



Published in final edited form as:

*Dev Psychol.* 2023 October ; 59(10): 1794–1806. doi:10.1037/dev0001597.

## Trajectories of Cognitive Flexibility Through Kindergarten and First Grade: Implications for Externalizing and Internalizing Behavior Problems in the Second Grade

Irina Patwardhan<sup>1,2</sup>, Chanelle Gordon<sup>1</sup>, W. Alex Mason<sup>3</sup>

<sup>1</sup>Boys Town Translational Research Center for Child and Family Studies, 14015 Flanagan Blvd #202, Boys Town, NE 68010 US;

<sup>3</sup>Department of Preventive Medicine, University of Tennessee Health Science Center, 66 N. Pauline St., suite 637, Memphis, TN, 38163.

### Abstract

Developmental delays in cognitive flexibility early in elementary school can potentially increase vulnerability for subsequent externalizing and internalizing psychopathology. The first goal of the current study was to identify latent subgroups of children characterized by different developmental trajectories of cognitive flexibility throughout kindergarten and first grade using data from the Early Childhood Longitudinal Study, Kindergarten Class of 2010–2011 dataset. The second goal was to examine whether identified longitudinal developmental trajectories of cognitive flexibility could be associated with internalizing and externalizing behaviors in the second grade, while accounting for background child (age, gender, Spanish-speaking) and family (family income and mother's education) covariates. The analytic sample consisted of 15,827 kindergarteners (51.20% male; 48.50% White, 13.5% Black/African American, 24.3% Hispanic/Latino, 7.60 % Asian, and 6.1% Other), who were approximately 5.62 years old ( $SD = 4.48$  months) at the study's outset. Most children lived in households with medium family income of approximately \$50,000–\$55,000. Using a growth mixture modeling approach, our analyses identified normative (91.05%; 50.4% male) and delayed (8.95%; 59.4% male) cognitive flexibility groups and demonstrated that delayed developers have higher levels of externalizing and internalizing behaviors in the second grade, even after adjusting for background covariates. Our findings, in conjunction with research on cognitive flexibility training, suggest that caregivers may lower the risk for externalizing and internalizing behaviors in delayed developers by correcting inflexible thinking, encouraging alternative solutions, and providing emotional support when children face challenging problems.

### Keywords

cognitive flexibility; longitudinal; growth mixture modeling; executive function; trajectories

<sup>2</sup>Corresponding author. irina.patwardhan@boystown.org.

Conflict of Interest:

The authors declare that they have no conflict of interest.

The ability to maintain one's focus of attention, inhibit impulses, and switch between instructions becomes critically important with the beginning of formal education in kindergarten. Kindergarten children face constant demands that include "novel tasks, concentration, planning, problem solving, coordination, change, conscious choices among alternatives, or overriding a strong internal or external pull" (Diamond, 2006, p. 70). To successfully perform these novel complex behaviors, children rely on a set of developing cognitive abilities, commonly conceptualized as executive functions (Brocki & Tillman, 2014). Executive functions (EFs) consist of three interrelated domains: working memory, inhibitory control, and cognitive flexibility that are characterized, respectively, by abilities to maintain and manipulate relevant information, inhibit distractions, and shift between competing responses (Diamond, 2006). Among the three executive function domains, ability to flexibly adapt behavior according to changes in the environment (i.e., cognitive flexibility) can be essential for emotional and behavioral health (Stange et al., 2017).

Children who are less cognitively flexible may have more difficulties adjusting to change and disengaging from behavioral strategies that are no longer effective. Indeed, studies have linked deficits in cognitive flexibility in kindergarten-age children with greater concurrent and longitudinal risk for internalizing (e.g., anxiety and depression; Kertz et al., 2016; Stange et al., 2017) and externalizing problems in elementary school (e.g., symptoms of attention deficit hyperactivity disorder; Pauli-Pott & Becker, 2011). It is evident that cognitive flexibility is a critical EF skill that enables individuals to flexibly modify previously learned behaviors and adapt to new demands (Anderson, 2002); however, to date, the research linking deficits in cognitive flexibility with internalizing and externalizing psychopathology in real life settings has been limited to single timepoint assessments of cognitive functioning, leaving important gaps in knowledge about the associations between *developmental trajectories of cognitive flexibility and these outcomes*. This gap in the literature is important to address because cognitive flexibility is not static but continues to develop, potentially in different ways for different subgroups of children. Improving our understanding of the different *developmental courses of cognitive flexibility* and their potential associations with subsequent internalizing and externalizing psychopathology in children can contribute, ultimately, to the refinement of targeted interventions providing timely services and supports to children with developmental delays specific to cognitive flexibility.

## Unity and Diversity of Executive Functions

Development of EFs is supported by the prefrontal cortex, which coordinates multiple neural systems contributing to complex cognitive functions (Friedman & Robbins, 2022; Moriguchi & Hiraki, 2013). According to the unity and diversity framework, EFs are comprised of a general cognitive ability that underlies each cognitive skill (i.e., unity) and specific EF abilities associated with each EF domain (i.e., diversity; (Miyake & Friedman, 2012)). General EF ability accounts for persistence and maintenance of goal-related information, which is imperative for all EF tasks, contributing to unity between EF domains (Friedman et al., 2008). Specific abilities are thought to contribute to diversity between EF domains. The shifting ability specific to cognitive flexibility represents the skills necessary for transitioning from "no-longer-active goals" to new, more relevant, goals (Herd et al., 2014,

p. 6). Current research supports the notion that EF development unfolds from the general factor, representing the unity of the working memory, inhibitory control, and cognitive flexibility abilities in early childhood (Wiebe et al., 2011), to more specific differentiated EF abilities throughout childhood and adolescence (Nelson et al., 2022). The differentiation between EF domains is associated with maturation and structural changes in the prefrontal cortex and begins during the formal school years (e.g., around ages 5–6; Chevalier et al., 2013; Bardikoff & Sabbagh, 2017) and further continues through late adolescence.

