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Do Children's Executive Functions Account for Associations Between Early Autonomy-Supportive Parenting and Achievement Through High School?

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This study evaluated whether the positive association between early autonomy-supportive parenting and children's subsequent achievement is mediated by children's executive functions. Using observations of mothers' parenting from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (N = 1,306), analyses revealed that mothers' autonomy support over the first 3 years of life predicted enhanced executive functions (i.e., inhibition, delay of gratification, and sustained attention) during the year before kindergarten and academic achievement in elementary and high school even when mothers' warmth and cognitive stimulation, as well as other factors (e.g., children's early general cognitive skills and mothers' educational attainment) were covaried. Mediation analyses demonstrated that over and above other attributes (e.g., temperament), children's executive functions partially accounted for the association between early autonomy-supportive parenting and children's subsequent achievement.

Keywords: achievement, autonomy support, executive functions, parenting, self-regulation

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There is much evidence that the more parents support children's autonomy (e.g., by allowing them choice and initiative) and the less they attempt to control children (e.g., through pressure and directives), the better children's achievement (for a review, see Pomerantz, Grolnick, & Price, 2005). This association is evident over time even when taking into account children's prior achievement (e.g., Ng, Kenney-Benson, & Pomerantz, 2004; Wang, Pomerantz, & Chen, 2007) as well as potentially confounding demographics such as parents' educational attainment (e.g., Hess & McDevitt, 1984; Joussemet, Koestner, Lekes, & Landry, 2005). Although there has been much speculation as to why parents' autonomy support (vs. control) predicts enhanced achievement among children (e.g., Grolnick, Deci, & Ryan, 1997; Pomerantz et al., 2005), there has been little empirical attention to this issue. Moreover, the small amount of extant research has focused exclusively on motivational resources (e.g., autonomous motivation and perceptions of competence) as potential mechanisms underlying the role of autonomy-supportive parenting in children's achievement (d'Ailly, 2003; Grolnick, Ryan, & Deci, 1991; Steinberg, Elmen, & Mounts, 1989).

The current research took a step toward addressing this issue by evaluating whether *executive functions*—a set of core cognitive skills that allow children to manage their attention and behavior (Blair & Ursache, 2011)—underlie the heightened achievement predicted by autonomy-supportive parenting. Executive functions include the ability to ignore distractions and inhibit automatic behaviors (i.e., inhibition), hold and manipulate information in mind (i.e., working memory), and flexibly change attention focus and strategies (i.e., switching and cognitive flexibility) (Diamond, 2006). Children's executive functions during early childhood appear to set the foundation for their later achievement (e.g., Best, Miller, & Naglieri, 2011; McClelland, Acock, & Morrison, 2006). Although the role of executive functions in the effects of autonomy-supportive parenting specifically has not been examined, there is evidence that executive functions partially account for the tendency for a variety of aspects of the early home environment to predict children's later achievement (e.g., Dilworth-Bart, 2012; NICHD Early Child Care Research Network, 2003; Razza & Raymond, 2013; Sektnan, McClelland, Acock, & Morrison, 2010).

Autonomy-Supportive Parenting and Children's Executive Functions

Substantial theory and research suggest that autonomy support is a dimension of parenting that facilitates the development of children's executive functions. Autonomy-supportive parenting recognizes children's needs and desires, thereby permitting chil-

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dren's initiative; in this context, children are often given the opportunity to solve problems on their own (Grolnick & Pomerantz, 2009; Grolnick & Ryan, 1989; Nolen-Hoeksema, Wolfson, Mumme, & Guskin, 1995). Conversely, controlling parenting is demanding and dominating, with parents intruding on children's activities and making decisions for them. Drawing on Self-Determination Theory (Deci & Ryan, 1985), Grolnick and colleagues (e.g., Frodi, Bridges, & Grolnick, 1985; Grolnick et al., 1997; Grolnick, Frodi, & Bridges, 1984; Grolnick et al., 1991) argue that when parents support children's autonomy rather than attempt to control children, they foster children's fulfillment of the basic need for autonomy. As a consequence, children's motivation is autonomous rather than controlled, such that they experience their pursuits as enjoyable or important rather than driven by internal (e.g., the avoidance of guilt) or external (e.g., the attainment of rewards) pressure.

Because autonomy-supportive parenting often involves giving children the opportunity to solve problems on their own, children exposed to such parenting may encounter challenging activities (e.g., a difficult puzzle) that frequently require executive functions. Moreover, when children are autonomously motivated, they may maintain their engagement in such activities for extended periods of time during which they ignore competing activities that are appealing (e.g., playing on the computer). Over time, engaging in challenging activities that require executive functions has the potential to provide opportunities to practice and strengthen these skills. Given that children may enjoy challenging activities more when they feel autonomous, executive functions may also be less taxing for children with autonomy-supportive parents. In a different vein, it has been proposed that because parents' autonomy support involves providing children with rationales, it fosters children's language skills, which children use in the context of self-talk to guide themselves through such endeavors as inhibition and switching (e.g., Matte-Gagné & Bernier, 2011; Vallotton & Ayoub, 2011).

There is much evidence from correlational research that sensitive parenting, which includes parents' autonomy support as well as warmth and responsiveness, foreshadows enhanced executive functions among children (e.g., Belsky, Pasco Fearon, & Bell, 2007; NICHD Early Child Care Research Network, 2003; Zhou, Eisenberg, Wang, & Reiser, 2004). Although conclusions about causation are not possible, correlational research focusing specifically on autonomy-supportive (vs. controlling) parenting suggests that such parenting may benefit children's executive functions. For example, Bernier, Carlson, and Whipple (2010) found that mothers' autonomy support when children were 12 to 15 months predicted children's executive functions at 18 and 26 months adjusting for children's general cognitive skills and mothers' educational attainment. Matte-Gagné and Bernier (2011) also examined mothers' autonomy support when children were 15 months; the more autonomy-supportive mothers were at this time, the better children's executive functions were at 36 months over and above their executive functions at 24 months as well as socioeconomic status (see also Hammond, Müller, Carpendale, Bibok, & Liebermann-Finestone, 2012).

Children's Executive Functions and Achievement

Children's executive functions are considered a critical ingredient in their achievement in school (e.g., Blair, 2002; Shonkoff & Phillips, 2000). Executive functions may support cognitive processes that are fundamental to learning. In the arena of math, Noël (2009) argues that executive functions facilitate simple arithmetic by, for example, helping children to keep their place while counting or glean the relevant information from a story problem. Executive functions may also benefit children's development in the area of literacy; for example, they may allow children to focus on individual letters and store the accompanying phonemic information to decode words (e.g., Nevo & Breznitz, 2011). Beyond supporting such cognitive processes, executive functions may support children in regulating their attention and behavior in a variety of learning environments; in the earliest years, this may be at home, with these skills transferring to the classroom once children start school, such that ultimately children engage productively in daily learning activities (e.g., McClelland & Cameron, 2011). Indeed, a correlational study showed that the association between children's executive functions and subsequent achievement across the transition to school was partially mediated by their learning-related behaviors (e.g., persistence) in the classroom even after adjusting for children's fluid intelligence (Neuenschwander, Röthlisberger, Cimeli, & Roebers, 2012; but see also Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009).

