Journal citation:

Cumming, M. M., Poling, D. V., Patwardhan, I., & Ozenbaugh, I. C. (2022). Executive function in kindergarten and development of behavioral competence: The moderating role of positive parenting practices. *Early Childhood Research Quarterly*, *60*, 161-172.

Executive Function in Kindergarten and the Development of Behavior Competence: Moderating Role of Positive Parenting Practices

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Acknowledgement

Research reported in this publication was supported by the Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health under Award Number R03HD097256 to Dr. Irina Patwardhan. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

This study was partially supported by the Institute of Education Sciences, U.S. Department of Education, through Grant #R324B160033 to the University of Nebraska–Lincoln. The opinions expressed are those of the authors and do not necessarily represent views of the Institute or the U.S. Department of Education.

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Executive Function in Kindergarten and Development of Behavioral Competence: Moderating Role of Positive Parenting Practices

Abstract

The present study used data from the Early Childhood Longitudinal Study–Kindergarten Cohort of 2011 (*N* = 15,827; 51.1% male; 48.4% White, 13.5% Black/African-American, 24.3% Hispanic/Latino, 7.5% Asian, and 6.3% other ethnicity) to examine the unique contribution of specific executive function processes (working memory and cognitive flexibility) at kindergarten entry on externalizing and internalizing behavior problems in spring of kindergarten, after controlling for fall behavior problems and demographic covariates. Due to the transition to elementary school being a critical identification and prevention period, we also focused on examining the moderating role of specific positive parenting practices (i.e., cognitive stimulation, warmth, and behavior management) on associations between child executive function processes and behavioral functioning. Results indicated working memory was negatively associated with parent-reported externalizing and teacher-rated internalizing behavior problems. Further, the association between working memory and parent-rated externalizing problems was moderated by cognitive stimulation, whereas the association between parent-rated internalizing problems was moderated by behavior management. Cognitive flexibility did not have any significant associations. We discuss implications for research and practice on how parenting practices may be leveraged to improve child outcomes.

Keywords: Executive function, working memory, cognitive flexibility, behaviors, parenting, kindergarten

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When compared to older youth, children with early onset behavior problems are at greater risk for poor short- and long-term outcomes, including low achievement, school dropout, incarceration, and later unemployment (Kauffman & Landrum, 2017; Ruchkin et al., 2003). Central to their emotional and behavioral development (Best et al., 2009; Diamond, 2013; Zelazo, 2020) is executive function (EF) – a set of neurocognitive attention-regulation processes consisting of inhibitory control, working memory, and cognitive flexibility (Best & Miller, 2010; Miyake et al., 2000; Zelazo et al., 2016) that are mediated by the brain's prefrontal cortex. Scholars have found that EF is not only a significant predictor of school readiness and achievement (Ahmed et al., 2018; Blair & Raver 2015), but also foundational to mental health and related behaviors (Schoemaker et al., 2013; Zelazo, 2020). Strong EF skills are associated with psychological well-being (Riggs et al., 2006; Schoemaker et al., 2013), whereas poor EF abilities have been linked to an array of problematic behaviors (Ellis et al., 2009; Schoemaker et al., 2013) and mental health disorders (Zelazo, 2020). Further, EF has been found to act as a protective factor in the presence of academic and psychosocial risk, such as associated with socioeconomic disadvantage and homelessness (e.g., Masten et al., 2012). Thus, EF is critical for children's behavioral competence and school- and life-long success.

Although individuals have a genetic EF predisposition (Miyake & Friedman, 2012), its maturation is also affected by environmental factors (Cumming et al., 2020; Diamond & Lee, 2011), especially those experienced within the home. These home-based experiences are critical during early childhood when EF maturation is particularly active (Best & Miller, 2010). For instance, supportive relationships and access to resources have been found to positively predict EF (Blair et al., 2011; Hackman & Farah, 2009), whereas adverse experiences (e.g., abuse, neglect, living in poverty) have been found to negatively relate to EF maturation (e.g., Irigaray et al., 2013; Pechtel & Pizzagalli, 2010), especially for those children with lower initial EF skills.

Specifically, parenting practices within the home may be especially salient for young children as they are dependent on their caregivers (Sameroff, 2010). Extant research provides insights into the link between parenting practices and EF maturation, such that positive (e.g., warmth) and negative (e.g., controlling, intrusive) parenting behaviors appear to differentially relate to EF growth (Fay-Stammbach et al., 2014; Valcan et al., 2018). Yet, there is limited research on how specific parenting practices (e.g., cognitive stimulation) serve as moderators between EF and behavior competence, especially with kindergarteners in the United States.

Given the transition to elementary school is a pivotal EF maturation stage (Best et al., 2009), lays the foundation for behavioral competence, and is an early identification and prevention/intervention period (Goldstein & Flake, 2015; Levitt et al., 2007), greater insight is needed to understand the interplay between EF and social-ecological systems (i.e., parenting) on the development of kindergartener's behavioral functioning. Thus, the purpose of the present investigation is to examine (a) the extent to which specific EF processes (i.e., working memory, cognitive flexibility) relate to behavior competence, and (b) how positive parenting practices (i.e., cognitive stimulation, warmth, and behavior management) moderate the relationships between kindergarteners' EF processes and behavior. We first review extant research on the relationships among EF, behavior, and parenting. Next, we present results from our analyses of the Early Childhood Longitudinal Study, Kindergarten Class of 2011 (ECLS-K: 2011), and discuss the implications of our findings.

The Link Between Executive Function and Behavioral Functioning

Although the definition of EF is variable, researchers tend to agree that EF is made up of three distinct, yet interrelated processes of inhibitory control (i.e., suppress prepotent or dominant responses), working memory (i.e., store, maintain, and manipulate information), and cognitive flexibility (i.e., shift and adapt to changing task demands or contexts; Diamond, 2013; Miyake et al., 2000). These core EF processes are implicated in self-regulation, problem-solving, and decision-making (Diamond, 2013; Nigg, 2017), which are skills critical for success in both

school and life. For instance, particularly for children entering elementary school, classrooms place frequent demands on students' EF (e.g., Clements et al. 2016). Kindergarteners are developmentally expected to take turns, interact well with peers, focus on academic work without being disruptive, and transition from one activity to another (McClelland et al., 2015). To do these tasks, they must draw upon EF to control their impulses (inhibitory control), remember and use rules (working memory), and shift their way of thinking and behaving (cognitive flexibility). Thus, it is unsurprising that a robust research base has established EF as a well-known predictor of school readiness (Blair & Raver, 2015), achievement (Ahmed et al., 2018; Best et al., 2011; Blair & Razza, 2007), and the prosocial behaviors and interpersonal skills (Riggs et al., 2006) necessary for healthy relationships with teachers and peers.