The diversity of EF domains has been supported by several studies that have shown that *cognitive flexibility* skills had weak or, in some instances, inverse associations with cognitive skills pertaining to other domains of EF. For example, better card-sort switching was associated with worse response inhibition in both Blackwell et al. (2014) and in Mittal et al. (2015). In addition, neuroimaging studies reported prefrontal activation in regions specific to cognitive flexibility during cognitive flexibility tasks (Quiñones-Camacho et al., 2019), suggesting that cognitive flexibility abilities rely on different cognitive mechanisms than working memory or inhibitory control domains of EF (Herd et al., 2014). The exact timing of differentiation between EF domains into three separate factors varies across studies and assessments, but it has been reported that highly notable changes in cognitive flexibility, especially in the ability to switch back and forth between different tasks, emerges around age 5 years, driven by advances in children's abilities to efficiently process task-specific cues (Chevalier et al., 2011). Thus, it is particularly important to study the development of cognitive flexibility during the critical period of EF differentiation, which begins in kindergarten and elementary school, using measures specific to cognitive flexibility to avoid conflating it with other EF abilities.

## Significance of Cognitive Flexibility for Internalizing and Externalizing Psychopathology

Broadly defined, flexibility involves two domains: a *cognitive* domain – represented by mental abilities to *shift* the focus of attention to different features of the object (Wager et al., 2004), flexibly *switch* between different tasks (Kiesel et al., 2010) or mental processes (Dajani & Uddin, 2015), or *consider* multiple (conflicting) characteristics of the same object or event (Jacques & Zelazo, 2005) – and a *behavioral* domain – represented by adaptive changes in behavior (Brown & Tait, 2014) in response to changes in goals or environment (Diamond, 2006) and abilities to *adjust* to changes (Nguyen & Duncan, 2019). Because cognitive tasks are usually measured by behavioral responses, “cognitive” and “behavioral” flexibility are often used interchangeably (Uddin, 2021). Cognitive flexibility is commonly conceptualized as a “complex, later developing ability that is made possible by improvements in inhibitory control and working memory” (Blakey et al., 2016, p. 513). It is typically measured with tasks requiring *switching* and *set shifting*, and requires activation of *working memory* to maintain the rules in mind between the switching conditions and *inhibitory control* to suppress previously relevant responses (Miyake et al., 2000). This ability to switch between tasks and change perspectives may be particularly important for reducing internalizing and externalizing behaviors (Visu-Petra & Marcus, 2019).

It has been suggested that cognitive flexibility could be linked with behavioral functioning through *representational flexibility* (Kloo & Perner, 2005) – an ability to represent and describe each stimuli from a different perspective (e.g., whether a red rabbit card should be sorted as “red” or as “rabbit”). Consequently, it is possible that inability to see problems from a different perspective could contribute to children being “stuck” in repetitive maladaptive patterns of behavior associated with internalizing or externalizing problems. Yet, despite a strong theoretical framework linking cognitive flexibility and behavioral functioning, methodological limitations of previous studies hinder our understanding of how *developmental trajectories* of cognitive flexibility can contribute to these associations. The only study that specifically examined this question longitudinally was limited to a small sample of participants (n = 188) and relied on caregivers reports of children’s cognitive flexibility at a single timepoint (e.g., Kertz et al., 2016), so it is yet to be determined whether delays in cognitive flexibility development are associated with long-term vulnerability to internalizing and externalizing psychopathology.

### **Cognitive flexibility and internalizing problems.**

Developmental delays in cognitive flexibility may create vulnerability for internalizing psychopathology (Stange et al., 2017). The construct of internalizing psychopathology includes depressive and anxiety symptoms, such as loneliness, sadness, anxiety, and low self-esteem (Liu et al., 2011). Cognitive flexibility may be linked with internalizing problems through processes delineated in the “impaired disengagement” hypothesis (Koster et al., 2011), according to which vulnerabilities in cognitive flexibility make it harder for an individual to disengage from a negative mental set and shift to more positive thoughts or consider alternative solutions to a problem, which eventually leads to rumination and depression (Visu-Petra & Marcus, 2019). Studies have shown that parent-reported deficits in cognitive flexibility in kindergarteners were associated with greater anxiety severity 3.5 years later and depression severity 5.5 years later, after accounting for symptoms severity at the beginning of the study (Kertz et al., 2016). Further, in a comprehensive qualitative review, Stange et al. (2017) examined empirical evidence from 147 cross-sectional and case-control studies on associations between deficits in different aspects of cognitive flexibility and depression. They reported that shifting deficits were consistently associated with depression across different assessment tasks and samples of participants but noted that “few prospective studies have been conducted” (p. 245). Thus, longitudinal studies are needed to determine whether trajectories reflecting developmental delays in cognitive flexibility predict subsequent internalizing psychopathology.

### **Cognitive flexibility and externalizing problems.**

Externalizing psychopathology consists of acts that are disturbing or harmful to others, either physically (e.g., fighting) or verbally (e.g., getting angry, arguing, or interrupting ongoing activities; (Kauten & Barry, 2020). A meta-analysis of 22 studies in this area of research reported an overall positive, yet small in magnitude, statistically significant association between deficits in cognitive flexibility and externalizing problems in young children (Schoemaker et al., 2013), and concluded by calling for additional longitudinal studies. Such studies are few in number, but those that exist have shown that prior deficiencies in cognitive flexibility predicted later externalizing behaviors in elementary

school children (Bellanti & Bierman, 2000; Eisenberg et al., 2000). Poor cognitive flexibility may influence the development of externalizing behaviors via its effects on adaptive skills that help children manage triggers for externalizing behaviors (e.g., provocations) in socially appropriate ways (Tremblay, 2000). Since cognitive flexibility helps children attend to and incorporate new knowledge, while disregarding outdated knowledge, it allows them to develop more socially acceptable alternatives to dealing with conflict as they mature (Morgan et al., 2019; Romero-López et al., 2018). Children with poor cognitive flexibility are less flexible in using adaptive problem-solving in social situations and, thus, may be more likely to use repetitive maladaptive (e.g., externalizing) means to achieve goals (Pinsonneault et al., 2015; Romero-López et al., 2018). Similarly to the case for internalizing psychopathology, longitudinal studies are needed to examine developmental trajectories of cognitive flexibility to determine if delays in those abilities predict subsequent externalizing psychopathology.