Substantial research indicates that children's executive functions in preschool and kindergarten predict their later math and literacy achievement, even when accounting for a host of potential confounds (e.g., children's general intelligence and mothers' educational attainment) (e.g., Blair & Razza, 2007; Clark, Sheffield, Wiebe, & Espy, 2013; Fitzpatrick, McKinnon, Blair, & Willoughby, 2014; McClelland et al., 2006; Neuenschwander et al., 2012). For example, McClelland and colleagues (McClelland et al., 2007) demonstrated that children's executive functions in the fall of kindergarten predicted their math, vocabulary, and literacy achievement in the spring of kindergarten adjusting for their achievement in the fall as well as their gender and age; it also appeared that child care experience, parents' educational attainment, and minority status did not account for the predictive significance of children's executive functions. Thus, it is quite possible that the executive functions that ensue from autonomy-supportive parenting are responsible for the enhanced achievement among children that appears to be fostered by such parenting.

Is the Predictive Significance of Autonomy-Supportive Parenting Unique?

Although the prior correlational research suggesting that there are benefits of autonomy-supportive (vs. controlling) parenting for children's executive functions and achievement has taken into account a variety of potential confounds (e.g., Hess & McDevitt, 1984; Joussemet et al., 2005; Matte-Gagné & Bernier, 2011), such work has not adequately evaluated the possibility that the predictive significance of parents' autonomy support is due to other dimensions of parenting that co-occur with autonomy support. This is important to consider because autonomy-supportive parenting covaries with a suite of other parenting practices predictive of children's achievement (e.g., Moorman & Pomerantz, 2010;

NICHD Early Child Care Research Network, 1999, 2005; Pianta, Smith, & Reeve, 1991; Razza, Martin, & Brooks-Gunn, 2010). For example, the more autonomy supportive parents are, the warmer they tend to be toward children (e.g., Clark & Ladd, 2000; Steinberg et al., 1989). Autonomy-supportive parenting also co-occurs with parents' use of structure (e.g., Grolnick & Ryan, 1989)—that is, their organization of children's environment to facilitate children's competence via such practices as guidance and scaffolding—which often includes cognitive stimulation. Parents' warmth and cognitive stimulation have been linked to enhanced executive functions as well as achievement among children (e.g., Hindman & Morrison, 2012; Kochanska, Aksan, Prisco, & Adams, 2008; Landry, Miller-Loncar, Smith, & Swank, 2002). Hence, these dimensions of parenting are potential confounds in the effects of autonomy-supportive parenting.

This issue has not gone unnoticed in the research on parents' autonomy support (vs. control). Studying achievement, Steinberg and colleagues (1989) demonstrated that autonomy-supportive parenting predicted children's subsequent achievement over and above parents' warmth. Bernier and colleagues (2010) also took up this issue in their research on children's executive functions: In addition to examining mothers' autonomy support when children were 12 to 15 months, these investigators examined mothers' responsiveness (i.e., mothers' sensitivity to children's needs) and mind-mindedness (i.e., talk about thoughts and feelings) at this time. When the three types of parenting were tested simultaneously, they all predicted enhanced executive functions at 18 months, but by 26 months, only autonomy support did so. However, it is unclear if autonomy-supportive parenting was uniquely predictive because of the distinct effectiveness of such parenting or because, unlike the other dimensions of parenting, it was coded during an interaction between mothers and children around a cognitive task (i.e., a puzzle), which may have been more relevant than the other observational contexts (e.g., a free-play session) to the development of children's executive functions. Moreover, parents' cognitive stimulation has not been examined as a potential explanation for the apparent benefits of their autonomy support; however, cognitive stimulation may be particularly important as it focuses on developing the skills, including executive functions that foster achievement.

The Current Study

The major goal of this report was to examine the hypothesis that autonomy-supportive (vs. controlling) parenting enhances children's achievement by facilitating the development of children's executive functions. Our first set of analyses tested whether mothers' autonomy support during the first 3 years of life predicts children's executive functions before entering kindergarten and children's subsequent achievement, even when accounting for other dimensions of parenting (i.e., warmth and cognitive stimulation) that might also be important. In addition to a set of demographic covariates (i.e., child gender and ethnicity, family income-to-needs ratio, and maternal education), these analyses adjusted for early temperament and general cognitive skills (i.e., during 6 to 36 months when parenting was assessed) as these factors may contribute to parenting as well as children's executive functions and achievement (e.g., Calkins, Hungerford, & Dedmon, 2004; Eisenberg et al., 2010; Olson, Bates, Sandy, & Schilling, 2002). Our second set of analyses examined if children's executive functions mediated the link between autonomy-supportive parenting and children's subsequent achievement. To ensure that the mediating role of executive functions was unique, we evaluated whether two alternative mediators, a proxy for general cognitive skills (i.e., vocabulary) and three major dimensions of temperament before entering kindergarten (i.e., at 54 months when executive functions were assessed) accounted for the mediating role of executive functions.

Data from the NICHD Study of Early Child Care and Youth Development (SECCYD) were used. We used observational assessments of mothers' autonomy support (vs. control) during semi-structured tasks when children were 6 to 36 months. During this phase of development, children's executive functions are developing rapidly; thus, they may be particularly open to the effects of experiences with caregivers (e.g., Clark et al., 2013; Garon, Bryson, & Smith, 2008; Wiebe, Sheffield, & Espy, 2012). Such experiences likely need to be ongoing—for example, brief interludes of autonomy-supportive parenting are unlikely to provide the necessary support for the development of children's executive functions. Thus, we combined the assessments of parenting over the 6 to 36 months phase; this approach also reduces error relative to examining each assessment on its own (Rushton, Brainerd, & Pressley, 1983). Observations of mothers' warmth (vs. hostility) and cognitive stimulation during the same tasks as those in which observations of their autonomy support were available, permitting a more stringent evaluation of whether autonomy-supportive parenting exerts a unique effect than has been possible in prior research in which different dimensions of parenting have been confounded with observational context.

Several measures of executive functions just before children entering kindergarten (i.e., 54 months) were the focus of this report. Although there is considerable debate regarding the structure of executive functions during these early years (see Hughes, 2011), evidence suggests that the component skills (i.e., inhibition, working memory, and cognitive flexibility) of executive functions at this time are best characterized as a single construct (e.g., Blair et al., 2011; Willoughby, Blair, Wirth, & Greenberg, 2011). Moreover, it has been argued that using an aggregate measure of executive functions reduces error specific to a given assessment tool (Carlson, Mandell, & Williams, 2004; Cuevas et al., 2013; Dilworth-Bart, 2012). Thus, we combined the SECCYD prekindergarten executive functions measures (i.e., inhibition, delay of gratification, and sustained attention) into a single, reliable latent construct. Children's achievement during both elementary and high school was investigated. This is a substantial improvement over prior research examining whether children's executive functions underlie aspects of the home environment given that previous studies have looked at only proximal achievement by using assessments just before or at kindergarten (e.g., Dilworth-Bart, 2012; NICHD Early Child Care Research Network, 2003; Razza et al., 2010; Razza & Raymond, 2013).