Conversely, individuals who have difficulties with aggressive behaviors, emotion regulation (e.g., outbursts), and social interactions (e.g., conflict; Ellis et al., 2009; Hughes & Ensor, 2011) tend to display less established EF skills, including those with mental health disorders (Zelazo, 2020). This pattern is evident in children as young as preschool, with studies linking child EF impairments with both externalizing and antisocial behaviors (Ogilvie et al., 2011; Schoemaker et al., 2013). Further, preschool and kindergarten EF has lasting implications for forecasting behavior problems in later grades (Morgan et al., 2019; Nelson et al., 2018), even when considering family-risk factors (Oh et al., 2020). Overall, EF is central not only to children's capacity to navigate the challenges of elementary school, but also lays the foundation for emotional and behavioral well-being.

Distinct Executive Function Processes and Behavioral Functioning

Some researchers suggest that distinct EF processes (i.e., inhibitory control, working memory, and cognitive flexibility) differ in the strength of their relationship to behavioral functioning (Riggs et al., 2006; Schoemaker et al., 2013), such that the degree to which each predicts behavioral competence or problems may depend on differential EF patterns of development. Although, all three EF processes are related to both externalizing and

internalizing behavioral problems, as they are interrelated, experts tend to hypothesize that certain processes may be more strongly implicated in certain behaviors. For instance, low inhibitory control is often associated with increased externalizing behaviors (i.e., aggression), as young children must recruit it to suppress a dominant response in favor of a socially-appropriate response, which is essential to behavior regulation (e.g., Poland et al., 2016). Yet, there is less research and conflicting findings related to internalizing behaviors among young children. For example, Kertz et al. (2016) found that inhibitory control deficits in preschoolers longitudinally predicted depression and anxiety at 7.5 years old, which supports the hypothesis that low inhibitory control may reduce a child's ability to curb negative thoughts that can lead to rumination – an established factor for depression (De Raedt & Koster, 2010). Conversely, other experts explain that elevated inhibitory control may contribute to children being inflexible and rigid, which can exacerbate internalizing problems like anxiety, as shown in several studies (e.g., Thorell et al., 2004). Poor working memory has also been linked to externalizing behaviors (Flouri et al., 2017) as deficits may limit children's ability to retrieve social goals and effectively navigate socially challenging situations, leading to increased aggression (McQuade et al., 2013). Additionally, difficulty with working memory is often associated with child internalizing behaviors (Flouri et al., 2017), as it may impede their ability to retrieve and focus on positive rather than negative thought patterns, increasing risk for preservation and rumination. Lastly, cognitive flexibility has been found to be related to externalizing behaviors (Shoemaker et al., 2013) and predictive of later internalizing problems (Morgan et al., 2019), as children are less able to shift from responding aggressively or engaging in perspective taking.

There has been mixed theory and evidence in terms of whether these EF processes are fully crystalized in early childhood (Best & Miller, 2010), and thus the extent to which they relate to behavioral outcomes at specific ages. In the hierarchy of EF development, there tends to be agreement that inhibitory control develops rapidly during the preschool years, working memory matures linearly throughout the school years, and cognitive flexibility is fairly

established by adolescence (Anderson, 2002; Best & Miller, 2010; Garon et al., 2008). Though there is support for separate yet interrelated EF processes in older children and adolescence due to neural pruning, Best and Miller (2010) caution that the degree of unity and independence amongst these domains may change as children age. In line with this point, a meta-analysis of studies involving preschool children found a stronger effect size correlation for inhibitory control and student externalizing behaviors (.24) compared to working memory (.17) and cognitive flexibility (.13; Schoemaker et al., 2013). When comparing their results to studies with older participants, Schoemaker et al. (2013) found the effects sizes were similar for inhibitory control but smaller for working memory and cognitive flexibility.

Given differential EF maturation rates, the degree to which particular EF processes relate to later kindergarten behavioral functioning may be distinct from younger or older students. Although a corpus of research has established the link between inhibitory control and behavioral functioning, the extent to which working memory and, particularly, cognitive flexibility uniquely relate to behavioral competence in kindergarten remains less examined (e.g., Schoemaker et al. 2013). Because kindergarten EF provides the foundation for students' short- and long-term school success (e.g., Morgan et al., 2019) and is malleable to intervention efforts (Takacs & Kassai, 2019), additional studies are needed comparatively examining the strength of the relationships between working memory and cognitive flexibility and behavioral outcomes for this age group.

Limitations of prior research. Limitations of previous EF research with children have created debate among scholars as to the utility of considering EF in relation to student outcomes (Jacob & Parkinson, 2015). Multiple studies have used cross-sectional designs, rarely consider confounds, such as previous behavior problems (e.g., Morgan et al., 2019), and tend to not include comparative analysis of EF processes. Given the stability of kindergarten behavior problems, as evidenced by Morgan et al.'s (2009) study which found that kindergarten behavior problems were fairly stable in forecasting later maladaptive behaviors, researchers must

consider behavior confounds when examining predictive relationships. Thus, to address these limitations, additional longitudinal research is warranted with kindergarteners that controls for previous behaviors, age, and gender to gain further insight into the differential association between EF processes and behavioral competence.

Parenting Practices and Child EF and Behavioral Functioning

In alignment with a developmental systems perspective (Overton, 2015) and attachment theory (Ainsworth, 1973), in which child development and learning are shaped by interactions among individual processes (e.g., cognitive) and environmental experiences (e.g., relationships, learning opportunities), we posit that behavioral competence or impairment is closely linked to interactions among (a) child EF, (b) parenting practices, and (c) behavioral outcomes. The specific behaviors parents engage in encompass two theoretically based categories: instructional and socioemotional (Pino-Pasternak & Whitebread, 2010). According to Valcan et al. (2018), instructional parenting behaviors typically capture parents use of scaffolding, autonomy support, cognitive assistance, and/or access to learning resources. Socioemotional parenting behaviors tend to include parental warmth (display support, affection, encouragement), responsiveness (respond to child feelings and needs), and control (efforts to control behavior). These parenting practices, in turn, are often designated into broader positive (e.g., warmth) or negative (e.g., harsh discipline [control]) parenting behaviors (e.g., Valcan et al., 2018). Although positive parenting practices are well known to positively impact child behavioral functioning as evidenced by parent training interventions/programs (see meta-analysis, Kaminski et al., 2008; Piquero et al., 2016), parenting behaviors may also shape child EF development. As outlined by attachment theory (Ainsworth 1973), positive parenting fosters children's internalization of self-regulatory processes, dependent upon EF (Nigg, 2017). Highly effective parenting likely also provides children with opportunities to refine and strengthen prefrontal and associated synaptic connections, which support EF development (Rothbart et al., 2011). Conversely, negative parenting practices diminish children's ability to internalize and

refine these skills. Though there is less research related to the direct impact of parenting on child EF through intervention studies (e.g., Lind et al, 2017), numerous correlational and longitudinal findings provide promising evidence. For instance, extant literature highlights the adverse association between negative parenting (e.g., controlling; harsh discipline) and child EF (Blair et al., 2011; Cuevas et al., 2014; Valcan et al., 2018), whereas, positive parenting practices and instructional opportunities positively relate to child EF development (Valcan et al., 2018).