### Differential Patterns of Growth in Cognitive Flexibility

Whereas most children tend to steadily improve cognitive flexibility skills during kindergarten and first grade and can successfully shift their attention between different tasks (Chevalie et al., 2013; Herd et al., 2014, Diani & Uddin, 2015), the development of cognitive flexibility is not homogenous. A person-centered developmental approach focuses on identifying latent subgroups of children who show different patterns of change in cognitive flexibility. Studies that focused on the longitudinal examination of EF development have reported conflicting results, partially due to heterogeneity in assessments (Willoughby et al., 2011). Zhou et al. (2007) used data on attention focusing which was created from teacher and parent reports and measures of behavioral persistence to identify low, moderate, and high stable growth trajectories of attention focusing in a sample of 356 five-year old children over a period of six years. Willoughby et al. (2017) used EF data from seven standardized measures, including ratings of cognitive flexibility, and identified two EF growth trajectories, typical and delayed developers, in a sample of 1,120 three-year old children over a period of three years. Montroy et al. (2016) used data on children's self-regulation to identify early, intermediate, and late growth trajectories of self-regulation in a sample of 1,386 children between ages of three and seven. Although informative, prior research has been limited, with a majority of the studies operationalizing cognitive flexibility in the context of broader EF skills and not focusing on abilities that are specific to cognitive flexibility (e.g., shifting attention between different tasks that require different rules; Chevalie et al., 2013; Herd et al., 2014, Diani & Uddin, 2015), thereby hindering our understanding of developmental trajectories specific to cognitive flexibility. Further, only two studies examined prospective links between deficits in cognitive flexibility and corresponding internalizing (Kertz et al., 2016) and externalizing (Bellanti & Bierman, 2000) psychopathology, but they relied on caregivers reports of cognitive flexibility. Thus, there is a need to evaluate trajectories of cognitive abilities specific to cognitive flexibility in relation to subsequent behavioral functioning in the form of internalizing and externalizing behaviors.

## Present Study

The first goal of the current study was to identify latent subgroups of children characterized by different trajectories of development in cognitive flexibility during the critical period of EF differentiation, throughout kindergarten and first grade, using data collected from four occasions in the fall and spring of kindergarten and first grade. Given evidence from previous research (Reid & Ready, 2022; Zhou et al., 2007), we hypothesized that *at least* two latent profiles will be identified based on children's development of cognitive flexibility: early normative developers and delayed developers (hypothesis 1). The second goal was to examine differences across identified profiles in the prediction of internalizing and externalizing behaviors in the second grade. If the delayed developers' subgroup would be identified, it was expected that this subgroup of children would have significantly more externalizing and internalizing behaviors in the second grade compared to the early normative developers (hypothesis 2).

To examine if observed associations persist after adjustment for other factors, the third goal was to examine differences in the internalizing and externalizing behaviors among identified latent groups, after accounting for background child (age, gender, speaking Spanish at home) and family (family income and mother's education) covariates, that have been previously associated with cognitive flexibility (hypothesis 3). For example, several studies provided evidence that young girls tend to outperform boys on tasks of cognitive flexibility (Patwardhan et al., 2021; Raaijmakers et al., 2008). There is also evidence suggesting that bilingualism can promote cognitive flexibility, since multiple studies have found the bilingual children are more likely to outperform monolingual children on tasks of cognitive flexibility (Mepham & Martinovic, 2017). Further, the rapid changes in executive functioning observed during early childhood highlight the importance of considering a child's age when studying the development of cognitive flexibility (e.g., Zelazo et al., 2013). In addition, children from low-income backgrounds often demonstrate delays in cognitive flexibility, while higher levels of family income and maternal education are associated with greater cognitive flexibility (Clearfield & Niman, 2012; Zeytinoglu et al., 2018).

## Method

### Dataset and Participants

Data were from the Early Childhood Longitudinal Study, Kindergarten Class of 2010–2011 (ECLS-K:2011) publicly available data set. The ECLS-K:2011 study was conducted by the National Center for Education Statistics (NCES) within the Institute of Education Sciences (IES) of the U.S. Department of Education and recruited a nationally representative sample of children who attended kindergarten in 2010–2011 school year and who continue to be followed. For our study, we used data from the cognitive flexibility assessments conducted in the fall and spring of the kindergarten year and fall and spring of the first grade; teachers' ratings of internalizing and externalizing behavior problems obtained in the spring of the second grade, and demographic data collected from parental interviews in the fall of kindergarten. The assessments were administered individually, in an unoccupied classroom, and took about 60 minutes per child. All responses were entered into a computer-assisted interviewing program. The cognitive flexibility assessment was part of a broader

assessment battery that focused on cognitive domains (e.g., reading, mathematics, science, and executive function). Detailed information about the ECLS-K:2011 study can be found at <http://nces.ed.gov/ecls>.

The complete ECLS-K:2011 dataset included 18,174 children who started kindergarten in 2010–2011 academic year. Prior to analyses, all children without a valid complex sample weight variable (W1C0;  $n = 2,347$ ) were excluded from analyses. The analytic sample consisted of 15,827 kindergarteners (51.20% male), who were on average 5.62 years old ( $SD = 4.48$  months) at the study's outset; 48.50% were White, 13.5% were Black/African American, 24.3% were Hispanic/Latino, 7.60 % were Asian, 0.60% were Native Hawaiian/Other Pacific Islander, 0.90% were American Indian/Alaska Native, and 4.60% were of two or more races; 9.8% of children spoke Spanish at home. Most children lived in households with medium family income of approximately \$50,000–\$55,000, and 4.8% of mothers completed 8<sup>th</sup> grade or below, 8.5% completed 9<sup>th</sup>–12<sup>th</sup> grades, 21.8% had had a high school diploma, 5.7% graduated from a vocational program, 26.7 % had some college education, and 32.5% had a bachelor's degree or higher.

## Measures

**Cognitive Flexibility.**—The Dimensional Change Card Sort task (DCCS; Zelazo, 2006) was used to collect information on children's cognitive flexibility. In this task, children were presented with 18 picture cards, where each card had a picture of either a red rabbit or a blue boat. The children were asked to sort the cards into trays first by color (6 trials), and then by shape (6 trials). If the child correctly sorted four out of six cards in the shape game, he/she then proceeded to the border game (6 trials), where the sorting rule was determined by the presence (or absence) of a black border on a card. The total score ranged from 0 to 18, representing the total number of correct responses. Previous studies with the DCCS reported high reliability (Chronbach's  $\alpha = .98$ ; Howngwanishkul et al., 2005), test-retest reliability (e.g., intraclass correlations for the DCCS ranged from .78 to .94 across the trials; Beck et al., 2011), and sensitivity to individual differences in cognitive flexibility (Mulas et al., 2006; Zelazo et al., 2002).