Method

Participants

Mothers were recruited for the NICHD SECCYD after giving birth in 30 hospitals in 10 locations throughout the United States

(Little Rock, AR; Irvine, CA; Lawrence, KS; Boston, MA; Philadelphia, PA; Pittsburgh, PA; Charlottesville, VA; Morganton, NC; Seattle, WA; and Madison, WI). This strategy yielded a sample of 1,364 infants and their mothers (for further sampling and recruitment details, see http://secc.rti.org). The analyses in this report used assessments from Phase 1 (birth to 3 years), Phase 2 (54 months to 1st grade), Phase 3 (2nd to 6th grade), and Phase 4 (age 15 years) of the study. Analyses were conducted on the 1,306 mother–child dyads who participated in at least one semistructured observation of parenting during Phase 1 (for sample sizes at each time point, see Tables 1 and 2). Mothers in the dyads participating in at least one semistructured observation of parenting during Phase 1 were more educated than those who did not do so, $t(1361) = 3.32$, $p < .01$, but otherwise the dyads did not differ on the variables included in this report. Children (52% male) were predominantly (77%) European American, with 12% being African American, 6% Hispanic, and 5% other ethnicities. Mothers' educational attainment ranged from seven to 21 years ($M = 14.28$, $SD = 2.50$): 10% of mothers had less than a high school degree, 21% had a high school degree, 55% had completed some college or earned a 4-year degree, and 15% had completed some graduate work or at least a master's degree. At Phase 1, 11% of the families were below the poverty threshold based on calculation of the income-to-needs ratio (i.e., the family's income relative to the federal poverty line).

Procedure

Trained researchers collected data from children and mothers in the home and lab during each of the four phases of the study analyzed in this report. Mothers' parenting was assessed at Phase 1 via videotaped observations when children were 6, 15, 24, and 36 months. Children's executive functions were measured in the lab at Phase 2 when children were 54 months; the alternative mediators (i.e., children's temperament and general cognitive skills) were also assessed at this time. Woodcock-Johnson assessments of children's achievement in the lab from Phase 2 and Phase 3 during elementary school (i.e., 1st, 3rd, and 5th grades) and Phase 4 during high school (i.e., age 15 years) were used. Covariates included infants' difficult temperament as reported by mothers when children were 6 months and children's early general cognitive skills measured with the Bayley Mental Developmental Index administered in the lab when children were 15 months.

Table 1
Descriptive Statistics for the Parent Variables

	N	*M* (*SD*)	ICC
Parenting variables			
Autonomy support			
6 months	1272	3.41 (0.78)	.65
15 months	1240	3.56 (0.73)	.77
24 months	1172	3.52 (0.72)	.69
36 months	1161	5.29 (1.10)	.72
Warmth			
6 months	1272	3.38 (0.41)	.83
15 months	1240	3.37 (0.39)	.65
24 months	1172	3.29 (0.53)	.76
36 months	1161	6.62 (0.82)	.82
Cognitive stimulation			
6 months	1272	2.59 (0.66)	.92
15 months	1240	2.67 (0.62)	.69
24 months	1172	2.71 (0.74)	.72
36 months	1161	4.47 (1.44)	.78
Demographics			
Maternal education at 1 month (years)	1306	14.28 (2.50)	—
Average income-to-needs ratio from 1–36 months	1302	3.62 (2.87)	—

Note. ICC = Intraclass correlation. Parenting ratings at 6, 15, and 24 months ranged from 1 to 4. Ratings at 36 months ranged from 1 to 7. Autonomy support was assessed using intrusiveness (reverse-coded) at 6, 15, and 24 months and support for autonomy at 36 months. Warmth was calculated using positive and negative regard codes at 6, 15, and 24 months; the average ICC for the positive and negative regard codes is presented. At 36 months, warmth was calculated using reverse scores of hostility.

Measures

Descriptive statistics and correlations for the measures are presented in Tables 1–3.

Maternal parenting. Mothers' parenting was observed during 15-min, semistructured play interactions in the home when children were 6 and 15 months and in the lab when children were 24 and 36 months. At 6 months, mothers and children spent the first 7 min of the interaction in free play, and then were given a standardized set of toys (e.g., a stuffed animal and a picture book) with which to play for the remaining 8 min. At 15, 24, and 36 months, mothers were given a set of three boxes, each containing a toy or activity (e.g., storybook and a toy kitchen) and were told to go through each of the boxes in order, interacting with children as little or as much as they wanted. Mothers' behavior during these interactions was coded for autonomy support (vs. control), warmth (vs. hostility), and cognitive stimulation by coders who had participated in intensive training and who met frequently to prevent drift (for the intraclass correlations between coders, see Table 1). At 6, 15, and 24 months, each dimension was coded on a scale from 1 (*not at all characteristic*) to 4 (*very characteristic*). At 36 months, each was coded on a 7-point scale (1 = *not at all characteristic* to 7 = *very characteristic*; for more information about the coding procedures see NICHD Early Child Care Research Network, 1999).

When children were 6, 15, and 24 months, mothers' behavior was coded for intrusiveness, which was operationalized as hurrying children, promoting their own (vs. children's) goals for the activity, stopping children's play and redirecting it without explanation, or issuing strict punishments regardless of the severity of children's misbehavior. Mothers' support for children's autonomy was coded when children were 36 months; autonomy-supportive practices included flexibility on the part of mothers, following children's pace and interests in the joint activity, and allowing children to take the lead when appropriate. An *autonomy-supportive* (vs. *controlling*) index was computed by averaging the standardized ratings across the four time points after reverse-scoring the intrusiveness ratings, such that higher numbers reflect heightened autonomy-supportive parenting. The autonomy support scores at the four time points were nontrivially correlated (rs = .22 to .37, ps < .001).

At the 6-, 15-, and 24-month observations, mothers' *warmth* (vs. *hostility*) was captured with positive and negative regard codes. Positive regard was operationalized as the use of a positive tone of voice, positive facial expression, physical affection, or praise when

Table 2
Descriptive Statistics for the Child Variables

	N	*M* (*SD*)	Reliability
Executive functions (54 months)			
CPT inhibition errors (reverse-scored)	1002	205.81 (21.30)	.65 to .74[a]
CPT sustained attention errors (reverse-scored)	1002	210.87 (7.59)	.65 to .74[a]
Delay of gratification (minutes waited)	961	4.48 (3.01)	—
Stroop (percent correct)	838	74.66 (20.53)	.79[b]
Academic achievement (*W* scores)			.80 to .87[a]
Elementary school			
1st grade reading	1025	463.26 (20.06)	—
1st grade math	1023	470.05 (15.54)	—
3rd grade reading	1008	494.58 (15.12)	—
3rd grade math	1007	493.59 (12.57)	—
5th grade reading	989	507.60 (14.18)	—
5th grade math	989	510.56 (12.80)	—
High school			
Reading	883	520.35 (12.44)	—
Math	883	524.52 (16.72)	—
Temperament			
Child difficult temperament (6 months)	1279	3.18 (0.40)	.81[b]
Negative affectivity (54 months)	1060	4.30 (0.64)	.60 to .76[b]
Surgency/extraversion (54 months)	1057	4.81 (0.62)	.70 to .85[b]
Effortful control (54 months)	1061	4.68 (0.71)	.74 to .75[b]
General cognitive skills			
Bayley Mental Development Index (15 months)	1180	108.58 (14.07)	>.80[c]
Picture vocabulary (*W* score, 54 months)	1060	459.54 (14.09)	≥.80[a]

Note. When no reliability information is provided, appropriate reliability information was not available for the NICHD SECCYD.
[a] Test–retest reliability. [b] Internal consistency reliability (coefficient α). [c] Split-half reliability.

working with children. Conversely, negative regard captured the frequency and intensity of mothers' negative affect directed toward children, either in the form of negative emotions such as anger or rough physical actions. At 36 months, only hostility was coded; the focus was on mothers' negative emotions including anger and rejection of children (e.g., visible irritation with children, provision of negative feedback about children's performance, or blaming children for not doing well). The negative regard and hostility codes were reverse scored to reflect warmth. The standardized scores were then averaged over the four time points to create an index of mothers' warmth (vs. hostility), with higher numbers reflecting heightened warmth. The scores at the four different time points were nontrivially correlated (*r*s = .25 to .36, *p*s < .001).

