs in *self-directed* contexts is semantic verbal fluency. In this task, children are given a categorical prompt (e.g., 'animals'), and are told to list as many examples of that prompt as possible (e.g., 'cat', 'dolphin', etc.). The most efficient way to complete this task involves spontaneously thinking of subcategories that relate to the target prompt (e.g. zoo animals; farm animals), and then switching between those subcategories when it is difficult to think of more words. This switching and clustering strategy likely taps executive processes, since children have to maintain, select, and switch between categories without being told to do so and without external reminders to produce many words on the task (Snyder & Munakata, 2012).

Little is known about how environments might support or hinder children's developing ability to engage EFs in a self-directed way. One possible explanation for how environments are benefitting child self-directed EF could be that the activities children spend time in have long-term implications for their executive function. Prior work has revealed that 6-year olds who spend more time in environments they are able to direct (e.g., free play with friends or independently exploring outside) show better self-

directed executive function (Barker et. al, 2014). This study used lab tasks to test the relationship between parent reported time schedules and children's EFs. Parents were instructed to give daily and weekly time estimates for how long their children were spending in less-structured situations (like free play, and social activities) versus adult-led activities (like homework or organized practice sessions). Children who spent more time in less-structured activities performed better on a self-directed lab measure of EF, verbal fluency (VF).

Findings relating children's time use to their self-directed executive function are informative, but correlative. Therefore, we cannot be certain about the direction of relationships between time use and children's verbal fluency performance. Children's time use may influence their EF, or children's EF could influence the amount of time they spend in less-structured activities. For example, a child with higher EF may be given more opportunities to participate in activities that he/she chooses (like when sitting/playing alone in the living room, or choosing what exhibits to visit during a family trip to the museum). Similarly, parents of lower EF children might be more inclined to enroll their children in more structured activities. Alternatively, a third factor could be driving the relationship between child EF and how children spend their time; for example, self-directed EFs could be highly heritable, as has been shown for externallydriven forms of EF (Friedman et al., 2008). If self-directed EFs are largely heritable, it is possible that parents with higher EF may choose more less-structured activities for their children (who tend to have higher EF), but these activities do not influence child EF.

However, if children's time in less-structured activities causally influences their developing self-directed EF, children may spend more time around adults who allow

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them to direct their own actions and thus have more opportunities to engage EFs in a selfdirected way. In contrast, children who spend more time around intrusive adults may be slower to develop those abilities. Adults that leave space for their child to make their own decisions, while providing assurance that the parent could intervene, are behaving in an *autonomy-supportive* way. This space is providing the child with the opportunity to select what to do and when in order to achieve goals. Adults make their daily decisions with minimal external reminders, while children often receive adult support in their decisionmaking and routines. Thus, while adult involvement is generally a good thing, it may be the case that too much control and involvement during play and activities hinders the child's ability to behave in a self-directed way.

#### **Parenting Behaviors and Child EF**

Parents spend a great deal of time with their children early in development; however, little is known about whether they may influence their children's transition from externally-driven forms of control to self-regulated control by supporting child autonomy. Some theorists have argued that adults who are intrusive (e.g., by controlling the content and pacing of children's activities) may undermine children's early attempts to achieve their own goals (Ispa et. al, 2004). Similarly, adults who encourage and support children to achieve goals independently and with confidence can support selfdirected behavior (Grolnick & Ryan, 1989). Self-determination theory (SDT) posits that social contextual events can either maintain or undermine intrinsic motivation when individuals are working to achieve a specific task or goal (Deci and Ryan, 1987). Critically, this theory emphasizes that individuals support autonomy via affective mechanisms (like instilling confidence or self-esteem), in contrast to our alternative

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theoretical position, which has suggested that autonomy support can be supported simply by allowing children to make their own decisions. For example, one study has shown that intrinsic motivation flourishes when adults provide "choices that are developmentally appropriate, encourage the child to self-initiate, minimize how often they control the child's behavior, and acknowledge the perspective and feelings of the child" (Grolnick, Deci, & Ryan, 1997, p. 147). This theoretical account highlights the importance of parents providing *affective* support to encourage children's desire to engage in tasks autonomously, with intrinsic motivation. The emphasis on affective support highlights the difference between SDT and our alternative understanding of autonomy supportive parenting, where children are provided with space to make decisions on their own, without external oversight or guidance.