**Internalizing and Externalizing Behaviors Problems.**—Children's internalizing and externalizing behaviors were reported by teachers in the spring of the second grade using modified questions from the valid and reliable measure of children's social skills, the Social Skills Rating System (SSRS; Gresham & Elliott, 1990), which has been used in studies with internalizing and externalizing behavior outcomes (Cumming et al., 2022; Patwardhan et al., 2021). Children's behaviors were rated on a four-point Likert scale, with higher scores representing higher frequencies of these behaviors. The four-item internalizing behavior scale assesses the presence of anxiety, loneliness, low self-esteem, and sadness ( $\alpha = .78$ ). The five-item externalizing behavior scale assesses the frequency with which a child argues, fights, gets angry, acts impulsively, and disturbs ongoing activities ( $\alpha = .87$ ). The subscales were calculated as the mean ratings of the items included in the scale.

Reports of children's externalizing and internalizing problems also were obtained from parents, although these assessments were limited. Specifically, parental reports were only

obtained in the spring of the first grade and, therefore, overlap with the assessment of cognitive flexibility, and parents had slightly lower response rates compared to teachers (74.2% vs. 87%). Moreover, the externalizing behavior scale was computed as the mean of only two items and the internalizing behavior scale had somewhat low reliability of  $\alpha = .58$ . For these reasons, parental reports were only used in a sensitivity analysis to determine how the results might compare with those based on teacher reports from the primary analyses.

**Sociodemographic Covariates.**—We included child gender, age, and the primary language spoken at home (i.e., speaking Spanish at home) as well as family income and maternal education as covariates in the current study. Parents reported their child's age and gender, and whether their child speaks Spanish at home (1 = “yes”, 0 = “no”), as well as mother's education and family income during phone interviews in the fall of kindergarten. Mother's education was rated on a scale from 1 (8<sup>th</sup> grade or below) to 8 (Master's degree or higher), and family income was rated on a scale from 1 (\$5,000 or less) to 18 (\$200,000 or more).

### Analytic Plan

The current study used growth mixture modeling (GMM; Jung & Wickrama, 2008) to identify latent classes of children with different rates of development in cognitive flexibility, using data from four occasions in fall and spring of kindergarten and first grade. According to the recommended practices (Jung & Wickrama, 2008), prior to conducting GMM, we conducted a latent class growth analysis (LCGA) to identify an optimum number of latent classes. One advantage of starting with the LCGA is that it assumes no within-class variability among individuals and thus presents less computational burden compared GMM, which estimates within-class variation in growth factors (Jung & Wickrama, 2008).

First, to determine the shape of the growth model, we specified a univariate unconditional (e.g., with no predictors) *single-class growth model* for cognitive flexibility starting with a random intercept and a random linear slope and considering the potential for nonlinear growth via the addition of a quadratic slope. Second, to determine the model with the optimal number of latent classes, we specified an unconditional *latent class* growth model for cognitive flexibility with no within-class variance and covariances among the intercept and linear and quadratic slope factors. Third, to examine individual variability within the latent class growth factors, we used a GMM approach to allow within class variance on the growth factors (i.e., intercept, linear slope, and quadratic slope) to be freely estimated within the classes. To determine the model with the optimal number of latent classes (hypothesis 1), we used information from the Akaike Information Criterion (AIC), Sample Size Adjusted Bayesian Information Criteria (SSA-BIC), the Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (VLMR-LRT), Lo-Mendell-Rubin Adjusted Likelihood Ratio Test (adjusted LMR-LRT), and classification accuracy. In general, models with the smaller AIC and SSA-BIC indicate better fit (Jung & Wickrama, 2008). A significant p-value on the VLMR-LRT and adjusted LMR-LRT indicates that a model with the  $k$  classes is preferred compared to the model with the  $k-1$  classes (Lo et al., 2001). Classification accuracy was determined by examining entropy values and class assignment probabilities (values closer to 1 indicate more precise classification accuracy). The contribution of the random intercept/

slope variance was determined through the  $-2LL$  deviance test, which uses  $-2LL$  (log likelihood) to test the significance of adding a random effect compared to the null model. To account for the complex non-random design of the of the ECLS-K:2011 dataset, corrections to the standard errors and chi-square test of model fit were made by using `type = mixture` complex option of the `analysis` command in conjunction with the `stratification`, `cluster`, and `weight` options of the `variable` command in Mplus statistical software (Muthén & Muthén, 1998–2017). Our analyses used the maximum likelihood estimator with robust standard errors (MLR), which accounted for non-normality of the cognitive flexibility distribution.

In a second set of analyses, we used a three-step BCH approach (Asparouhov & Muthén, 2014) to determine if there was a significant difference between the identified latent classes on their levels of externalizing and internalizing problems in the spring of the second grade (hypothesis 2). The BCH approach is capable of performing the equality of means test among the identified trajectories, while taking into account the assigned class membership, and has been shown to be a more robust approach compared to other step-wise approaches dealing with continuous distal outcomes (Bakk & Vermunt, 2016).

In order to examine if between-class differences in the externalizing and internalizing behavior problems would remain significant after accounting for background child and family covariates (hypothesis 3), we conducted a third set of analyses, where latent class assignment data was extracted using the `CPROBABILITIES` option, which saves the variable that contains each individual's most likely class membership and the highest posterior probability for each class (Muthén & Muthén, 1998–2017). The latent class membership was used as a predictor in liner regression models predicting externalizing or internalizing behavior problems in the spring of the second grade, after accounting for background child and family covariates. This approach was chosen because currently *Mplus* does not allow for simultaneous examination of associations between identified latent classes and predictors and outcomes in the same model.