At all four time points mothers' *cognitive stimulation* was operationalized as their efforts to teach children in ways that would facilitate their cognitive development. Examples of behaviors coded as cognitive stimulation are helping children focus on a task or object, pointing out unique features or characteristics of the toy or activity, and responding to and elaborating on children's ver-

Table 3
Correlations Between Indicators in the Central SEM Models

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Autonomy support	—														
2. Warmth	.57***	—													
3. Cognitive stimulation	.34***	.58***	—												
4. CPT inhibition	.20***	.20***	.17***	—											
5. CPT sustained attention	.20***	.15***	.20***	.24***	—										
6. Delay of gratification	.29***	.27***	.28***	.31***	.24***	—									
7. Stroop	.09**	.08*	.05	.16***	.08*	.12**	—								
8. Elementary reading	.26***	.29***	.26***	.22***	.22***	.23***	.09*	—							
9. Elementary math	.30***	.30***	.29***	.24***	.27***	.27***	.09**	.76***	—						
10. High school reading	.39***	.35***	.32***	.24***	.22***	.31***	.09*	.62***	.62***	—					
11. High school math	.35***	.29***	.28***	.18***	.20***	.27***	.10**	.53***	.72***	.69***	—				
12. Maternal education	.41***	.41***	.43***	.21***	.18***	.25***	.12***	.34***	.37***	.40***	.40***	—			
13. Income-to-needs	.32***	.34***	.33***	.14***	.13***	.23***	.10**	.27***	.31***	.32***	.31***	.54***	—		
14. Infant difficult temperament	−.17***	−.14***	−.17***	−.06*	−.06	−.08*	.03	−.13***	−.13***	−.13***	−.16***	−.14***	−.15***	—	
15. Bayley MDI	.20***	.18***	.24***	.20***	.20***	.20***	.07*	.24***	.30***	.27***	.24***	.13***	.14**	−.06*	—

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

Table 4
Fit Statistics for the SEM Models

Model	χ^2	CFI	TLI	RMSEA
Parenting predicting executive functions				
Models with one dimension of parenting and covariates				
Autonomy support	88.84	.963	.905	.043
Warmth	87.68	.962	.908	.042
Cognitive stimulation	89.37	.962	.903	.043
Model with three dimensions of parenting and covariates	103.06	.976	.935	.040
Parenting predicting elementary achievement				
Models with one dimension of parenting and covariates				
Autonomy support	23.16	.994	.975	.032
Warmth	25.45	.994	.974	.032
Cognitive stimulation	16.90	.995	.978	.029
Model with three dimensions of parenting and covariates	30.59	.995	.975	.032
Parenting predicting high school achievement				
Models with one dimension of parenting and covariates				
Autonomy support	37.56	.986	.937	.046
Warmth	43.44	.983	.929	.047
Cognitive stimulation	38.50	.985	.933	.047
Model with three dimensions of parenting and covariates	43.70	.991	.952	.043
Mediation models				
Model predicting elementary achievement				
Model without vocabulary and temperament 54 months	115.10	.975	.941	.039
Model with vocabulary and temperament at 54 months	145.70	.977	.937	.036
Model predicting high school achievement				
Model without vocabulary and temperament 54 months	123.16	.968	.925	.041
Model with vocabulary and temperament at 54 months	153.80	.973	.924	.037

Note. All models included maternal education, ethnicity, income-to-needs ratio, child gender, difficult temperament at 6 months, and Bayley Mental Development Index score at 15 months as covariates.

balizations. The standardized scores from each time point were averaged to create an index of mothers' cognitive stimulation, with higher numbers reflecting heightened cognitive stimulation on the part of mothers. The assessments of cognitive stimulation at the four different time points were nontrivially correlated (rs = .22 to .38, ps < .001).

Child executive functions. The Day-Night Stroop task, delay of gratification task, and Continuous Performance Test (CPT) were used to assess executive functions when children were 54 months. Four measures of executive functions were drawn from these tasks. The Day-Night Stroop task is primarily a measure of inhibition (Gerstadt, Hong, & Diamond, 1994). Children were shown a picture of a moon and stars or a picture of a sun. They were instructed to say "day" when they saw the moon and stars and "night" when they saw the sun. There were two practice trials followed by 16 test trials with half being day and half night. The

Table 5
SEM Results for Early (6 to 36 Months) Parenting Predicting Children's Later (54 Months) Executive Functions

	B	*SE*	β
Covariates			
Maternal education (years)	0.06	0.02	.18***
Ethnicity (European-American = −1, all others = 1)	−0.11	0.04	−.11**
Income-to-needs ratio	0.03	0.01	.09*
Child gender (boys = −1, girls = 1)	0.20	0.03	.23***
Child difficult temperament at 6 months	0.01	0.08	.01
Bayley Mental Development Index at 15 months	0.01	0.00	.20***
Parenting at 6 to 36 months			
Autonomy support			
Model with covariates only	0.24	0.05	.20***
Model with other dimensions of parenting and covariates	0.18	0.06	.16**
Warmth			
Model with covariates only	0.22	0.05	.19***
Model with other dimensions of parenting and covariates	0.07	0.06	.07
Cognitive stimulation			
Model with covariates only	0.20	0.05	.17***
Model with other dimensions of parenting and covariates	0.14	0.06	.12*

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

Table 6
SEM Results for Early (6 to 36 Months) Parenting Predicting Children's Elementary and High School Achievement

	Elementary school			High school		
	B	*SE*	β	B	*SE*	β
Covariates						
Maternal education (years)	1.18	0.20	.21***	1.17	0.17	.28***
Ethnicity (European-American = −1, all others = 1)	−0.90	0.50	−.05	−1.41	0.42	−.11***
Income-to-needs ratio	0.50	0.16	.10**	0.31	0.14	.09*
Child gender (boys = −1, girls = 1)	−0.78	0.39	−.06*	−1.06	0.33	−.10**
Child difficult temperament at 6 months	−1.56	0.97	−.05	−0.86	0.83	−.03
Bayley Mental Development Index at 15 months	0.22	0.03	.22***	0.15	0.03	.20***
Parenting practices at 6 to 36 months						
Autonomy support						
Model with covariates only	2.42	0.61	.13***	3.31	0.52	.23***
Model with other dimensions of parenting and covariates	1.79	0.68	.09**	3.03	0.58	.21***
Warmth						
Model with covariates only	2.35	0.59	.13***	2.08	0.50	.15***
Model with other dimensions of parenting and covariates	1.07	0.72	.06	0.33	0.61	.02
Cognitive stimulation						
Model with covariates only	1.78	0.61	.09**	1.43	0.52	.10**
Model with other dimensions of parenting and covariates	1.07	0.67	.06	0.88	0.58	.06

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

percent of the 16 test items correctly answered was calculated, with higher scores reflecting stronger executive functions ($\alpha = .79$).