Given that positive parenting plays an important role in children's development and learning (Overton, 2015), these practices may serve as important mechanisms by which to improve children's EF and behavioral functioning, particularly during kindergarten. For the purposes of this study, we focus on instructional (i.e., cognitive stimulation) and two socioemotional (i.e., warmth and positive behavior management) parenting practices relative to EF and behavioral functioning. Cognitive stimulation refers to parental behaviors that provide opportunities or experiences that facilitate children's learning and cognitive development. A large body of research has established the link between parents use of cognitive stimulation (e.g., scaffolding, autonomy support, cognitive assistance) and child EF development (Fay-Stammbach et al., 2014; Valcan et al., 2018), with more pronounced associations for younger children. Even access to early learning resources (e.g., visible books) within the home plays a role in child EF skills, such that young children with fewer learning resources lag in EF skills that continue into kindergarten (Clark et al., 2013). Although there is robust research on the link between cognitive stimulation and academic outcomes (e.g., Cook et al., 2012), there is limited research on its association with behavioral functioning among young children. Baker and Brooks-Gunn (2020), however, found parental cognitive stimulation (i.e., frequency of weekly reading) not only positively predicted EF and negatively related to problem behavior, but also mediated the associations between socioeconomic disadvantage (e.g., poverty) and child EF and behavior problems. Baker and Brooks-Gunn (2020) posited that these practices likely provided parents with an opportunity to teach children to practice and engage in more positive behaviors

(e.g., sitting quietly and listening to story). Additionally, high-quality parenting (e.g., cognitive stimulation) likely serves to enhance children's ability to manage their own behaviors by strengthening EF related neuro-networks (Rothbart et al., 2011).

Warmth includes parenting practices that focus on providing emotional sensitivity, positive regard, and praise. Although Fay-Stammbach et al. (2014) in their review of studies investigating the association between parenting and EF reported mixed results, Valcan et al. (2018) in their meta-analysis of 42 studies determined parental displays of warmth and sensitivity correlated positively with child EF (0 to 8 years old). Further, in a meta-analytic review of training programs designed to improve parenting skills, results showed that emotional communication, as well as sensitive and nurturing child-parent interactions, were associated with lower child externalizing behaviors (Kaminski et al., 2008); yet, fewer studies have examined parenting in relation to child internalizing behaviors.

Behavior management, which refers to parents' efforts to reduce their child's problem behaviors and increase desired behaviors, is well established in shaping behavioral outcomes in children (Grusec et al., 2017). Specifically, negative controlling behavior management practices (e.g., harsh discipline, physical force) have been found to adversely relate to children's externalizing and internalizing behavior problems (Grusec et al., 2017), as well as global EF and inhibitory control (Valcan et al., 2018). Research is more limited relative to working memory and cognitive flexibility with young children (Valcan et al., 2018). Positive approaches, which tend to encompass parents' ability to respond appropriately and positively, have shown promising results in terms of child behavior and EF (Grusec et al., 2017; Valcan et al., 2018). Further, it is well known that teaching children responsibility and self-control is critical for reducing problematic behaviors (Heckman, 2006; Moffitt et al., 2013), as are the positive impacts of common behavior management practices (e.g., reinforcing positive behaviors, use of time-outs; Kaminski et al., 2008).

Parenting Moderates Associations Between EF and Behavioral Functioning

According to a differential susceptibility model (Belsky & Pluess, 2009), individual characteristics can lead to variation in sensitivity to environmental experiences, such as parenting practices, and resulting outcomes. As outlined by multiple EF related theories (Blair & Ursache, 2011; Williams et al., 2009), much of this sensitivity may be based on individual EF predisposition (Miyake & Friedman, 2012) and environmental experiences. Therefore, instead of solely focusing on child EF or parenting, interactions between EF and parenting practices must be considered in the context of behavioral outcomes. In fact, results from multiple studies examining genetic and environmental factors suggest parenting can moderate genetic influences on child behavioral outcomes (e.g., Lipscomb et al., 2012). Although there is limited research examining parenting as a moderator between child EF and behavioral outcomes, emerging EF related research has provided support for the importance of parenting. For instance, Helm et al. (2020) found child EF was fairly stable across the transition to school (4- to 6-year-olds) for students with high levels of positive parenting, but lacked stability with low levels. Additionally, Cioffi et al. (2020) determined that maternal warmth moderated the association between infant attentional control and later inhibitory control, such that it played a protective role. In their longitudinal study with 3-year-olds, Karreman et al. (2009) found certain positive parenting practices (e.g., positive control) buffered the risk of behavior problems for children with low effortful control. Given the promising findings of evidence-based parenting programs (e.g., Parents Plus Program, The Incredible Years, and The Triple P Parenting Program; Carr et al., 2017; Menting et al., 2013; Nowak & Heinrichs, 2008), it is critical to gain insight into the extent to which positive parenting practices moderate the relationship between individual EF and behavioral outcomes in kindergarten. Such insight will provide implications for whom and to what extent specific parenting practices may serve as levers to improve the behavioral outcomes of children during the transition to elementary school.

The Present Study

Using a large, nationally representative sample of kindergarteners from the ECLS-K:2011

data set, our present study had two main foci. First, we were interested in determining the extent to which the EF processes of working memory and cognitive flexibility, assessed in fall of kindergarten, predicted spring externalizing and internalizing behavior problems, after controlling for demographic covariates and fall behavior problems. It is of note that in the ECLS-K:2011, cognitive flexibility and working memory were obtained via performance-based, direct assessments. Conversely, inhibitory control was rated by teachers on a Likert-type scale, which tends to capture more subjective contextualized EF (e.g., self-regulation) versus objective EF (Toplak et al., 2013); therefore, we excluded inhibitory control from our analyses. We expected that children with stronger working memory and cognitive flexibility skills in the fall of kindergarten would have fewer externalizing and internalizing problems in the spring of kindergarten, controlling for fall behavior.

Second, we examined the moderating role of parental cognitive stimulation, warmth, and positive behavior management on the associations between EF (i.e., working memory and cognitive flexibility) and behavioral outcomes (i.e., externalizing and internalizing). We hypothesized the strength of the relationships among working memory/cognitive flexibility and behavioral outcomes would vary depending on kindergarten children's level of exposure to specific parenting practices, such that EF processes would more strongly predict better behavioral outcomes among kindergarteners receiving higher levels of positive parenting.