**Analysis of Missing Data.**—Prior to analyses, all cases with missing values on the complex sample weight variable (`W1C0`;  $n = 2347$ ) were excluded from original dataset, resulting into analytic sample  $N=15,827$  children. It is also of note that the ECLS-K:2011 *fall* data collection for the *first* and *second* grade were intentionally conducted with approximately one-third of the sample of children who participated in the fall of kindergarten data collection. The amount of missing data across four assessments for cognitive flexibility was 1.4% ( $n = 224$ ) in the fall of kindergarten, 4.4% ( $n = 699$ ) in the spring of kindergarten, 71.6% ( $n = 11,337$ ) in the fall of the first grade, and 16.6% ( $n = 2628$ ) in the spring of the first grade. The amount of missing data on teacher-reported externalizing and internalizing behavior problems in the spring of second grade was 29.8% ( $n = 4,716$ ) and 30.2% ( $n = 4,779$ ) correspondingly. Our analyses used MLR estimator with robust standard errors and full information maximum likelihood (FIML) estimation to address missing data. Children missing cognitive flexibility assessment in the fall and spring of kindergarten came from families with significantly lower income (fall:  $t(127) = 5.53$ ,  $p < .001$ ; spring  $t(244) = 5.16$ ,  $p < .001$ ) and had mothers with fewer years of education (fall:  $t(165) = 5.47$ ,  $p < .001$ ; spring  $t(532) = 5.86$ ,  $p < .001$ ) compared to children who completed cognitive flexibility assessments. During the planned missingness in the fall

of first grade, children missing cognitive flexibility assessments had mothers with higher education  $t(6967) = -4.46, p < .001$ , but did not differ on family income  $t(6426) = -.551, p = .582$  from children who completed the cognitive flexibility assessment. Further, in the spring of first grade, children missing cognitive flexibility assessments did not differ from children who completed cognitive flexibility assessments on mother education  $t(3075) = 1.64, p = .09$ , but came from families with lower income  $t(11878) = 6.29, p < .001$ .

## Results

### Descriptive Analyses

Descriptive statistics and correlations among the study variables are presented in Table 1. Overall, cognitive flexibility was significantly correlated across four assessments (range  $r = .26$  to  $r = .33, p < .001$ ). Higher cognitive flexibility across kindergarten and first grade was associated with fewer teacher-reported externalizing (range  $r = -.07$  to  $r = -.09, p < .001$ ) and internalizing (range  $r = -.08$  to  $r = -.09, p < .001$ ) behavior problems in the second grade. Teacher reported externalizing and internalizing child behavior problems were significantly moderately correlated ( $r = .32, p < .01$ ).

### Identifying Multiple Growth Patterns in Cognitive Flexibility

A single class linear growth curve model for cognitive flexibility was estimated first and had an acceptable model fit:  $\chi^2 = 82, df = 5, p < .001$ ; CFI = .95, TLI = .94, RMSEA = .03). A single class quadratic growth curve model for cognitive flexibility was estimated next and had an acceptable model fit  $\chi^2 = 2.25, df = 1, p = .134$ ; CFI = .99, TLI = .99, RMSEA = .01. Based on comparisons of model fit, the best fitting single-class unconditional model for cognitive flexibility was a quadratic growth curve model ( $-2\Delta LL = 243.50, df = 4, p < .001$ ).

We further proceeded with the quadratic LCGA to identify an optimal number of distinct developmental trajectories in cognitive flexibility. As shown in Table 2, AIC, SSA-BIC, VLMR-LRT and adjusted LMR-LRT suggested that the two-class model provided the best fit. After successfully running the two-class LCGA model, the decision was made to increase model complexity and estimate, independently, within-class variances of either of the intercept or a linear slope within each class (note that the model where within-class variance of the intercept, slope, and quadratic slope factors were freely estimated simultaneously did not converge). While the free intercept model fit equally well compared to the free linear slope model (as indicated by the  $-2LL$  deviance test in Table 3), given our focus on the growth rather than actual [initial?] performance in cognitive flexibility, the decision was made to proceed with the two-class model with freely estimated within-class variance of the linear *slope*.

Parameter estimates of the two-class fixed quadratic, fixed intercept, random linear slope latent GMM for cognitive flexibility are presented in Table 4. To be consistent with the previous literature, we labeled the classes as “early developers” ( $n = 14,368$ ; 91.05%; 50.4% male) and “delayed developers” ( $n = 1,379$ ; 8.95%; 59.4% male). The average latent class probability for participants’ most likely latent class membership was 97.3%. Children who were labeled “*early developers*” were characterized by high initial values of cognitive

flexibility ( $b = 14.53$ ,  $p < .001$ ; range 0–18) in the beginning of kindergarten, which did not vary among children; positive linear increase during the first semester in kindergarten ( $b = 1.67$ ,  $p < .001$ ), which varied significantly among children ( $b = 0.17$ ,  $p < .001$ ), indicating that cognitive flexibility increased in the first semester in kindergarten by on average, 1.67 points, and that the rates of increase varied among children; and a slight negative accelerated rate across kindergarten and first grade ( $b = -0.38$ ,  $p < .001$ ), which did not vary among children. These results indicate that for children who started kindergarten with relatively high values in cognitive flexibility, the gain in cognitive flexibility decreased with the repeated assessment times (possibly indicating that more children were reaching the level of proficiency).

Children who were labeled “*delayed developers*” were characterized by lower initial values of cognitive flexibility ( $b = 10.82$ ,  $p < .001$ ; range 0–18) in the beginning of kindergarten, which did not vary among children; a rapid linear decrease during the first semester in kindergarten ( $b = -5.10$ ,  $p < .001$ ), which varied significantly among children ( $b = 1.18$ ,  $p < .001$ ) and became less negative in the presence of the positive accelerated rate across kindergarten and first grade ( $b = 2.11$ ,  $p < .001$ ), which did not vary among children. These results indicate that delayed developers who began kindergarten with relatively lower scores demonstrated more rapid growth in cognitive flexibility with repeated assessment. Further, to examine if delayed developers caught up with the normative developers at the end of the first grade, the mean differences between two latent groups at the end of the first grade were tested for significance via the model constraint option in Mplus. The results indicated that at the end of the first grade delayed developers ( $M = 14.52$ ,  $SE = .20$ ) still did not catch up with the early developers ( $M = 16.17$ ,  $SE = .04$ ),  $t(df = 1) = 63.62$ ,  $p < .001$ . The estimated latent growth trajectories for cognitive flexibility are depicted in Figure 1.