Using Mischel, Shoda, and Rodriguez's (1989) well-validated paradigm for assessing children's delay of gratification, children were brought to a testing room where they chose their preferred snack (i.e., animal crackers, M&Ms, or pretzels). A trained research assistant then set out two plates, one with a small pile of the treat and one with a big pile. Children were given a bell and told that if they rang it before the assistant returned, they would get to eat the smaller pile of food. Alternatively, if they waited until the assistant returned (i.e., 7 min), they would get to eat the larger pile. The length of time children waited before ringing the bell (or 7 min if the child did not ring the bell) was used to index executive functions, with higher numbers indicating better inhibition skills.

In the CPT task, children viewed pictures of familiar items (e.g., a flower or butterfly) on a two-inch computer screen and were told to press a key only when they saw the target picture, which was a chair. There were 10 items per block, and 22 blocks of items, with each item presented for 500 ms with a 1,500 ms fixation cross between items. The CPT required approximately 7 min, 20 s to complete. Two measures of executive functions were gathered from this task: (a) inhibition, which was operationalized as the number of incorrect button presses, or "commission errors" made and (b) sustained attention—that is, the number of omission errors, or target items missed. Some children were not able to complete all

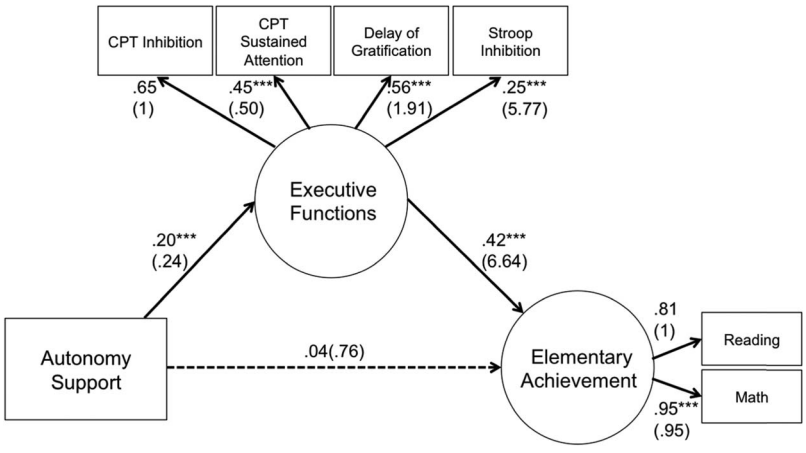

Figure 1. Mediational model predicting elementary school achievement. Coefficients outside parentheses are standardized; coefficients in parentheses are unstandardized. Covariates included maternal education, ethnicity, income-to-needs ratio, child gender, difficult temperament at 6 months, and Bayley Mental Development Index score at 15 months. *** $p < .001$.

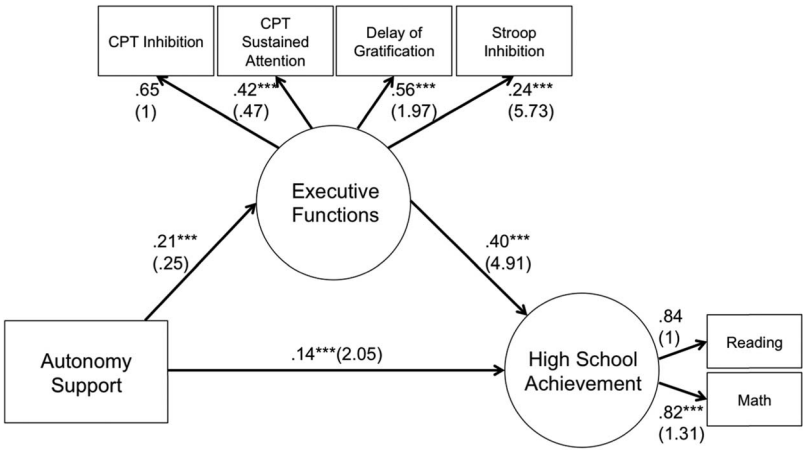

Figure 2. Mediational model predicting high school achievement. Coefficients outside parentheses are standardized; coefficients in parentheses are unstandardized. Covariates included maternal education, ethnicity, income-to-needs ratio, child gender, difficult temperament at 6 months, and Bayley Mental Development Index score at 15 months. *** $p < .001$.

220 items; all children who completed at least 110 items were assigned scores that were scaled to 220 items. Because these two sets of scores were highly skewed, natural log transformations were used (see NICHD Early Child Care Research Network, 2003, 2005). Each was then reverse-scored so that higher numbers reflect stronger executive functions.

In line with prior approaches that have used multiple executive functions measures (Blair et al., 2011; Carlson et al., 2004; Cuevas et al., 2013; Willoughby et al., 2011), the four measures were combined into a single latent construct, with the standardized loadings ranging from .24 to .64. Pairwise correlations between the two CPT measures and the delay of gratification measure were moderate (rs = .27 to .33, ps < .05), but the Day-Night Stroop scores correlated weakly with the other measures (rs = .07 to .22, ps < .05). Dropping the Day-Night Stroop scores from the construct did not notably change the results of the central analyses.

Child achievement. Children's achievement was assessed using subtests from the Woodcock-Johnson Psycho-Educational Battery (Woodcock & Johnson, 1990). *Elementary school achievement* was assessed at the 1st, 3rd, and 5th grades. Math achievement was indexed with scores on the Applied Problems subtest (i.e., math word problems), and the Calculation subtest (available only at 3rd and 5th grade), which includes basic math operations (e.g., addition and division). Reading achievement was indexed with scores on the Letter-Word subtest, which assesses children's ability to decode letters and words, as well as the Passage Comprehension subtest (available only at 3rd and 5th grade), and the Word Attack subtest (available only at 3rd and 5th grade), which requires children to read nonwords aloud using their phonological skills. *High school achievement* was assessed when children were 15 years, with the Applied Problems subtest for math and the Passage Comprehension for reading. The raw scores from each subtest were transformed into *W* scores, which are a specialized version of the Rasch ability scale centered on 500 (i.e., the average achievement level for 10 years). For both math and reading, the achievement scores were substantially associated over time during the elementary school years (rs = .50 to .86, ps < .001); thus, the average over the three grades was taken, with higher numbers reflecting higher achievement in each area. Latent constructs of elementary and high school achievement were created using the math and reading achievement test scores as indicators.

Child temperament. Ratings of children's temperament at 6 months made with an adapted version of the Early Infant Temperament Questionnaire Revised (Carey & McDevitt, 1978) were used as a covariate. Mothers rated how often (1 = *almost never* to 6 = *almost always*) children displayed behaviors reflecting high levels of activity and energy, withdrawal from (vs. approach to) new stimuli and people, adaptability (i.e., how easily children's reactions to stimuli can be modified when desired by the caregiver, and negative emotions (e.g., "My baby lies still [little squirming] when held in my arms between feedings" and "My baby objects [cries, frets] if someone other than myself gives care"). Following Pluess and Belsky (2010), the mean of the 39 items (reverse-scoring when necessary), was used as an index of difficult temperament, with higher values representing heightened difficulty (α = .81).