Method

Sample and Procedures

In the current study, we used data from the ECLS-K:2011, which followed a nationally representative sample of children from kindergarten through fifth grade. The National Center for Education Statistics, within the Institute of Education Sciences of the U.S. Department of Education sponsored the longitudinal study, which included multi-source information from teachers, parents, and researchers related to children's early cognitive, academic, and social development. The complete dataset included 18,174 children who attended kindergarten during

2010-2011 academic year. For our study, we used data from the fall and spring of kindergarten. Children's working memory and cognitive flexibility were assessed through direct performance-based measures in the fall of kindergarten. Parental practices were assessed through parent interviews during both the fall and spring of kindergarten. Children's externalizing and internalizing behaviors were measured through both parent and teacher report in fall and spring of kindergarten. All children without valid sample weights (W1C0; *n*= 2,327) were excluded from the analyses. The analytic sample consisted of 15,827 children (51.1% male) who were on average 5.6 years old (SD = 4.48 months) at the beginning of kindergarten, and 48.40 % White, 13.5% Black/African-American, 24.3% Hispanic/Latino, 7.5% Asian, and 6.3% Other. Most children lived in households with an income between $50,000-$55,000.

Measures

Executive Function

Working memory. Kindergarten children were administered the well validated and reliable Numbers Reversed task from the Woodcock-Johnson III Test of Cognitive Abilities (WJ III COG; Woodcock et al., 2005) to assess their working memory. The Numbers Reversed task consisted of 30 trials in which children were asked to repeat an orally presented sequence of numbers in reverse order starting with two-digit numbers (five trials) up to eight-digit numbers (four trials). To illustrate, if presented the numbers "2, 3, 9", the participant would need to respond with "9, 3, 2". The Numbers Reversed task ended if the child received three consecutive incorrect number sequences. Each item was scored "correct", "incorrect", or "not administered". Children who had "not administered" items were recoded 0, indicating zero correct responses for the non-administered items. We used the W-ability scores on the Numbers Reversed task in our analyses, as recommended in the manual. The W-ability scale is a standardized scale with a mean of 500 and standard deviation of 100, which represents the average abilities of a 10-year-old child. The W-ability score is based on the child's ability and the item difficulty. Since the developers of the Woodcock-Johnson III set the mean as the average performance for a child of

10 years, 0 months, it was expected that children in the ECLS-K:2011 sample (who were on average 5.51 years old at the beginning of kindergarten), would score below 500. For instance, children at the beginning of kindergarten demonstrated an average working memory of 433 (*SD* = 30.21, range = 393-581). As children develop, it is expected that their W-ability scores will increase to reflect their growth and enhanced ability with the task. Previous examinations of the WJ III COG provide evidence of content validity and test-retest reliability for the Numbers Reversed task (median reliability = .87; McGrew & Woodcock, 2001).

Cognitive flexibility. Children were administered the Dimensional Change Card Sort task (DCCS; Zelazo, 2006) to assess their cognitive flexibility. The DCCS task consisted of three phases in which children were asked to sort picture cards first by color (pre-switch phase; six trials) and then by shape (post-switch phase; six trials). Administrators then proceeded to the mixed phase, where the sorting rule depended on whether the card had a black border around it (six trials). Children who were unable to advance to the mixed phase due to inaccurate responses were recorded from (-1) inapplicable to 0, indicating zero correct responses for the non-administered items. The total score ranged from 0 to 18, representing the total number of correct responses. The DCCS has established test-retest reliability (intra-class correlations [ICC] = .78 - .94 across trials; Beck et al., 2011) and positive correlations with the other EF measures (Zelazo, 2006).

Parenting Practices

Parents reported on their practices in fall (cognitive stimulation) and spring of kindergarten (warmth and behavior management). The majority of information related to parenting practices was reported by mothers (87%), followed by fathers (10%), or another relative (3%). Parenting scales were calculated as the mean of responses for each subscale.

Cognitive Stimulation. Parents were asked how often, in a typical week, they or other family members engaged in activities with their child on a 4-point Likert-type scale ranging from 1 “not at all” to 4 “every day”. We created the cognitive stimulation subscale from the mean

of 10 items that related to creating opportunities or experiences that facilitate child cognitive development: telling stories, playing games, talking about nature, building things, doing sports, reading books to a child, singing songs, helping child to do art, practicing reading, and writing (α = .73). Higher scores indicate increased use of cognitive stimulating practices.

Warmth. Parents were asked to rate four statements about their relationship with their child on a 4-point Likert-type scale ranging from 1 "completely true" to 4 "not at all true". We created the parental warmth subscale as the mean of four items: 1) "Child and I often have warm, close times together"; 2) "Most of the time I feel that child likes me and want to be near me"; 3) "Even when I am in a bad mood, I show child a lot of love"; and 4) "I express affection by hugging, kissing, and holding child" (α = .66). Prior to analyses, the items were reverse-coded such that higher values represent greater warmth.

Behavior Management. To capture behavior management, parents were told "Most children get angry with their parents from time to time. If child got so angry, that he/she hit you, what would you do?". The parents were then asked to provide yes/no responses (yes = 1, no = 0). The behavior management subscale was created as a mean of five items: Would you: 1) "Discuss what child did wrong"; 2) "Make child do chores"; 3) "Make child apologize"; 4) "Take away a privilege"; and 5) "Give child a warning" (α = .71). Higher scores indicate higher frequency of positive behavior management practices.

Externalizing and Internalizing Behavior Problems

In the fall and spring of kindergarten, teacher- and parent-reported behavior problems were assessed with select items (developed for the ECLS-K:2011) that were either taken verbatim or modified/adapted (developed for the ECLS-K:2011) from the well-validated and reliable Social Skills Rating System (Gresham & Elliott, 1990). Teachers and parents rated the frequency of child behavior on a 4-point Likert-type scale ranging from 1 "never" to 4 "very often". The teacher-reported externalizing behavior scale included five items representing the frequency the child displayed impulsive, disturbing, and angry behaviors (fall kindergarten α =

.88; spring kindergarten α = .89). The internalizing behavior scale consisted of four items related to anxious, sad, lonely, and low self-esteem behaviors (fall kindergarten α = .79; spring kindergarten α = .78). Parent-reported externalizing behavior scale entailed two items on the frequency the child exhibited impulsive and overactive behaviors, and the internalizing behavior scale consisted of four items indicative of a child's sadness and loneliness (fall kindergarten α = .56; spring kindergarten α = .58).

Control Variables

We controlled for children's age, gender, ethnicity, and family income, as these have been found to be uniquely associated with child EF and externalizing and internalizing behavior. We also chose to control for fall behaviors due to the stability of behavior over time (Morgan et al., 2009). Because EF maturation occurs throughout childhood and adolescence (Best & Miller, 2010), such that children develop stronger EF skills with age, we included age as a covariate. Additionally, previous early childhood research suggests girls tend to outperform boys on various laboratory-based EF tasks, including working memory and cognitive flexibility (Wiebe et al., 2008). Gender has also been found to predict student externalizing or internalizing problems in kindergarten with lasting implications for later behaviors in elementary school (Morgan et al., 2009). Additionally, although racial/ethnic differences in EF and behavior problems have been noted in previous studies using the ECLS-K:2011 (Little, 2017), researchers caution that these differences may be better explained by socioeconomic status (Little, 2017; Martel, 2013).