Although many different adult relationships and interactions may influence children's developing autonomy (Martin, Ryan & Gunn, 2007; Deci & Ryan, 1981), mothers have often been a focus of developmental investigations. Children spend a significant amount of time playing with their mothers in the earliest years of life and relative differences in support for autonomy are frequently observed during co-play with children and their mothers (Deci et. al, 1993; Smith et. al, 1999, Bernier et. al, 2010; Ispa et. al, 2004). Play interactions are considered informative because they are naturalistic and are associated with a child's feeling of responsibility and mastery in their environment (Grolnick, Frodi & Bridges, 1984).

In correlational studies, the children of intrusive mothers show decreased motivation and interest during co-construction or co-play tasks (Deci et. al, 1993; Bernier, 2010). Maternal intrusiveness in these play contexts is categorized as featuring

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adult-centered interactions despite signals from the child that a different activity, level or pace is needed (Smith et al., 1999). When the mother is controlling the environment, this revokes the opportunity for the child to make decisions toward a goal, which may discourage children's self-directed behavior. For example, the children of mothers who use controlling language as they work on a task show less interest in continuing to explore that task on their own and decreased competence and persistence (Grolnick, Frodi, and Bridges, 1984, Deci et. al, 1993). Although competence and persistence could be reflective of more self-directed behavior, SDT has focused on broader outcome variables such as academics and motivation (Deci et.al, 1993) versus children's cognitive control.

A related theoretical account builds on the mechanisms proposed in SDT by suggesting that mothers support their children's self-directed behavior by describing and explaining the child's decision-making process. These explanations are thought to teach the child how to plan and initiate goal-directed behaviors. Some correlational studies have shown that these maternal behaviors are related to children's externally-driven forms of EF in early toddlerhood (e.g., Bernier et. al, 2010; NICHD Early Childcare Research Center, 1997). One study of EFs and mother's behaviors hypothesized that an increase in maternal autonomy support, along with sensitivity and mind-mindedness, would be associated with better performance on EF tasks in their children (Bernier et. al, 2010). Sensitivity is the ability of the mother to respond to cues and needs from the child, whereas mind-mindedness is the parents' tendency to speak on behalf of the child and describe the child's thoughts and emotions during play. This behavior is thought to develop cognition and give children the tools to be more self-directed. This study used a

mother-child puzzle task to evaluate autonomy support (Grolnick, Frodi, and Bridges, 1984). Maternal autonomy support was found to positively relate to children's working memory abilities at 18 months and conflict EF, or the ability of a child to inhibit a prepotent response, at 26 months (p < .10) (Bernier et. al, 2010). Sensitivity was related to conflict EF, but was not related to any of the working memory tasks (Bernier et. al, 2010). Mind-mindedness was related to working memory EF at 18 months and only marginally related to any of the EF tasks at 26 months.

Although findings linking maternal parenting behaviors to children's externallydriven EF are suggestive, they have been investigated using correlational methods, similar to work relating children's self-directed EF to their time use. Therefore, observed relationships could be driven by externally-driven child EF or by outside factors, such as parental EF. For example, higher EF children may enjoy puzzles more, and need less adult support in completing them. In such cases, parents may show support for child autonomy by giving the child space because they do not need the parents' help in reaching the goal (puzzle completion). It is also possible that parents find it easier to understand and explain the cognitive choices of relatively advanced children, leading to a positive correlation between parent mind-mindedness and child EF.<sup>1</sup> Moreover, as in research between children's time use and EF, links between parenting behaviors and child EF could be driven by genetic factors. In addition to these methodological limitations, it remains to be tested whether self-directed EF shows similar relationships with maternal parenting behaviors.

<sup>&</sup>lt;sup>1</sup> It is potentially less clear whether such children are also more likely to elicit more sensitivity and warmth from parents.

#### Parent Autonomy-supportive Behaviors and Child Self-directed EF

The present study investigates links between maternal autonomy support, affective support, and children's self-directed EF in a longitudinal twin sample. Mothertwin dyads (N=108) completed a co-construction task when twins were 5 years old. Maternal behaviors during the task were rated using a validated scale (NICHD. Mother Child Interaction Rating Scale). A measurement for self-directed EF was indexed by children's switching and clustering performance in semantic verbal fluency, which was independently completed by twins at ages 4 and 7. By investigating how year-5 parenting behaviors relate to year-7 VF, controlling for earlier VF, this study tests whether maternal behavior is related to child's VF, while controlling for their baseline performance. This approach addresses limitations of prior work in two key ways. First, the longitudinal design allows us to control for the influence of children's earlier abilities on their later abilities, helping to test a causal hypothesis relating early autonomy support to children's developing self-directed EF. As a second step, we have attempted to distinguish maternal autonomy support and affective support, which have not been dissociated in prior work, by coding for these behaviors separately. If initial tests demonstrate relationships between autonomy-supportive behaviors and child EF, future analyses can draw on comparisons from this twin sample to determine whether these correlations can be explained by common genetic factors, addressing a third limitation of prior work. In the present thesis, analyses focus on simple directional relationships between maternal parenting and children's emerging self-directed EF.