Children's temperament was assessed at 54 months with mothers' reports on a shortened version of the Children's Behavior Questionnaire (CBQ; Rothbart, Ahadi, & Hershey, 1994). Mothers rated (1 = *extremely untrue* to 7 = *extremely true*) items regarding children's behavior in the past 6 months. In line with procedures used by Honomichl and Donnellan (2011), who replicated previous factor analyses of longer versions of the CBQ (Rothbart, Ahadi, Hershey, & Fisher, 2001) using the NICHD SECCYD data, three scales were created: (a) Negative affectivity was comprised of the 30 items from the fear, sadness, and anger/frustration subscales (e.g., "Cries sadly when favorite toy gets lost"); (b) surgency/extraversion was comprised of the 28 items from the shyness (reverse-scored), activity level, and approach/anticipation subscales (e.g., "Seems to be at ease with almost any person"); (c) effortful control was comprised of the 18 items from the attention focus and inhibitory control subscales (e.g., "Can wait before entering a new activity").

Child general cognitive skills. Standardized scores from the Bayley Mental Development Index (MDI; Bayley, 1991) administered in the home when children were 15 months were used to assess children's early general cognitive skills. The MDI assesses several dimensions of infants' cognitive skills including memory and learning, verbal skills, and the ability to form categories. Split-half reliability coefficients reported for the standardization sample of 2- to 30-month-olds exceeded .80.

The *W* score from the Woodcock-Johnson Picture Vocabulary (Woodcock & Johnson, 1990) subtest administered in the lab at 54 months was used as a proxy for children's general cognitive abilities just before formal school entry. This subtest requires children to recognize or name pictures of familiar and unfamiliar objects. Vocabulary knowledge is considered to reflect crystallized intelligence; it is also strongly predictive of general cognitive skills (Marchman & Fernald, 2008). As a consequence, vocabulary is widely used as a covariate in studies seeking to isolate executive functions from aspects of general cognitive ability including verbal skills and intelligence (e.g., Bernier, Carlson, Deschênes, & Matte-Gagné, 2012; Blair, Granger, & Peters Razza, 2005; Blair et al., 2011; Blair & Razza, 2007; Brock et al., 2009; Miller, Müller, Giesbrecht, Carpendale, & Kerns, 2013; Nesbitt, Baker-Ward, & Willoughby, 2013).

Demographics. Mothers' provision of demographic information allowed for their educational attainment (i.e., years of education) at 1 month and average family income-to-needs ratio across Phase 1 of the study, as well as children's gender and ethnicity, to be used as covariates.

Results

Two sets of analyses were conducted. In the first, we evaluated whether mothers' early (i.e., 6 to 36 months) autonomy support (vs. control) predicts children's subsequent executive functions (i.e., 54 months) and achievement (i.e., elementary and high school) when taking into account mothers' early warmth (vs. hostility) and cognitive stimulation as well as the covariates. The second set tested whether children's executive functions mediated the effect of mothers' early autonomy support on children's achievement in elementary and high school, with attention to the confounding role of children's temperament and general cognitive skills. The analyses were conducted with structural equation modeling (SEM) using version 21 of AMOS (Arbuckle, 2011), which uses full information maximum likelihood estimation (FIML) in the presence of missing data; FIML provides more reliable standard errors to handle missing data under a wider range of conditions than does either listwise or pairwise deletion or mean imputation (Arbuckle, 1996; Wothke, 2000). Observed (i.e., manifest) variables were used for each of the dimensions of parenting as well as the covariates; as described earlier (see Method), latent constructs were used for executive functions and achievement (see Figures 1 and 2). As shown in Table 4, all the models fit well.

The Predictive Significance of Mothers' Autonomy-Supportive Parenting

Children's executive functions. Three separate initial models were used to test the effects of each dimension of mothers' parenting on children's executive functions. In each, only one dimension of parenting was included as a predictor of children's executive functions. Each model took into account the covariates assessed before or at the time of parenting (i.e., temperament at 6 months, general cognitive skills at 15 months, maternal educational attainment, income-to-needs ratio, and child gender and ethnicity), which were allowed to covary with the included parenting dimension. Covariates were allowed to correlate with one another only if a significant correlation was evident in preliminary analyses; this resulted in all covariates being intercorrelated with the exception of children's gender, which was correlated only with general cognitive skills at 15 months. The covariates were also included in the models as predictors of children's executive functions. As shown in Table 5, when considered independently, mothers' early autonomy support, warmth, and cognitive stimulation all predicted children's subsequent executive functions, such that the more mothers were autonomy supportive (vs. controlling), warm (vs. hostile), or cognitive stimulating early in children's lives the better children's executive functions before entering kindergarten over and above the covariates.

Given that the three dimensions of parenting were moderately to strongly correlated (rs = .34 to .58, ps < .001), we next evaluated whether the effect of autonomy-supportive parenting was unique or due to its overlap with warm and cognitive stimulating parenting. To this end, we tested a model in which all three dimensions of early parenting simultaneously predicted children's executive functions at 54 months. The three dimensions were allowed to covary with one another as well as with the covariates assessed before or at the time of parenting, which were also included as predictors of children's executive functions as in the earlier models. Mothers' early autonomy support and cognitive stimulation both predicted enhanced executive functions at 54 months, but mothers' warmth did not do so (see Table 5).

Children's achievement. Models identical to those for children's executive functioning were used to examine the role of the three dimensions of parenting in children's achievement, with separate models for children's elementary and high school achievement. Paralleling the results for children's executive functions, as shown in Table 6, the more autonomy supportive, warm, and cognitively stimulating mothers were early in children's lives, the better children's achievement in elementary and high school, over and above the covariates. Notably, the effects of mothers' autonomy support on children's achievement during elementary and high school held up when the two other dimensions of parenting were included in the models (see Table 6). However, neither warmth nor cognitive stimulation was predictive of children's achievement with the other dimensions of parenting in the model.

Supplementary analyses. Further analyses were conducted to test the contribution of each dimension of parenting at each time point (i.e., 6, 15, 24, and 36 months) included in the composites of early parenting to children's executive functions and achievement. In the models examining autonomy-supportive parenting without the other dimensions of parenting, autonomy support always positively predicted children's executive functions and achievement, with this association being significant 83% of the time (i.e., in 10 out of 12 analyses). When the other dimensions of parenting were included, autonomy-supportive parenting positively predicted children's executive functioning and achievement, with the exception of

one nonsignificant, negative association. The association was significant 75% of the time (i.e., 9 out of 12). There was not a consistent tendency for autonomy-supportive parenting to be significant at some time points, but not others (see Part A of the online Supplementary Materials).

The Mediating Role of Children's Executive Functions

Our next set of analyses tested whether children's executive functions accounted for the positive associations between early autonomy-supportive (vs. controlling) parenting and children's later achievement. To examine this possibility, mediation analyses were conducted following Baron and Kenny's (1986) guidelines (see also Shrout & Bolger, 2002). We already demonstrated evidence of the total effect in finding that early autonomy-supportive parenting predicts children's enhanced achievement during elementary and high school adjusting for the covariates (see Table 6). In addition, we also established partial evidence for the indirect effect: Mothers' early autonomy support predicted more advanced executive functions among children before kindergarten (see Table 5). In the context of SEM, we examined the indirect effect as a whole. As shown in Figures 1 and 2, we added executive functions to the model predicting children's achievement from mothers' autonomy support, such that children's executive functions were predicted by mothers' earlier autonomy support with children's executive functions also predicting their later achievement. In these models, the covariates were correlated with one another and mothers' autonomy support as in the earlier models (see above); in addition, the covariates were included as predictors of children's executive functions and achievement.