Analytic Approach

To examine the degree to which children's working memory and cognitive flexibility in fall of kindergarten predicted behavior problems in spring, as well as the extent to which parenting practices moderated these relationships, we ran a series of regression models. Predictors were children's performance on the EF assessments (i.e., working memory and cognitive flexibility) at the beginning of kindergarten, parenting practices (i.e., cognitive

stimulation, warmth, and behavior management), demographic covariates, corresponding behavior problems in the fall of kindergarten, and all two-way interactions between EF domains and each of the parenting practices. To aid in interpretation, both predictor variables (i.e., working memory and cognitive flexibility) were standardized. All models for teacher-rated behavior problems controlled for school-level variance in externalizing and internalizing behaviors.

All models included sampling weight variable (W1C0). In Mplus statistical software (Version 8.4), Full Information Maximum Likelihood (FIML) approach was used to handle missing data in models with continuous outcomes with the maximum likelihood robust (MLR) estimator. The missing data on primary outcomes were 21% and 22% for teacher rated-, and 36% and 36% for parent-rated externalizing and internalizing behavior problems correspondingly. The missing data on childhood predictors was 14% for working memory and 14% for cognitive flexibility. The missing data on parenting practices was 28% for cognitive stimulation, 38% for warmth, and 37% for behavior management. Attrition analyses showed the analytic sample had a larger number of White/Caucasian children (48.4% vs 46.7%) than the original national dataset, χ^2 (1, N = 33,918) = 9.78, p =.002. The analytic sample did not differ from the national dataset on children's age (M = 67.45 months vs. M = 67.45 months), number of males (51.1% vs. 51.1 %), or family income (M = 10.48 vs. M=10.60).

Prior to analyses, we investigated descriptive statistics and bivariate correlations between variables of interest. Then, we estimated simple linear regression models independently for teacher- and parent-rated externalizing and internalizing behavior problems in spring of kindergarten. Next, to investigate the moderating effects of parenting practices, we mean-centered parenting practices at the sample average to aid in interpretation of two-way interaction model parameters (Aiken et al., 2018). We conducted post-hoc simple slopes tests for each of the significant two-way interactions at high (1 SD > mean) and low (1 SD < mean) levels of parenting practices for the high and low levels of children's EF skill. This allowed us to

capture differential effects based on the level of parenting practices and child EF ability.

Results

Descriptive Statistics and Bivariate Correlations

Descriptive statistics and bivariate correlations for all analytic variables are presented in Table 1. Based on total possible scores, children at the beginning of kindergarten demonstrated an average working memory of 433 (*SD* = 30.21, range = 393-581) and cognitive flexibility of 14.20 (*SD* = 3.33, range = 0-18). Overall, children had low levels of externalizing and internalizing behavior problems both in the beginning and the end of kindergarten, as indicated by parent (fall externalizing, *M* = 2.04, *SD* = 0.68, spring externalizing, *M* = 1.91. *SD* = 0.68, range 1-4; fall internalizing, *M* = 1.49, *SD* = 0.38; spring internalizing, *M* = 1.47. *SD* = 0.38, range 1-4) and teacher (fall externalizing, *M*= 1.60, *SD* =0.63; spring externalizing, *M* = 1.64, *SD* = 0.64, range 1-4; fall internalizing problems, *M* =1.46, *SD* = 0.49; spring internalizing, *M* = 1.51, *SD* = 0.50, range 1-4) reports. Additionally, parents reported using high levels of cognitive stimulation (*M* = 2.96, *SD* = 0.46, range = 1-4) and warmth (*M* = 3.76, *SD* = 0.36, range = 1-4), and moderate levels of behavior management (*M* = 0.55, *SD* = 0.30, range = 0-1). Bivariate correlations were in the expected direction, such that children's EF skills were significantly negatively correlated with teacher- and parent-reported externalizing and internalizing behavior problems in the fall and spring of kindergarten. Further, teacher- and parent-reported behavior problems in the fall and spring of kindergarten were moderately associated with externalizing problems, but only slightly for internalizing problems.

Regression Analyses

It should be noted that each model was just-identified (i.e., a model with zero degrees of freedom, where the number of free parameters equaled the number of knowns values). In the models with teacher-rated externalizing and internalizing behavior, intraclass correlations (ICCs) were calculated to estimate the proportion of variance in the corresponding behavior problems that was accounted for by the child's school. The ICC was .09 for teacher-rated

externalizing behaviors and .10 for teacher-rated internalizing behaviors. Given the minimum amount of variance in behavior problems explained by school nesting, our models controlled for child's school assignment in kindergarten.

Working Memory and Cognitive Flexibility as Predictors of Behavioral Outcomes

The simple main effect of working memory was significant for parent-rated externalizing (b = -.01, p =.025; β=-.02), but not internalizing, and teacher-rated internalizing (b = -.03, p <.001; β=-.06), but not externalizing, behavior problems in spring of kindergarten (see Table 2). The simple main effect of cognitive flexibility was nonsignificant for parent- or teacher-rated behavior problems in spring of kindergarten.

Moderating Effects of Parenting Practices on EF Domains and Behaviors

Cognitive Stimulation. The results showed a significant two-way interaction between working memory and cognitive stimulation (b = -.03, p =.041; β=-.02) for parent-rated externalizing problems in spring of kindergarten. Simple slope analyses were conducted at the high and low levels of cognitive stimulation (one standard deviation above and below the mean). The simple slopes of working memory on externalizing behavior problems were significant at the average (b = -.01, p = .025) and high level (b = -.03, p = .002) of cognitive stimulation, but nonsignificant at the low level of cognitive stimulation (see Figure 1). Thus, the lowest levels of externalizing behavior problems were present at the high level of cognitive stimulation for children with high working memory.

Behavior Management. The results showed a significant two-way interaction between working memory and behavior management (b = .03, p =.016; β=.03) for parent-rated internalizing problems in kindergarten. Simple slope analyses were conducted at the high and low levels of behavior management (one standard deviation above and below the mean). The simple slopes of working memory on internalizing behavior problems were significant at the high level of behavior management (b = 0.01, p = .028), but nonsignificant at the average or low levels of behavior management (see Figure 2). These results indicate that high levels of parental

behavior management relate to high levels of internalizing problems for children with high working memory. It is also noteworthy that at the low levels of behavior management the contribution of working memory to internalizing behavior problems was negative, even though nonsignificant.

Warmth. Parental warmth did not significantly moderate the relationship between working memory or cognitive flexibility and children's externalizing or internalizing behavior problems in the spring of kindergarten.