Consistent with theories suggesting that maternal support for child autonomy can influence children's independent motivation and persistence, I hypothesize that the

children of autonomy-supportive mothers at age 5 will show better self-directed EF at age 7, controlling for children's self-directed EF at age 4. To distinguish between autonomysupportive and affective-supportive maternal behaviors, we rated interactions using multiple scales that capture distinct aspects of each. Maternal intrusiveness captures the amount of time that a mother intervenes to take over play, as well as the extent that these interventions shift the child's perspective. Maternal *detachment* is an evaluation of how much time the mother spends disconnected from the interaction. Higher levels of detachment also reflect the mother's level of emotional involvement with the child. Measures of maternal *positive regard* and maternal *sensitivity* focused on the mother's ability to boost their child's self-esteem and confidence during co-play. This support may be helpful to the child beyond just giving the child time to make independent decisions (Grolnick, Deci, & Rvan, 1997; Bernier 2010). We also tested whether maternal stimulation of cognitive development predicted children's self-directed EF. Mothers engaging in high levels of stimulation of cognitive development are talking to the child about their play environment as it pertains to their real environment, and engaging the child in pretend play. This may include how they perceive the child is feeling about the real world and how they can apply it to the play scenario in front of them. Similar to the construct of mind-mindedness explored in previous parenting studies (e.g., Bernier et al., 2010), this cognitive development may be helping to give the child tools to engage in more self-directed EFs.

#### Methods

## Participants

Mother-twin interactions were coded from videos of a dyadic co-construction task conducted as part of the Longitudinal Twin Study at the University of Colorado at Boulder when twins were age 5. There were 108 individual twins rated on 10 constructs from the NICHD Maternal-Child Interaction Rating Scale. 11 videos were dropped, 9 due to significant family interference and 2 due to poor video quality (N=97). Two additional raters trained by the primary investigator evaluated the videos with the NICHD scale. Ratings for each of the ten constructs were averaged in analyses to reduce subjectivity, after checking that sufficient interrater reliability across coders had been met.

Twins completed the verbal fluency task at ages 4 (N=89; prompts were 'things that are soft', 'things that make noise', and 'things that are round') and 7 (N=91; prompts were 'things that are round', 'things that are metal', and 'animals'). Multiple raters coded twin responses to each verbal fluency prompts to ensure reliability of the switch scores. Raters achieved a high level of agreement (rs > .80 for all prompts). Switch scores were averaged across raters within prompt, z-scored, and combined to generate a composite score.

#### **Co-Construction Task Coding**

Videos were scored in the laboratory by three coders, each trained by the principal investigator. The training consisted of watching the videos together and discussing the different elements of the NICHD scale (described in detail below), and jointly coding example interactions to anchor ratings. After newly trained coders scored 10 and ~25 dyadic interactions, coder reliability was calculated, and retraining took place for all

coders who failed to demonstrate an interclass correlation of 0.75 or above (kappas= .77-.79). Videos were not watched in the same order by all three coders to ensure that the scales were used consistently regardless of differences in the order the videos were watched. Coders were not blind to the hypothesis, but all coders were blind to twin verbal fluency performance.

For each twin, coders rated the first 6 minutes of co-construction time, immediately following the conclusion of task instructions. The task consisted of building a "Lego house" with four rooms. Dyads were allowed 6-7 minutes to complete the task, and were not given specific instructions about how to build the house or use the available Lego pieces. Coders watched each video segment three times, and then assigned a rating to each NICHD construct.