The mediation models for both elementary and high school achievement indicated that the better children's executive functions at 54 months, the better their achievement during elementary and high school, taking into account mothers' autonomy support as well as the covariates (see Figures 1 and 2). The direct effect of mothers' early autonomy support on children's achievement during elementary school was reduced to nonsignificance ($\beta = .04$, $t = 1.41$, *ns*) with children's executive functions in the model accounting for 69% of the total effect. The Sobel test indicated that the indirect effect of autonomy support on elementary-school achievement via executive functions was significant, $Z = 3.70$, $p < .001$. A similar pattern was evident for children's achievement in high school, but mediation was only partial (see Table 6): Children's executive functions accounted for 39% of the effect of mothers' autonomy support on children's high school achievement; however, the direct effect remained significant ($\beta = .14$, $t = 3.62$, $p < .001$) with children's execution functions in the model. The Sobel test revealed a significant indirect effect of autonomy support on high school achievement through executive functions, $Z = 3.57$, $p < .001$.

Supplemental analyses. We conducted two sets of supplemental analyses. First, to verify that the indirect effects in the mediation models did not vary for the four indicators (i.e., CPT inhibition, CPT sustained attention, Stroop, and Delay of Gratification) of the latent executive functions construct, we tested additional models using each executive function assessment as an observed mediator. When predicting both elementary and high school achievement, there were significant indirect effects through all the indicators of executive functions, $Zs > 2.10$, $p < .05$, with the exception of the Stroop task ($Zs < 1.18$, *ns*; see Part B of the online Supplementary Material).

Second, we evaluated the possibility that the mediating role of executive functions was due to other attributes of children that covary with their executive functions. To this end, we added the three scales of children's temperament (i.e., negative affectivity, surgency/extraversion, and effortful control) and the Woodcock-Johnson Picture Vocabulary scores at 54 months to the existing models as mediators (see Part C of the online Supplementary Material). The errors of the three dimensions of temperament and the vocabulary scores were allowed to covary with one another, executive functions, and the covariates. When accounting for the three dimensions of temperament and the vocabulary scores, the links between children's executive functions and achievement were reduced but remained significant ($\beta = .39$ for elementary school achievement and $\beta = .32$ for high school achievement, $ts > 4.34$, $ps < .001$). The indirect path from autonomy support to children's achievement in elementary and high school via children's executive functions also remained significant as evidenced by Sobel tests, $Zs > 3.19$, $ps < .01$. The indirect pathways via executive functions accounted for 60% of the total effect for children's achievement in elementary and 28% of the total effect for children's achievement in high school.

Discussion

There is much evidence that parents' support of children's autonomy predicts heightened achievement among children over time (for a review, see Pomerantz et al., 2005). However, the issue of why such an association reliably occurs has received limited empirical attention. The current research provides support for the idea that autonomy-supportive parenting may enhance children's achievement by promoting the development of children's executive functions—that is, core cognitive skills that allow children to manage their attention and behavior. Mothers' autonomy support (vs. control) over the first 3 years of children's lives predicted children's achievement not only in elementary school, but also in high school, over and above children's early general cognitive skills and temperament as well as a number of demographic factors (e.g., mothers' educational attainment). Notably, the association between early autonomy-supportive parenting and children's achievement during elementary and high school was accounted for in part by enhanced executive functions among children before kindergarten entry. The predictive significance of mothers' autonomy support was not entirely attributable to mothers' early warmth or cognitive stimulation, pointing to the unique role of mothers' autonomy support.

Given the robust evidence from correlational research in line with the idea that early executive functions play an important role in children's development in a variety of areas (e.g., Blair & Razza, 2007; Moffitt et al., 2011), a key question is how the environment shapes these skills. To this end, there has been much attention to parenting, with prior correlational research suggesting that autonomy support (vs. control) may promote children's executive functions (e.g., Bernier et al., 2010; Hammond et al., 2012; Matte-Gagné & Bernier, 2011). Similarly, in the current research, autonomy-supportive parenting predicted children's executive functions over time taking into account children's early general cognitive skills and temperament as well as several demographic

factors (i.e., child gender, ethnicity, income-to-needs, and maternal education). Extending prior research, we also controlled for other dimensions of parenting (i.e., warmth and cognitive stimulation) associated with autonomy-supportive parenting (e.g., Moorman & Pomerantz, 2010; Razza et al., 2010). A key improvement over prior research is that all the dimensions of parenting were assessed during the *same* interaction such that the parenting dimensions and contexts of assessment were not confounded. Our examination of mothers' cognitive stimulation was of particular import as it has not received attention in prior research on autonomy-supportive parenting, but may have consequences for children's executive functions as it is focused on developing these and other cognitive skills. Notably, in the current research, the effects of mothers' autonomy support were unique in that they were not due to mothers' warmth or cognitive stimulation, although the latter also had a unique effect.

The positive association between early autonomy-supportive parenting and children's subsequent executive functions is important not only in and of itself, but because it may be through children's executive functions that such parenting benefits children's achievement as they navigate the school system. Consistent with prior research (e.g., Grolnick & Ryan, 1989; Grolnick et al., 1991), the more autonomy supportive mothers were, the higher children subsequently scored on standardized achievement tests in the current research. Notably, the predictive value of early autonomy-supportive parenting was evident for children's achievement in elementary school as well as high school. As was the case for children's executive functions, mothers' autonomy support predicted children's achievement over time after accounting for mothers' warmth and cognitive stimulation in addition to other important covariates. In line with our perspective that parenting needs to be ongoing over time to provide the necessary support for the development of children's executive functions thereby fostering their achievement, our index of early parenting combined parenting across four time points (i.e., 6, 15, 24, and 36 months) over the first 3 years of children's lives. Although the four observations were only modestly correlated with one another, this approach is useful in that it reduces error (Rushton et al., 1983). Moreover, further analyses indicated that autonomy-supportive parenting at the different time points generally predicted children's executive functions and achievement similarly (see Part A of the online Supplementary Material). However, to make conclusions about differences in the role of autonomy-supportive parenting at different points over the first 3 years of children's lives, further research would be needed to ensure that the coding of autonomy support at the different points was equivalent given that parents' practices and the contexts in which they use them may vary with children's age (i.e., allowing children to choose toys before they are mobile vs. allowing them to explore their environment once they are mobile vs. allowing them to take the lead on solving problems once more cognitive tasks are introduced).

In line with extant research (e.g., Bernier et al., 2010; Joussemet et al., 2005), the effect sizes for the links between autonomy-supportive parenting and children's executive functions and achievement were nontrivial, but in the small range. For executive functions, the effects of autonomy support as well as other forms of parenting were close in size to mothers' educational attainment as well as children's early general cognitive skills (i.e., the Bayley Mental Development Index at 15 months), suggesting that all these factors—as well as others—may jointly contribute to children's executive functions. A similar picture emerged when predicting achievement, but the effects of autonomy-supportive parenting were sometimes smaller than those of mothers' educational attainment and children's early general cognitive skills. Thus, although autonomy-supportive parenting was a unique predictor of children's executive functions and achievement in that its effects were not due to a variety of potential confounds, it appears to be only one of several contributors to children's executive functions and achievement.