Discussion

In this study, we examined the extent to which working memory and cognitive flexibility differentially related to kindergarten behavioral functioning and how parents reported use of positive parenting practices (i.e., cognitive stimulation, warmth, and behavior management) moderate the relationship between kindergarteners' EF skills and behavioral functioning. Given that we addressed limitations of previous EF and behavior research through longitudinal analysis and controlled for previous behaviors in the fall, our study provides compelling evidence that kindergarteners' fall working memory and not cognitive flexibility uniquely relates to reductions in externalizing behavior problems as reported by parents and internalizing behaviors as reported by teacher in spring of kindergarten over and above fall behaviors. Children who scored higher on working memory tasks displayed fewer impulsive, disruptive, and angry behaviors at home and less sadness and loneliness in school. These findings are in line with a robust line of research illustrating the importance of working memory in predicting children's behaviors (Poland et al., 2016; Schoemaker et al., 2013), yet differ from previous research with cognitive flexibility (e.g., Schoemaker et al., 2013). These differences may be due to how EF processes develop during kindergarten and the degree to which kindergarten children draw upon them for behavioral competence. In the hierarchy of EF development (Garon et al., 2008), scholars theorize that cognitive flexibility builds upon working memory and inhibitory control processes and is more established later (Best & Miller, 2010). As such, scholars suggest

that for some young children cognitive flexibility may not be differentiated from working memory because it is less developed at this age. Before children can successfully engage in cognitive flexibility, they must be able to keep two or more rules in mind and then inhibit their response; therefore, these skills are pre-requisites to successful cognitive flexibility. Thus, kindergarten children in our sample may have drawn on more established working memory skills to control their behaviors by remembering and using rules (e.g., rules for working through a problem) versus drawing on less established cognitive flexibility to shift their way of thinking (e.g., imagining a peer's perspective) or behaving.

We found that, controlling for fall behavior problems, higher working memory in fall was predictive of lower externalizing behavior problems in spring of kindergarten for children whose parents used high or average cognitive stimulation, yet was nonsignificant at the low level. These findings are consistent with developmental systems perspective (Overton, 2015) and attachment theory (Ainsworth, 1973), suggesting that working memory and externalizing behavioral outcomes may develop within the context of cognitive stimulating parenting practices when at moderate to high levels. As posited by researchers, high-quality parenting may serve to enhance EF related neuro-networks needed for behavior regulation (Rothbart et al., 2011), as well as may provide parents the opportunity to guide students' behavior, such as sitting still while reading a book (Baker & Brooks-Gunn, 2020). Thus, in addition to aligning with extant research that cognitive engaging opportunities or experiences support child EF development (Fay-Stammbach et al., 2014; Valcan et al., 2018) and emerging research on behavior (e.g., Baker & Brooks-Gunn, 2020), our study provides initial evidence that cognitive stimulation may serve as a moderating mechanism by which kindergarten children are able to build EF and behavioral competence. Yet, additional intervention research is warranted.

Though the directionality was contrary to our hypothesis, we found that working memory was associated with increased internalizing behavior in the presence of high levels of behavior management. Both moderate and low levels were not significant, which is contrary to

previous research on the compensatory effect of positive behavior management, such that children whose parents engage in effective behavior management practices tend to experience less risk for internalizing behavior problems (e.g., Scaramella et al. 2000). These findings can be interpreted in several ways. First, since we were constrained by the question in the data set which asked parents how they would respond to the specific incident of their child hitting them with a limited number response options (e.g., discuss what child did wrong, make child do chores), our behavior management construct did not fully represent the range of effective parenting practices associated with decreased internalizing behaviors (Grusec et al., 2017), which likely biased results. Second, the items of "discuss what child did wrong" and "give child a warning" may have captured parental verbosity, which is considered a maladaptive parenting behavior of excessive verbalization (see Patterson 1982; Scaramella & Leve, 2004) that has been linked to internalizing behaviors in young children (Shaw et al., 1997). Additionally, some research has shown the use of more directive parental management language (e.g., commands) is associated with lower child EF (Bindman et al., 2013), as these may be more intrusive. Thus, the items "make child do chores" and "make child apologize" may have captured parents use of directive language. Yet, additional research is warranted to further the field's understanding of how positive behavior management practices may moderate the relationship between working memory and internalizing behaviors in kindergarten children.

Although we found warmth was related to lower parent-reported internalizing and externalizing behavior problems, it did not serve as a significant moderator. This was unexpected given the robust research highlighting the relationship between warm parenting practices and (a) child EF gains (Valcan et al., 2018) and (b) behavioral outcomes (Kaminski et al., 2008). Additionally, previous research has underscored the positive moderating effects of maternal warmth (e.g., Cioffi et al., 2020). However, because many previous studies did not include multiple parenting moderators within the same model and did not necessarily control for previous behavior problems, it could well be that kindergarten age children benefit most

from parenting practices that focus on cognitive stimulation.

Limitations and Future Directions

Although the current study has many noted strengths including an analysis of longitudinal data, a large nationally representative sample, accounted for previous behaviors, and included performance-based measures of EF, there are several limitations and future directions. First, conclusions about causation are not possible from the data analyzed as only true experiments offer definitive evidence for causation. Yet, correlational studies, especially longitudinal studies that provide temporal order of precedence, such as the present study, can be informative when researchers are testing theoretical relationships that provide useful data to inform inferences (Thompson et al, 2005).

We also acknowledge measurement limitations. For instance, parenting constructs were derived entirely from parent self-report items, which may increase the likelihood of social desirability bias (Bornstein et al., 2015). Relatedly, our measures of child behavioral functioning that relied on teacher reports may increase the risk of cultural and ethnic bias (Mason et al., 2014), which may impact teacher reporting; therefore, researchers should consider including observational measures of parenting and student behavior. Additionally, the internal consistency of the parenting constructs and parent reported child behaviors was slightly low, as evidence by Cronbach's alphas. Thus, it will be important for future studies to include well-validated measures. Further, since the ECLS-K:2011 was designed to assess children's skills in educational settings (i.e., school), our choice of potential covariates that could have been linked to parenting practices (e.g., parent-child interactions) was limited to the variables that were included in our study. Lastly, we chose not to include inhibitory control due to both the wealth of research with this age group and because it was a teacher report measure in the ECLS-K:2011 data base; Toplak et al., (2013) posit, due to low convergence, performance-based and rating measures of EF assess different aspects of EF, such that rating scales capture parents' and teachers' subjective view of child EF use in everyday circumstances. Thus, future investigations

should include a performance-based measure of this EF process and its relationship to parenting and problem behavior.

Though statistically significant, the estimates for kindergarten children's EF in our study were relatively small in magnitude (-.02 to -.06). Yet, they are similar in direction to studies focusing on working memory and behavior problems. For example, in their meta-analysis, Shoemaker at al. (2013) reported a working memory effect size of 0.17 on behavior across 13 studies. Similarly, Flouri et al. (2017) with a nationally representative sample (*N*=17,160) of children, after accounting for child and family covariates, reported an estimate of .002 between poor spatial working memory and internalizing behavior problem. Even though the magnitude of effects tended to be small (Keith, 2006), they may have a larger impact at the population level when incorporated into universal interventions (Greenberg et al., 2017).