NICHD scale. This scale was designed for a "three-box assessment" developed by the National Institute of Child Health and Human Development (NICHD) to evaluate mother-child interactions. The three-bag assessment presents a mother-child dyad with three different bags of toys that they play with and the interactions are later scored for mother and child behaviors. The Likert scale ratings start at 1 ("very low") and go up to 7 ("very high") based on the quantity and quality of behaviors observed (NICHD Early Childcare Research Network, 1997, 1999). Scales included maternal sensitivity, maternal intrusiveness, maternal stimulation of cognitive development, maternal positive regard, maternal negative regard, maternal detachment, child engagement of mother, child negativity toward mother, child sustained attention, and mutuality and connectedness. The scales were adapted to account for increased agency and communication in 5 year olds compared to the 18-26 months age range they have been previously used with (see Appendix). The adaptations were geared towards age-typical behaviors for 5-year-olds, who are old enough to stay engaged for a greater amount of time and manipulate Lego pieces independently compared to a 24 month old. Consider a child who picks up a Lego 'drawer' and is investigating what the piece is. A young toddler will likely need mom's help and fine motor skills to open the drawer and understand how the piece works, whereas a five year old will spin the toy around and open the drawer alone.

To investigate how often mothers were willing to allow children to engage in the task on their own, without outside interference, mothers were rated for levels of intrusiveness and detachment. Intrusiveness was measured as the number of times and the extent to which the mother made the play adult-centered (NICHD Early Childcare Research Network, 1997, 1999). The scale rates mothers as highly intrusive when they fail to account for the child's interests or wants, and continue to follow their own agenda even when the child averts his or her gaze and expresses negative affect towards her. A mother who is very low (1) on intrusiveness does not instigate any defensive behaviors from the child, whereas a moderately (4) intrusive mother elicits child protesting, but stops before escalating the behavior and allows the child to regain control for at least some of the remaining interaction. A mother who is highly intrusive (7) gives the child no room for self-direction and could be displaying physical and forceful behavior. Maternal detachment was meant to be a measure of how well the mother is able to provide space for the child to make decisions. In the NICHD scale however, it involved a more emotional measure of how attentive the mother was during the interaction. A low score (1-3) meant that the mother was emotionally involved in the interaction and could be acting in a sensitive or intrusive way. A moderately detached (4-5) mother may check out

of the interaction periodically, but is still more emotionally involved with the child than not. A highly detached (6-7) mother is not connected to the child and is just going through the motions in order to complete the task.

In addition to intrusiveness, we investigated supportive affective behaviors that have been posited to influence children's self-directed behavior, including maternal sensitivity and positive regard (Grolnick, Frodi, and Bridges, 1984; Deci & Ryan, 1981; Grolnick, Deci and Ryan 1997). Maternal sensitivity is a measure of how well the mother is responding to child cues. A low sensitivity mother is adult-centered or unresponsive to child needs, wants, and goals, whereas a moderately sensitive mother is closer to responding to the child about half of the time. A highly sensitive mother is attuned to all the child's cues and frequently praises the child. Similarly, low and moderate ratings of maternal positive regard focus on whether the mother is enjoying playing with her child and displaying warmth and positivity during the interaction. In the higher Likert scale ratings, the mother is characterized by her high engagement and positivity throughout the interaction, in addition to her ability to promote the self-esteem of her child.

Stimulation of cognitive development will be investigated to test relationships between self-directed EF and mind-mindedness, which is a component of cognitive stimulation. Low ratings of stimulation of cognitive development are given to mothers who do not attempt to teach the child anything in the interaction. This can include a parent that is involved, but not pointing anything about the environment out, or a parent that is uninvolved. At higher levels of cognitive stimulation, the mother engages the child in pretend play and attempts to foster sophistication and mastery in the child's play

throughout the entire interaction. These higher ratings incorporate elements of mindmindedness.

#### **Verbal Fluency**

In the verbal fluency task, children were asked to generate as many words as possible in response to a given categorical prompt. At age 4, the prompts were 'things that are soft', 'things that are round', and 'things that make noise'. At age 7, they listed 'animals', 'things that are metal', and 'things that are round'. All twin responses were hand-recorded by the experimenter. At age 7, prompts were structured as "Tell me all of the you can think of." At age 4, children were given an example of the prompt before they were asked to list words themselves. For example, for the 'noise' prompt, children were told: "Let's play a word game. I will tell you something that makes noise, and then you tell me something that makes noise that is different. "How about a 'whistle'. Now tell me something else that makes noise." If the child did not appear to understand the task, the experimenter repeated the previous statement using 'radio' as an example. If the child did appear to understand the task, the experimenter continued, "Now tell me all of the things you know that make noise." Children who lost interest or stopped producing words were encouraged to continue ("Can you tell me some more things that make noise?") This procedure was repeated for each prompt.