### Associations Between Latent Class Membership and Behavior Problems

To examine if the two identified patterns of development in cognitive flexibility are associated with different levels of externalizing and internalizing problems in the spring of the second grade, we performed the equality of means test among these two classes using BCH procedure. As shown in Table 4, children who were identified as delayed developers had significantly more externalizing ( $\chi^2 = 24.48$ ,  $p < .001$ ) and internalizing ( $\chi^2 = 24.84$ ,  $p < .001$ ) behavior problems compared to children identified as early developers at the end of the second grade.

**Sensitivity Analyses with Parent-Reported Behavior Problems.**—The equality of means test among the two latent classes (with the BCH procedure) was also performed using parental reports of internalizing and externalizing behavior problems at the end of the first grade (which was the last time point where parent reports were available). Results indicated that delayed developers ( $M = 1.98$ ,  $SE = .03$ ) had significantly higher levels of parent-reported externalizing problems compared to the early developers ( $M = 1.87$ ,  $SE = .01$ ),  $\chi^2 = 11.48$ ,  $p < .001$ . Further, delayed developers ( $M = 1.49$ ,  $SE = .02$ ) did not differ from early developers ( $M = 1.46$ ,  $SE = .01$ ) in their levels of parent-reported internalizing problems ( $\chi^2 = 2.97$ ,  $p = .085$ ).

## Covariates

To examine if observed differences in internalizing and externalizing behavior problems among delayed and early developers would persist after accounting for background child (age, gender, and speaking Spanish) and family (mom's education and family income) covariates, we performed two independent linear regressions predicting child's externalizing or internalizing behavior problems in the spring of the second grade with the latent class membership (early/delayed) and accounting for child gender, age, and the primary language spoken at home (i.e., speaking Spanish at home) as well as family income and maternal education. Results from both models indicated that after accounting for child and family covariates, delayed developers had higher levels of internalizing and externalizing problems compared to early developers (Table 5). After accounting for delayed latent class membership, it was found that boys had higher levels of internalizing ( $b = 0.04$ ,  $p < .001$ ,  $\beta = .04$ ) and externalizing ( $b = 0.27$ ,  $p < .001$ ,  $\beta = .22$ ) behaviors compared to girls, while children from families with higher income had lower levels of internalizing ( $b = -0.01$ ,  $p < .001$ ,  $\beta = -.10$ ) and externalizing ( $b = -0.02$ ,  $p < .001$ ,  $\beta = -.15$ ) behaviors. Mom's education was significantly associated with fewer internalizing ( $b = -0.02$ ,  $p < .001$ ,  $\beta = -.06$ ), but not externalizing ( $b = -0.01$ ,  $p = .28$ ,  $\beta = -.02$ ) behaviors. In addition, children speaking Spanish at home had fewer internalizing ( $b = -0.15$ ,  $p < .001$ ,  $\beta = -.09$ ) and externalizing ( $b = -0.19$ ,  $p < .001$ ,  $\beta = -.10$ ) behaviors compared to children who do not speak Spanish at home, and child's age was not significantly associated with any behavior problems.

## Discussion

Recent research on EF has become increasingly interested in the links between cognitive performance and behavioral functioning. The current study suggests that a small group of children that we characterized as delayed developers started kindergarten with lower cognitive flexibility abilities and displayed improvements in cognitive flexibility throughout kindergarten and the first grade. Despite these improvements, delayed developers had higher levels of internalizing and externalizing behavior problems in the second grade compared to early developers, even after controlling for socio-demographic covariates. The findings from our study expand prior research that has measured cognitive flexibility at a single timepoint or conflated it with other aspects of EF by examining the long-term associations of developmental trajectories of cognitive flexibility with subsequent internalizing and externalizing psychopathology.

### Heterogeneity in the Development of Cognitive Flexibility

Our results indicated that development of cognitive flexibility through kindergarten and first grade was heterogeneous and was best described by two groups that we labeled *early* (91.05%; 50.3% male) and *delayed* (8.95%; 59.4% male) developers. *Early developers* identified in our study were characterized by high initial values of cognitive flexibility and steady high performance during kindergarten and first grade. It is possible that early developers begin kindergarten with higher levels of cognitive flexibility skills to effectively handle the Dimensional Change Cart Sort (DCCS) task, and their performance trajectories would be flatter compared to children who started kindergarten with delays

in cognitive flexibility. *Delayed developers* were characterized by low initial values of cognitive flexibility that improved according to a u-shaped curve over kindergarten and first grade. These results suggest that for a small group of children the ability to successfully switch their attention between the rules of the DCCS is not fully developed during the first two years of formal schooling, potentially making them vulnerable for later maladaptive behavioral adjustment.

The fact that approximately 9% of children in our study were characterized with delayed development of cognitive flexibility corresponds with a report from a nationally representative sample of teachers, according to which approximately 16% of children did not have the necessary executive function skills for a positive transition to kindergarten (Rimm-Kaufman et al., 2000). Further, trajectories of cognitive flexibility identified in our study were consistent with research examining developmental trajectories of executive function. For example, Willoughby et al. (2017) reported that approximately 9% of children ages 3 to 5 years in their sample were characterized as delayed developers, displaying low levels of executive function at the beginning of the study, and showing slight non-significant improvements over time. Further, Montroy et al. (2016) reported that 20–30% of children ages 3 to 7 years in their study were characterized as later developers, who started with low levels of self-regulation and proceeded with slower gains. Because cognitive flexibility continues to develop throughout middle childhood and adolescence (Chevalier et al., 2013), longer term longitudinal studies with older children are needed to determine if *delayed developers*, a group that has been consistently observed across all the above-mentioned studies, would continue to fall behind (e.g., remain delayed) or if some children would eventually catch-up with the normative EF developers. Similarly, it will be interesting to see whether the early developers continue their steady performance or if some subgroups of children would fall behind.