Lastly, we examined directional effects based on theory and research. Yet researchers should consider individual and family characteristics (e.g., culture) in future research. For instance, researchers have found bidirectional relationships between EF and parenting, such that child EF predicted parenting quality (Blair et al., 2014). We also note that our findings cannot be generalized to other age groups and we encourage future researchers to examine the relationships between parenting, EF, and behavioral functioning among older children and youth.

Implications and Conclusions

Notwithstanding these limitations, this study provides important implications. Given that the transition to elementary school is a time of active EF maturation (Garon et al., 2008), lays the foundation for school success, and is a pivotal identification and intervention period (Goldstein & Flake, 2015; Levitt et al., 2007), researchers and practitioners should consider the importance (e.g., universal screenings, targeted programming) of working memory in children's development of behavioral competence in kindergarten, as increases in this EF process was associated with improved behavioral functioning.

Additionally, in support of developmental systems perspective (Overton, 2015), cognitive stimulation emerged as a significant moderator. Thus, our study provides initial evidence that cognitive stimulation may serve as a meaningful pathway for intervention. As such, focusing on child EF or parenting in isolation may be less effective in the context of child behavioral competence. Indeed, research has shown that parent training programs, which engage parents in learning relevant content related to their child's development, increases the use of effective practices, and enhances learning opportunities (Kaminski et al, 2008). Aligned with our finding on the importance of cognitive stimulation, evidence-based parenting programs such as *Parents Plus Program, The Incredible Years*, and *The Triple P Parenting Program* (Carr et al., 2017; Menting et al., 2013; Nowak & Heinrichs, 2008) include specific content for creating a positive home learning environment and promoting children's language development. Example parenting practices include spending time together reading, offering creative outlets (e.g., painting, dancing), and encouraging expression of emotions and ideas. Additionally, some research suggests that parenting programs can have carry over effects into the classroom based on teacher reports of reduced behavior problems (Nixon, 2002) and, when combined with classroom intervention programs, can improve emotion regulation among elementary students with behavioral risk (Reid et al., 2007). Overall, our study not only provides compelling evidence of the differential importance of working memory in kindergarten behavioral functioning, but identifies cognitive stimulation as a potential mechanism that supports strong EF and behavioral competence in kindergarten.

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Table 1

Summary of Intercorrelations, Means, and Standard Deviations for the study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
EF																	
1. CF																	
2. WM	.30**																
Fall K																	
3. Ext. (T)	-.11**	-.15**															
4. Int. (T)	-.06**	-.10**	.26**														
5. Ext. (P)	-.06**	-.10**	.25**	.05**													
6. Int. (P)	-.01	-.02*	.08**	.10**	.27**												
Spring K																	
7. Ext. (T)	-.10**	-.13**	.72**	.17**	.26**	.06**											
8. Int. (T)	.08**	-.13**	.23**	.56**	.06**	.11**	.30**										
9. Ext. (P)	-.08**	-.10**	.27**	.05**	.59**	.20**	.29**	.08**									
10. Int. (P)	-.02*	-.02	.09**	.10**	.19**	.48**	.10**	.13**	.30**								
Parenting Practices																	
11. CogS.	.06**	.06**	-.03	-.01	-.04**	-.07**	-.02	.00	-.03**	-.07**							
12. Warmth	.42	.01	-.03*	-.01	-.10**	-.16**	-.02*	.00	-.11**	-.16**	.21**						
13. BehMan	.67	-.01	.024*	.00	.04**	.02*	.03**	.0	.04	.03	.02	.00					
Covariates																	
14. Age	.10**	.13**	.01	.00	.03**	.03**	.01	.01	.02**	.01*	.00	-.01	.01				
15. Male	-.05**	-.04**	.22**	.04**	.13**	-.01	.21**	.04**	.12**	.00	.00	-.02*	.01	.07**			
16. Race	.17**	.21**	-.03**	.01	-.03**	-.04**	-.03**	.00	-.04**	.03	.15**	.04**	-.01	.10**	.01		
17. Income	.17**	.30**	-.13**	-.07**	-.15**	-.05**	-.14**	-.10**	-.14**	-.04**	.06**	.03**	-.01	-.01	.00	.33**	
Mean/%	14.20	433.01	1.60	1.46	2.04	1.49	1.64	1.51	1.91	1.47	2.96	3.76	0.55	67.45	51.10	48.40	10.48
SD	3.33	30.21	0.63	0.49	0.68	0.38	0.64	0.50	0.68	0.38	0.46	0.36	0.30	4.48			5.60
Range	0-18	393-581	1-4	1-4	1-4	1-4	1-4	1-4	1-4	1-4	1-4	1-4	0-1	45-94	0-1	1-8	1-18
Valid N	15603	15597	14310	14166	12815	12889	14279	14245	11583	11639	13034	11263	11459	15747	15790	15789	11880

Note. *$p < 05$, **<.01.

CF = Cognitive Flexibility, WM = Working Memory; Ext – Externalizing problems, Int.-Internalizing problems; CogS = Cognitiv

Stimulation, BehMan = Behavior Management; T = Teacher's rating; P = Parent's rating.