Verbal fluency data were transcribed from written records, and then coded for semantic clusters and switches between clusters. Two raters coded each twin. Coders determined whether items were semantically related, by separating the responses into subcategories. (E.g. "horse, cow, chicken" are a "farm" cluster for animals). To generate a measure of self-directed EF from the verbal fluency task, we will calculate a weighted switch score. This happens by coding for semantic clusters and calculating the number of switches in order to increase confidence that children were intentionally using a clustering strategy (Barker et. al, 2014). This measure of verbal fluency will be associated with observations from the mother-child co-construction task. VF performance was calculated by averaging switch scores across raters and then z-scored for each prompt. The z-scores for each prompt were averaged into VF composite scores at age 4 and age 7.

### **Child Socioeconomic Status (SES)**

In order to control for the potential impacts of socioeconomic status, which has been shown to predict children's verbal fluency performance (e.g., Barker et al., 2014), a parental occupation measure was used. This was collected from each family when the twins were 14 months from both the mother and the father. This is a proxy for socioeconomic status because it does not include income or education, but is valuable because it helps to control for potential differences in the opportunities given to the children..

#### Results

#### **Preliminary Results and Analysis Approach**

Two participants had verbal fluency switch scores greater than 3 standard deviations (SD) above the sample mean and were excluded from all analyses. For each analysis, we also tested for additional outliers using a measure of observational leverage, Cook's Distance, removing observations where Cook's D > 3 SD above the mean for the sample. No more than 3 twins were removed from any analysis.

Preliminary analyses showed longitudinal stability of verbal fluency, internal validity of the NICHD scale, and no relationship between parental occupation and verbal fluency when using parenting behaviors as the predictor. Specifically, age 4 VF switching ability was moderately associated with verbal fluency switch scores at age 7 (Figure 1, r=

			Child						1	1	L
		Child	Negativity	Child				Parental	Parental		L
		Engagement	Toward	Sustained	Mutuality and	Parental	Parental	Negative	Positive	Parental	L
		of Parent	Parent	Attention	Connectedness	Detachment	Intrusiveness	Regard	Regard	Sensitivity	Ĺ
	Child										Γ
	Engagement of										Ĺ
	Parent										
	Child Negativity										Γ
_	Toward Parent	-0.52***									
	Child Sustained										Γ
	Attention	0.40***	-0.39***								
	Mutuality and										
	Connectedness	0.76***	-0.58***	.45***							
	Parental										Ĺ
	Detachment	-0.46***	0.14	-0.13	-0.65***						
	Parental										Ĺ
	Intrusiveness	-0.19	0.54***	-0.30**	-0.26*	-0.21*					
	Parental										Ĺ
	Negative Regard	-0.21*	0.53***	-0.33**	-0.39***	0.11	0.56***				L
	Parental Positive										
	Regard	0.70***	-0.45***	0.35***	0.79***	-0.52***	-0.25*	-0.37***			L
	Parental									1	Ĺ
	Sensitivity	0.47***	-0.35***	0.28**	0.75***	-0.50***	-0.40***	-0.40***	0.72***		L
	Stimulation of										l
	Cognitive										l
	Development	0.45***	-0.05	0.24*	0.49***	-0.52***	0.27**	0.08	0.48***	0.36***	L

Table 1| Correlation table for NICHD Scale constructs.

Note: Three stars denotes p < .001, 2 stars denotes p < .01, and one star denotes p < .05. .35; p = .001). For the NICHD scale, similar constructs had strong correlations (Table 1) (including parental positive regard and child engagement of parent (r = .70, p < .001), and child negativity toward parent and mutuality and connectedness (r = -.58, p < .001)). As predicted, maternal intrusiveness was inversely related to maternal sensitivity (r = -0.38; p < .001), suggesting that mothers who are responding to child cues are less likely to control play when the child is looking to do something different. Although SES has been found to predict VF performance independently of parenting behaviors (Barker et al., 2014), we did not find a relationship between parental occupation (a proxy for SES) and year 7 verbal fluency switching (p > .7). This relationship continued to be null after controlling for year 4 verbal fluency switching (p > .64).



Figure 1 | Year-4 VF switching ability positively related to year-7 ability. (r= .35; p= .001)

#### Maternal Autonomy-supportive Behaviors

We used linear regression models to evaluate whether maternal intrusiveness and detachment, which reflect levels of autonomy support, were independently predictive of children's VF switching ability after controlling for their earlier VF performance. In contrast to our hypothesis, we did not find that maternal intrusiveness at age 5 predicted worse verbal fluency switching at age 7 (correlation shown in Figure 2, p > .3). Similarly, maternal detachment did not positively predict children's VF performance (p > .6). These null relationships persisted when we controlled for year-4 VF switching ability.