### **Associations Between Trajectories of Cognitive Flexibility and Internalizing and Externalizing Behaviors in a Second Grade**

Our study provides evidence that delayed developers had higher levels of teacher-reported externalizing and internalizing behaviors at the end of the second grade compared to the early developers of cognitive flexibility. These observed differences also persisted when behavior problems were rated by parents, but only in regard to externalizing, not internalizing, behavior problems. Results from the parent-report assessments should be interpreted with caution in light of their limitations, which are noted above. Still, these differences in associations between teacher- and parent-reported internalizing behaviors may be because teachers could be more likely to report *problematic* internalizing behaviors and may overlook the presence of occasional internalizing behaviors compared to parents (Cai et al., 2004). Importantly, observed differences between delayed and early developers persisted after accounting for socio-demographic child- and family-covariates commonly associated with internalizing and externalizing behavior problems. Therefore, it could be argued that after accounting for a robust set of covariates, *difficulties* with cognitive set shifting in delayed developers were associated with *difficulties* in disengaging from maladaptive repetitive patterns of behaviors (e.g., higher frequency of repeatable externalizing and internalizing behaviors that were reported by teachers) to more healthy

adaptive behaviors. This pattern supports previous findings on associations between cognitive and behavioral flexibility (Uddin, 2020).

The associations observed in our study may represent underlying *difficulties* with representational flexibility when children fail to understand that a blue boat can be described as “blue” in the color condition, and as a “boat” in the shape condition (Kloo et al., 2010). According to this approach, switching between two dimensions does not require inhibition of the previously learned responses per se, but rather builds on improvements in re-description and perspective taking that facilitate shifting between different ways of thinking about the same object. Alternatively, the associations between cognitive and behavioral flexibility may represent difficulties with disengagement from previously learned rules (Koster et al., 2011), also called “negative priming” (Chevalier & Blaye, 2008). From this perspective, switching to a different set of rules (e.g., sort by shape, not by color) requires inhibition of the no-longer relevant rules. Consequently, individuals who tend to preserve only one set of rules may have higher tendencies for repetitive behaviors. While current theories differ in their hypotheses on underlying mechanisms between cognitive and behavioral flexibility, nevertheless delays in cognitive flexibility may increase risk for multiple forms of psychopathology beyond internalizing and externalizing behavior problems (Aldao et al., 2010). Further research examining specific underlying mechanisms between cognitive and behavioral flexibility is needed (Ip et al., 2019; Visu-Petra & Marcus, 2019; Uddin, 2020).

**Covariates.**—The effects of covariates were consistent with previous research indicating lower risk for internalizing and externalizing psychopathology for children from families with higher income. The fact that mom’s education was associated with lower risk only for internalizing (but not externalizing) behaviors could be because educated mothers tend to be more mindful (i.e. present, accepting, and curious) to the internalizing symptoms that are not so easily visible to others (Lam et al., 2022). Further, the findings of higher levels of internalizing and externalizing behaviors in boys compared to girls in the beginning of elementary school are consistent with previous findings from this dataset (Patwardhan et al., 2021) and with research showing that elevated risk for girls (e.g., for internalizing problems) tends to arise later in development. Speaking Spanish at home was associated with lower levels of internalizing and externalizing behaviors, indicating a potentially protective role of second language learning for positive adjustment; however, given that Speaking Spanish at home was negatively associated with cognitive flexibility, these results should be interpreted with caution.

## Strengths and Limitations

The present study has several strengths. First, we analyzed data collected on a large sample of diverse participants using multiple methods, including performance-based tasks and teacher (as well as parent) reports. Second, application of the growth mixture modeling approach allowed us to estimate individual variability in the rates of change in cognitive flexibility within classes, whereas most of the research is limited in capturing only between-classes variability (Jung & Wickrama, 2008). Third, combining advanced statistical techniques allowed us to examine associations between the latent profiles of cognitive

flexibility and study outcomes after controlling for background child and family covariates. Despite these strengths, our study also has few limitations. The major limitation of the current study pertains to the archival nature of the ECLS-K:2011 dataset; therefore, we were limited to only one measure of cognitive flexibility and four assessment points. In this regard, our observation of two latent profiles in the development of cognitive flexibility is specific to children's performance over the time frame studied on the DCCS (Zelazo, 2006), which was becoming relatively easy for some children (e.g., 8% – 30% across assessments) who sorted each card correctly and could not improve. To overcome these measurement issues, it would be beneficial to include other measures of cognitive flexibility (e.g., Tower of London; Shallice et al., 1982) and examine development of cognitive flexibility in children beyond first grade and throughout elementary school. In addition, because parental reports of student behaviors were not collected in the second grade, our primary analyses used teachers' reports of children's internalizing and externalizing behaviors. More comprehensively collecting data from multiple informants (i.e., self-, peer-, parents) would increase generalizability of the results. Further, the use of the CPROBABILITIES option also introduced possible classification uncertainty by extracting individual's most likely latent class membership for use in regression analyses. For this reason, we consider results based on the CPROBABILITIES analyses as preliminary, complementing our findings from the more robust BCH procedure performed earlier. In addition, even though statistically significant, the estimates for delayed cognitive flexibility in our study were relatively small in magnitude (.05-.06), and the results have no apparent practical significance at this stage of research. Because of the small effect sizes and lack of practical significance for the associations of the delayed developer class with externalizing ( $\beta = 0.05$ ) and internalizing ( $\beta = 0.06$ ) behaviors, the findings from this single study cannot suggest any policy implications. Also, we note that the results were derived from data-driven analyses and may reflect idiosyncrasies of the dataset and sample; follow-up confirmatory analyses are needed to establish the potential replicability of the findings. Finally, our study focused on the associations between earlier cognitive flexibility and levels of internalizing and externalizing psychopathology in the second grade and did not account for previous levels of the corresponding behavior problems to study changes in internalizing and externalizing behaviors over time; thus, further repeated measures research is needed to extend our findings.