The unique contribution of the current research is in showing that the association between mothers' autonomy support and children's subsequent achievement was at least in part accounted for by children's earlier executive functions. This finding held even when testing more complex models accounting for the potentially confounding role of children's general cognitive skills (i.e., vocabulary) and temperament assessed concurrently to executive functions. For children's elementary school achievement, their executive functions before kindergarten reduced the total effect to nonsignificance. For children's high school achievement, the total effect was also reduced, but remained significant. However, the total effect was larger for high school (vs. elementary school) achievement suggesting that, despite the longer time lag, parents' autonomy support is more important for children's achievement during this phase of development for other reasons than the benefits it appears to confer on children's executive functions. For example, the transition to high school can often be challenging for children (for a review, see Benner, 2011) and the autonomous foundation established by early autonomy supportive parenting—and likely maintained over time—may allow children to navigate the difficulties successfully by keeping them interested and engaged.

The current findings add to several studies providing evidence that children's executive functions serve as a mechanism by which children's home environment may contribute to their achievement (e.g., Dilworth-Bart, 2012; Razza et al., 2010). For example, an earlier analysis of the NICHD SECCYD data demonstrated that children's sustained attention and inhibition skills (assessed via only the CPT) at 54 months partially mediated the association between a composite of several measures of the early home environment and children's achievement in kindergarten (NICHD Early Child Care Research Network, 2003). The current research extends such research in two major ways. First, it focuses specifically on mothers' autonomy support rather than the home environment (e.g., learning materials and the physical environment) or parenting in general (e.g., sensitivity that includes responsiveness, autonomy support, and warmth). As such, it is suggestive of the unique role that autonomy-supportive parenting plays in setting the foundation for children's achievement via their executive functions. Second, prior research has not examined children's achievement beyond kindergarten, with children's executive functions and achievement often being assessed contemporaneously. Thus, it was unclear if the executive functions established by the home environment foreshadowed children's achievement over time. The current research indicates the predictive value of autonomy-supportive parenting is sustained as children move into elementary and even high school.

Limitations and Future Directions

The current research has several limitations that should be considered in interpreting the findings. For one, because the parenting data were collected through observations in structured tasks, mothers in the study may not have demonstrated the full range of their parenting, particularly in terms of warmth (vs. hostility). Indeed, warmth was positively skewed so that the means were near, but not at, ceiling with less variance than either autonomy support or cognitive stimulation. Hence, the finding that mothers' early warmth did not predict children's subsequent executive functions or achievement over and above the other dimensions of parenting may simply reflect that there were not large enough differences among mothers in terms of their warmth dipping below a meaningful threshold. To address this issue, future research should examine parents' warmth either in structured tasks eliciting dampened warmth (e.g., a situation in which children and parents are easily frustrated) or via methods that assess parents' warmth in their day-to-day interactions with children.

A second limitation concerns the measures used to assess children's executive functions. The current analyses made use of the measures available just before children entering kindergarten in the SECCYD given that executive functions at this time appear to be important to later achievement (e.g., Best et al., 2011; Blair & Razza, 2007; McClelland et al., 2006). Three (i.e., the Continuous Performance Test, Day-Night Stroop, and delay of gratification task) of the four measures used focus heavily on inhibition skills as opposed to the other components of executive functions (i.e., working memory and cognitive flexibility). Prior research examined the predictive value of mothers' autonomy-support for different types of executive functions (e.g., delay of gratification tasks vs. those tapping inhibition, working memory, and cognitive flexibility; Bernier et al., 2010; Matte-Gagné & Bernier, 2011), but did not demonstrate whether mothers' autonomy support mattered significantly more for one type versus another. Thus, although we would expect a similar pattern of findings for different types of executive functions, it will be useful for future research on autonomy-supportive parenting to examine its effects on diverse types.

A third limitation is that it was not possible to account for children's early executive functions when parenting was observed. Thus, it is plausible that mothers' provision of autonomy support was in some part a reaction to children's executive functions; there is some evidence to suggest that when children have poor executive functions, mothers may respond with dampened autonomy support (e.g., Eisenberg et al., 2010). Indeed, such a process may underlie the link we documented between children's executive functions before entering kindergarten and their subsequent achievement: Executive functions at this phase may elicit or maintain autonomy-supportive parenting during the elementary and high school years, which may enhance achievement either via executive functions or other mechanisms (e.g., autonomous motivation). Importantly, however, Bernier and colleagues (Bernier et al., 2010; Matte-Gagné & Bernier, 2011) found that autonomy-supportive parenting predicted children's executive functions when accounting not only for children's general cognitive skills, but also their prior executive functions.

Fourth, despite the range of controls included in our models as well as the prospective, longitudinal design, the research is ultimately correlational leaving open the possibility of additional confounds. In this context, particular care must be taken in considering two key covariates. The indexes we used of children's temperament and general cognitive skills may not be maximally reliable. For one, only single assessments were used for each index at the time points of interest. The assessments before or at the time of parenting were made quite early in children's lives (i.e., temperament was assessed at 6 months and general cognitive skills were assessed at 15 months). This was important in terms of identifying attributes of children that might shape parenting. However, it is unclear how valid such assessments are at such a young age. The later (i.e., 54 months) assessments of temperament and general cognitive skills that were included as alternative mediators were similarly limited in that they were manifest (as opposed to latent) variables. The Woodcock-Johnson vocabulary assessment—the proxy of general cognitive skills in the current study—has received extensive psychometric attention, making it particularly reliable and valid (McGrew, Werder, & Woodcock, 1991), but represents only one component of children's general cognitive skills. Given these issues, it is possible that, despite our many controls, the associations between autonomy-supportive parenting and children's executive functions and achievement simply reflect shared genes as suggested by Scarr (1992; see also Scarr & McCartney, 1983). That said, Roisman and Fraley (2012) demonstrated that only a small portion of the link between early parenting and children's achievement is attributable to shared genes. A final limitation is that although the NICHD SECCYD sample includes families who vary widely in terms of their socioeconomic status, it consists primarily of middle- to upper-middle class families in which children are not at risk academically. Future research is needed to ascertain whether the patterns observed here would be evident among lower socioeconomic status families.

Conclusions

The current research is one of only a few studies to address the issue of what underlies the apparent benefits of autonomy-supportive parenting for children's achievement. As such, it is the first to provide evidence to suggest that the association between such parenting and children's achievement over time is due in part to children's executive functions: Mothers' early autonomy support predicted children's executive functions before kindergarten, which foreshadowed enhanced achievement among children in both elementary and high school. A particularly notable aspect of the current research is that the predictive significance of autonomy-supportive parenting was evident over and above not only children's attributes in the earliest years of their lives as well as potential demographic influences, but also other dimensions of parenting that co-occur with autonomy supportive parenting.

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Correction to Kizilcec, Bailenson, and Gomez (2015)

In the article "The Instructor's Face in Video Instruction: Evidence From Two Large-Scale Field Studies" by René F. Kizilcec, Jeremy N. Bailenson, and Charles J. Gomez (*Journal of Educational Psychology*, Advanced online publication. March 23, 2015. http://dx.doi.org/10.1037/edu0000013), "value" was inadvertently included after "*p*" in the first column of both Tables 2 and 3.

http://dx.doi.org/10.1037/edu0000046