Figure 2 | No relationship between maternal intrusiveness and year-7 switching ability. (p > .3)

## Maternal Affect and Stimulation of Cognitive Development

In secondary analyses, we tested whether maternal sensitivity, positive regard, and stimulation of cognitive development independently related to year-7 switching ability. None of these maternal behaviors related to verbal fluency performance, before or after controlling for year-4 VF switching performance (all ps > .3).

# **Exploratory Analyses**

Figure 3 shows the relationship between year-7 switching abilities and all of the parenting dimensions from the NICHD Scale. None of the constructs have a significant relationship with year-7 VF switching ability.



Figure 3 | Relationships between NICHD Maternal Behavior measures and year -7 verbal fluency. No relationships are significant. (*ps>*.3)

#### Discussion

The present study hypothesized that more autonomy-supportive mothers, who provide children with space to make decisions about how play activities should proceed, would have children with better self-directed EF. We simultaneously predicted that more intrusive mothers, who engage in more adult-centered interactions and rarely acknowledge the child's perspective, would have children with worse self-directed EF. However, neither maternal intrusiveness nor detachment, which we believe reflects support for child autonomy, predicted children's verbal fluency switching ability, before or after controlling for earlier VF ability. In secondary analyses, we investigated if there were relationships between maternal affect and VF performance. Sensitivity and maternal positive regard were not related to VF performance at age 7. Stimulation of cognitive development was also tested for its ability to predict VF performance at age 7 in an effort to see if the child was better able to self-direct, as parent stimulation may be similar to mind-mindedness. The relationship remained null. Exploratory analyses did not reveal any trends or significant relationships. None of the 10-parenting and child behavior constructs on the NICHD scale predicted children's self-directed EF at age 7.

Although it is difficult to interpret null findings, one possibility is that the coconstruction task used in this study did not provide a sensitive measure of maternal behaviors related to autonomy support. The instructions did not explicitly require the dyad to pursue a specific type of story, unlike the challenging puzzle tasks given in Bernier's analysis with autonomy support, which have a problem and a subsequent solution (2010). In the present task, mothers may have felt less motivation to help achieve a 'goal', and therefore showed lower levels of overall intrusiveness. Additionally, the length of the co-construction task may have limited the effectiveness of the NICHD scales in capturing dyadic behaviors. The observational period in this study was limited to 6 minutes in an artificial setting that may have failed to reflect typical situations and behaviors for the dyad. This could be addressed in the future by increasing the length of the observation and also having the opportunity to watch the dyad behave in a few different task environments in order to create a composite autonomy supportive and intrusiveness score.

It is also possible that systematic differences in task administration across twins could have diminished our power to detect relationships between maternal behaviors and child outcomes. During the coding process, raters determined that task instructions were not given consistently across dyadic interactions; specifically, there was variability in the order the Lego pieces were presented and the structure that the pieces were presented in. Raters recorded information about instructions given to each dyad, and found that in

some cases, the experimenter handed the plastic bags of Lego furniture and people to the mother-child dyad asking them to tell a story. In other cases, the experimenter waited to hand the bags to the dvad and took specific pieces of furniture out of the bag in order to label all of the rooms and then proceeded to take the people out and label them one by one. In this latter scenario, the experimenter finishes instructions by asking the dyad to tell a story, but this version of the task instructions could have created the impression that the dyad was meant to tell a story with a nuclear family. The differences in task administration could have created different mindsets for the mothers when they went about playing with their child. If they believed that they were supposed to be making a story with a traditional family, mothers could have persuaded their child in either an overtly or subtly intrusive way to follow a traditional family storyline. This may not be representative of how the mother would traditionally play with the child when no implied task demands were imposed. Additionally, the labeling could have prompted the mother to become more involved in directing the child's play, in order to correctly complete what they believed was the task goal. In the more relaxed task instruction, dyads had no direction for how their story should be told, which may have influenced how mother's chose to let the child direct the task.

Another possibility is that the NICHD scales used to rate dyadic behaviors in this study failed to capture fine-grained differences in behaviors across mother-twin pairs, since it was developed to rate maternal interactions with infants instead of older children. The behaviors that qualified dyads into levels of the Likert scales was adapted for 5-yearolds, but the descriptions in the scales were not altered because they used more general language focusing on the quality and quantity of dyadic behaviors. This may have created

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issues in interpretation for coding because the 5-year olds may have demonstrated different behaviors than infants, and there may be a different balance in the quantity and quality of each of the rated behaviors. For example, a mother who uses subtle comments to slowly shift the interaction toward her personal objective, without greatly changing the child's demeanor, is different from a mother that removes a toy from a child's hands. These two behaviors will have different levels of repetition in order to be rated with the same intrusiveness score.