Table 2

Results of Multiple Regression Analyses with Moderation by Parenting Practices

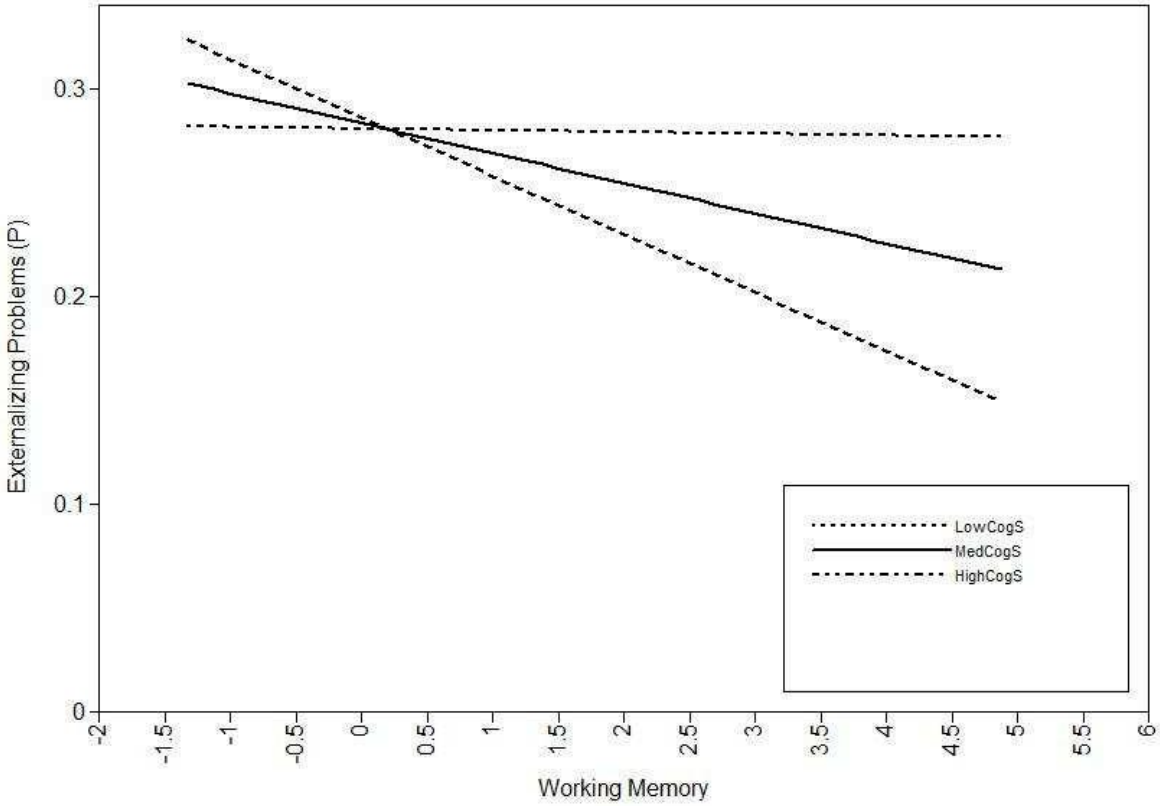
	Parent report				Teacher report			
	Externalizing		Internalizing		Externalizing		Internalizing	
	b	*β*	*b*	*β*	*b*	*β*	*b*	*β*
Fall K outcome	0.59**	0.58**	0.48**	0.47**	0.71**	0.70**	0.56**	0.55**
Cognitive Flexibility	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02
Working Memory	-0.01*	-0.02*	0.01	0.01	-0.01	-0.01	-0.03**	-0.06**
Warmth	-0.09**	-0.05**	-0.10**	-0.09**	0.01	0.01	0.01	0.01
BehMan	0.04*	0.02*	0.03*	0.03*	0.03	0.01	-0.01	-0.01
CogS	0.01	0.01	-0.01	-0.02	0.00	0.00	0.01	0.01
CF X Warmth	-0.03	-0.01	0.01	0.01	-0.02	-0.01	-0.01	-0.01
CF X BM	-0.01	-0.01	-0.02	-0.01	-0.01	-0.01	-0.02	-0.01
CF X CogS	0.02	0.02	0.01	0.01	0.01	0.01	-0.01	-0.00
WM X Warmth	-0.01	-0.01	-0.02	-0.02	0.02	0.01	-0.01	-0.01
WM X BM	-0.01	-0.01	0.03*	0.03*	0.02	0.01	0.01	0.00
WM X CogS	-0.03*	-0.02*	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
Child Age	0,00	-0.01	0.01	0.01	-0.01	-0.01	0.00	0.01
Child Gender (Male)	0.05**	0.04**	0	-0.01	0.06**	0.05**	0.01	0.01
Child Race (White)	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Family income	-0.01**	-0.06**	-0.01*	-0.02*	-0.01**	-0.06**	-0.01**	-0.06**
School ID	----------				0	0.01	0	-0.01

Note. *p <.05, **p<.01.

CF = Cognitive Flexibility, WM = Working Memory; CogS = Cognitive Stimulation, BehMan = Behavior Management.

Figure 1

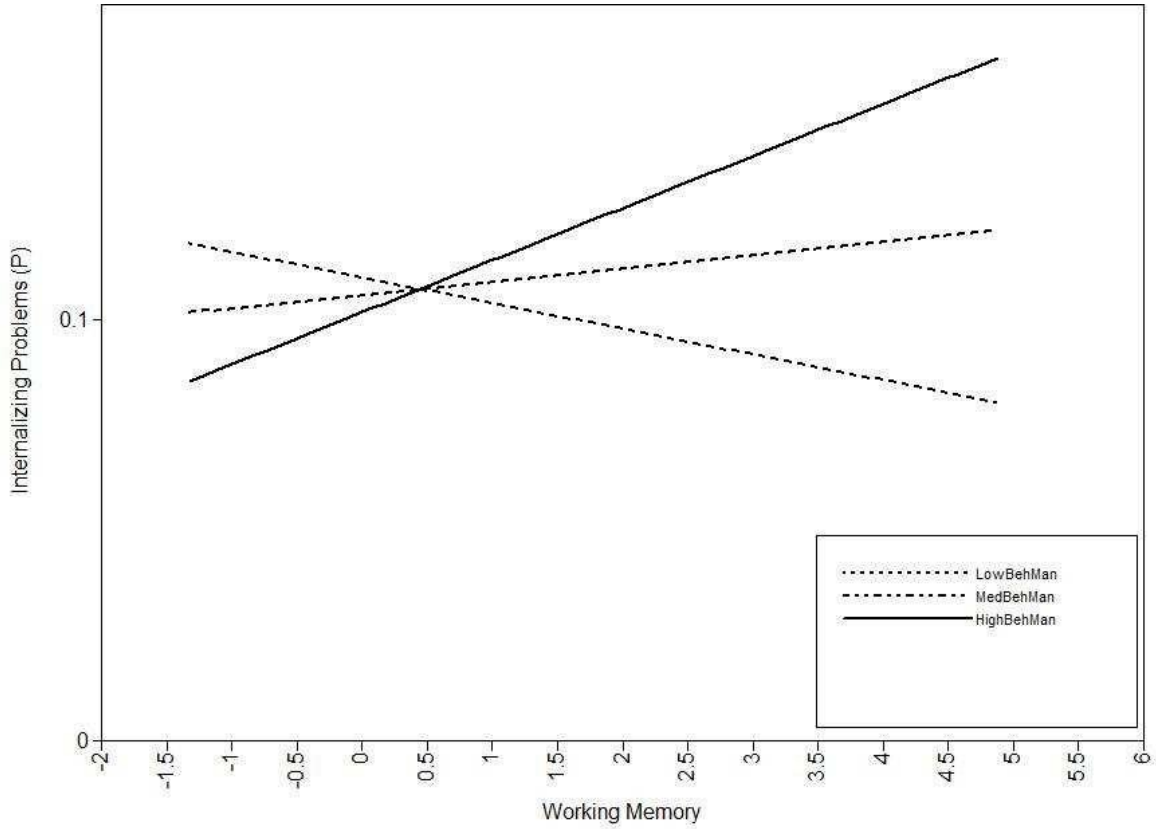
Associations Between Children's Externalizing Problems and Working Memory at Different Levels of Cognitive Stimulation



Note. High, medium, and low values were based on the standard deviation units (1 SD above, at the mean, and 1 SD below the mean).

Figure 2

Associations Between Children's Internalizing Problems and Working Memory at Different Levels of Behavior Management



Note. High, medium, and low values were based on the standard deviation units (1 SD above, at the mean, and 1 SD below the mean).