More broadly, the scales used to evaluate mother-twin interactions may have been inadequate to capture the constructs of interest. We specifically hypothesized that mothers, who gave their children more time to engage in behaviors on their own, without external reminders, would support their children's self-directed EF. Therefore, the goal was to focus on maternal non-involvement (which allowed the child to make decisions) rather than the emotional component of autonomy support. However, both the intrusiveness and detachment subscales used in this study have at least one Likert rating that includes an affective component. For example, for a dyad to rate moderately low on the intrusiveness scale, a child would overtly protest and show frustration toward the mother. Similarly, mothers who score highly on detachment are characterized as emotionally unavailable to their children, which is supported in its negative relationships with maternal positive regard (r= -.52) and maternal sensitivity (r=-.50). Due to the inclusion of affective behaviors in both of these scales, it was not possible to cleanly distinguish the autonomy supportive behavior from those that depended on emotions.

Similarly, it is not clear that the intrusiveness scale captures the support and space that a mother is giving to her child in order to help them achieve goals at lower ratings. A

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mother that takes away a toy from the child when they are independently exploring its functions is more obviously intrusive as compared to a mother who makes quick statements to redirect a child's storyline during play, but does not necessarily elicit feedback from the child. This particular operationalization of intrusiveness does not capture the extent that the mother is taking away opportunities for the child to act in their own goal-directed way.

Another limitation of this work is that our observational measure focused on maternal interactions, and therefore fails to capture information about child interactions with other adults who may support or hinder their autonomy. If the adults in a child's life consistently provide autonomy support then they could develop better self-directed EF as compared to a child who has more adults that are managing the child's environment. For example, adults such as a coach or a teacher could be providing opportunity throughout practices and class for a child to be self-directed, which may help to foster better VF performance in conjunction with autonomy supportive parents. It could also be the case that even when a mother is autonomy supportive, if a child's coaches and teachers are micromanaging the child's time and giving clear directions throughout the whole day, the mother's efforts will not counterbalance the other time to improve VF performance.

An alternate explanation could be that we captured reliable information about adult support for child autonomy, and that support for autonomy is not the mechanism that promotes development of EFs in self-directed contexts. For example, it could be the case that children develop self-direction through social play, practice planning, or mind wandering. Social play may be important because it leads to changes in neural development that improve planning behavior and language abilities (Barker and

Munakata, 2015). Practice planning may give children the opportunity to think ahead about how they will achieve a goal and in doing this often, they are able to make more plans independently. Mind-wandering is sometimes seen as a negative for kids, but other theory suggests that this time spent reflecting on past and future events helps kids to develop connections across time, supporting future self-directed planning (Smallwood & Andrews-Hanna, 2013; Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011; Suddendorf, Addis, & Corballis, 2009; Tulving, 1987).

The present study was motivated from previous work looking at the impact of time on children's developing self-directed EF. In order to address some of the previous limitations, we looked at the specific role that parents could have in playing with their children during early childhood. Although we did not find evidence that maternal behaviors relate to children's emerging self-directed EF, future studies could investigate better ways to operationalize and capture autonomy support, since the observational measures we used do not entirely dissociate affective support from support for child self-directedness. It is also possible that other environmental or genetic factors besides autonomy support could account for differences in self-directed EF across children. For example, it is possible that children engage with and choose their environments in ways that reflect their EF abilities. Additional research could investigate other mechanisms that might benefit developing self-directed EF using controlled experimental designs.

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# Appendix

Summary of the adaptations from the NICHD Mother-Child Interaction Ratings Scale to account for age-appropriate differences in 5 year-olds and 18-26 month olds.

## <u>Parental Sensitivity</u>

-Child-centered (demonstrating attention to child's needs, moods, interests, and capabilities

## At 5 years of age:

-Child will want to place Lego pieces themselves, manipulate them and create the scene independently

→ Sensitivity will reflect promptness in responding to the child when the child asks for assistance and allowing the child to continue their own story when they demonstrate a desire to be independent (this independence helps develop self-regulation skills) - Structuring the activity so that the child remains engaged and continuing to make steps toward the goal of the activity (GOALS OF THIS TASK: Build this Lego house with mom and with the people provided make a story)

- A sensitive parent here will keep the objective given by the experimenter in mind while also trying to give the child choice
- Mother uses the "checking-in" technique by actively showing interest to the child's activity or takes the time to re-engage the child based on child's preferences for play

1 1 2			
Indicators of Sensitivity	Indicators of Insensitivity		
<ul> <li>Being sympathetic to child's emotions and statements</li> <li>Helping child develop the play</li> <li>Being aware of the pace that the child needs</li> <li>Gentle and patient when child goes off task</li> <li>Having reasonable desires fro child's behavior</li> </ul>	<ul> <li>Ignoring the child (because they are not focused on the activity or because they are busy with their own agenda)</li> <li>Responding with developmentally inappropriate comments and behavior</li> <li>Repeatedly denying the child during the play</li> <li>Disciplining the child during the activity</li> </ul>		

# Parental Intrusiveness

-Adult-centered actions where it is clear that they are over-controlling the situation and making their own idealization of the task a reality

 $\rightarrow$  Child does not have to be defensive as the child could be adapted to taking demands

Child behavior: averting gaze, turning away, expressing negative affect AND parent continues whatever started that behavior

-Can occur when parent perseverates on a toy after the child has expressed disinterest or is aiming to switch between toys too rapidly and the child cannot process between recommendations

Intrusive Indicators

- Persisting with activity that does not interest the child
- Not allowing the child to process the different activity choices
- Prohibiting the child from deciding what to do (taking toys away, not allowing the child to handle certain toys, controlling play)
- Poking the child with toys, fingers other objects
- Controlling the house (placing furniture and spinning the house without the child seeking another room)

# Parental Stimulation of Cognitive Development

-Looking to see if mother is engaging the child at their level of cognitive development and then aiming to get the child to take it one step further by pushing their upper limits

→ Scaffolding: Vygotskian

Minimally Stimulating	Moderately Stimulating	Highly Stimulating		
<ul> <li>Getting the child to focus on the task</li> <li>Labeling the objects in the house</li> <li>Answering child's questions</li> <li>Encouraging engagement with the task</li> </ul>	<ul> <li>Suggesting the child go one step further and encouraging mastery</li> <li>Labeling and interpreting the child's experience</li> <li>Responding and elaborating when the child asks a question</li> <li>Labeling actions and expanding on child's observations</li> <li>Asking questions then demonstrating or having the child demonstrate the function</li> <li>Allowing the child to manipulate independently</li> <li>Modeling pretend play</li> </ul>	<ul> <li>Encouraging and engaging in pretend play</li> <li>Presenting activities sequentially</li> <li>Relating play activity to child's experience</li> </ul>		

# Parental Positive Regard

Measure of parents' expression of love, respect and/or admiration

### Indicators of Positive Regard

- Speaking in warm tone of voice
- Physical affections
- Smiling or laughing
- Enthusiasm about child and their participation in the activity
- Praise/complimenting
- Concern for child's distress

## Parental Negative Regard

Measure of parents discontent, anger, and rejection of child.

Indicators of Negative Regard

- Disapproving or negative tone of voice
- Signs of frustration
- Curt responses to child
- Harsh vocalizations
- Physical roughness
- Tense body language
- Threatening child for not paying attention to task or not completing the task properly
- Belittling the child

## Parental Detachment

Parental awareness, attention and engagement with the child

- Parent not focused on reacting to the child's actions or helping develop the storyline or build the house
- Could be unfocused or disinterested

## Indicators of Detachment

- Flat affect
- Rarely making eye contact
- Ignoring the child
- Disinterested in task and ambivalent to what the child does
- Brief looks
- Blank starring
- Monotonic
- Speaking without engaging the child

# Child Engagement of Parent

Indications of Engagement	Indicators of Disengagement		
<ul> <li>Approaching/orienting to parent</li> <li>Positively responding to parents ideas and suggestions</li> <li>Involving parent in their own play</li> </ul>	<ul> <li>No sharing emotions with parent</li> <li>Denying parental suggestions</li> <li>Engaging in self-occupied play</li> <li>Ignoring suggestions from parent</li> </ul>		

## **Child Sustained Attention**

Indicators of Child's Su	ustained Attention
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- Child "focuses in" when playing with an object
- Manipulating the toy to find all different possible functions
- Ability to focus and place one piece of furniture before grabbing another
- Time spent to understand the toy

## Child Negativity

Extent that child returns negative behaviors to parental actions or general demeanor towards parent.

-Anger -Hostility -Denying suggestions/ Lego pieces

## Mutuality/Connectedness

Dyad sharing perspectives, energy levels, and affective states →Consistency and cohesion= high connectedness →Mutual goals