### Clinical Implications

Our study highlights the important role cognitive flexibility plays in the development of externalizing and internalizing behaviors in early childhood. Kindergartens demonstrating lower levels of cognitive flexibility than their peers may benefit from cognitive training, since these students are likely delayed developers and may be at risk for later externalizing and internalizing problems. Several studies have demonstrated that verbal corrective feedback and explanations can improve young children's cognitive flexibility performance (Buttelmann & Karbach, 2017; Kloo & Perner, 2005; van Bers et al., 2014). Having children engage in metacognition reflection—e.g., thinking about their own thinking—may also improve their cognitive flexibility (Buttelmann & Karbach, 2017). For example, Moriguchi et al. (2015) encouraged metacognition reflection in 3- to 5-year-olds by asking them to think about the rules and possible solutions for the DCCS task before explaining the task

to a puppet. The children's performance on the DCCS task not only improved after this reflection but neuroimaging also revealed improved activations in the regions of the brain associated with cognitive flexibility. Thus, identifying and correcting inflexible thinking, while also encouraging children to think about alternative strategies and solutions may be beneficial for delayed developers. In particular, since impairment disengagement is theorized to have a role in the link between cognitive flexibility and internalizing problems (see Koster et al., 2011), caregivers and teachers should note when delayed developers fixate on a negative mindset and encourage them to consider alternative approaches to problems. Likewise, to reduce their risk for externalizing behaviors—which may be exacerbated by decreased adaptability to social situations (see Morgan et al., 2019; Romero-López et al., 2018)—delayed developers may need assistance in learning new, adaptive solutions to deal with challenging social situations. Past research also suggests that parents can further support the development of cognitive flexibility by providing emotional support (e.g., increased emotional responsiveness and decreased intrusiveness and negativity) when assisting their children in solving challenging problems (Zeytinoglu et al., 2018). Future research should further explore refining cognitive flexibility training to target delayed developers specifically.

## Funding:

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. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

## References

- Aldao A, Nolen-Hoeksema S, & Schweizer S (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*, 30(2), 217–237. 10.1016/j.cpr.2009.11.004 [PubMed: 20015584]
- Anderson P (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology*, 8(2), 71–82. 10.1076/chin.8.2.71.8724 [PubMed: 12638061]
- Asparouhov T, & Muthén B (2014). Auxiliary variables in mixture modeling: Three-step approaches using *Mplus*. *Structural Equation Modeling: A Multidisciplinary Journal*, 21, 329–341. 10.1080/10705511.2014.915181
- Bakk Z, & Vermunt JK (2016). Robustness of stepwise latent class modeling with continuous distal outcomes. *Structural Equation Modeling: A Multidisciplinary Journal*, 23(1), 20–31. 10.1080/10705511.2014.955104
- Bardikoff N, & Sabbagh M (2017). The differentiation of executive functioning across development: Insights from developmental cognitive neuroscience. In Budwig N, Elliot T, & Zelazo PD (Eds.), *New perspectives on human development* (pp. 47–66). Cambridge University Press.
- Beck DM, Schaefer C, Pang K, & Carlson SM (2011). Executive function in preschool children: Test–retest reliability. *Journal of Cognition and Development*, 12(2), 169–193. 10.1080/15248372.2011.563485 [PubMed: 21643523]
- Bellanti CJ, & Bierman KL (2000). Disentangling the impact of low cognitive ability and inattention on social behavior and peer relationships. *Journal of Clinical Child Psychology*, 29(1), 66–75. 10.1207/S15374424jccp2901\_7 [PubMed: 10693033]
- Blackwell KA, Chatham CH, Wiseheart M, & Munakata Y (2014). A developmental window into trade-offs in executive function: The case of task switching versus response inhibition in 6-year olds. *Neuropsychologia*, 62, 356–364. [PubMed: 24791710]

- Blakey E, Visser I, & Carroll DJ (2016). Different executive functions support different kinds of cognitive flexibility: Evidence from 2-, 3-, and 4-year-olds. *Child Development*, 87(2), 513–526. 10.1111/cdev.12468 [PubMed: 26659697]
- Brocki KC, & Tillman C (2014). Mental set shifting in childhood: The role of working memory and inhibitory control. *Infant and Child Development*, 23(6), 588–604.
- Brown VJ, & Tait DS (2014). Behavioral flexibility: Attentional shifting, rule switching, and response reversal. *Encyclopedia of Psychopharmacology*, 1–7.
- Buttelmann F, & Karbach J (2017). Development and plasticity of cognitive flexibility in early and middle childhood. *Frontiers in Psychology*, 8(1040). 10.3389/fpsyg.2017.01040
- Cai X, Kaiser AP, & Hancock TB (2004). Parent and teacher agreement on child behavior checklist items in a sample of preschoolers from low-income and predominantly african american families. *Journal of Clinical Child and Adolescent Psychology*, 33, 303–312. [PubMed: 15136195]
- Chevalier N, & Blaye A (2008). Cognitive flexibility in preschoolers: The role of representation activation and maintenance. *Developmental Science*, 11, 339–353. [PubMed: 18466368]
- Chevalier N, Huber KL, Wiebe SA, & Espy KA (2013). Qualitative change in executive control during childhood and adulthood. *Cognition*, 128(1), 1–12. [PubMed: 23562979]
- Chevalier N, Wiebe SA, Huber KL, & Espy KA (2011). Switch detection in preschoolers' cognitive flexibility. *Journal of Experimental Child Psychology*, 109(3), 353–370. 10.1016/j.jecp.2011.01.006 [PubMed: 21353678]
- Clearfield MW, & Niman LC (2012). SES affects infant cognitive flexibility. *Infant Behavior and Development*, 35(1), 29–35. 10.1016/j.infbeh.2011.09.007 [PubMed: 22018718]
- Cumming MM, Poling DV, Patwardan I, & Ozenbaugh IC (2022). Executive Function in Kindergarten and Development of Behavioral Competence: Moderating Role of Positive Parenting Practices. *Early Childhood Research Quarterly*, 60, 161–172. [PubMed: 35990732]
- Dajani DR, & Uddin LQ (2015). Demystifying cognitive flexibility: Implications for clinical and developmental neuroscience. *Trends in Neurosciences*, 38(9), 571–578. 10.1016/j.tins.2015.07.003 [PubMed: 26343956]
- Diamond A (2006). The early development of executive functions. In Bialystok E & Craik FIM (Eds.), *Lifespan Cognition: Mechanisms of Change* (pp. 70–95). Oxford University Press. 10.1093/acprof:oso/9780195169539.001.0001
- Eisenberg N, Guthrie IK, Fabes RA, Shepard S, Losoya S, Murphy B, Jones S, Poulin R, & Reiser M (2000). Prediction of elementary school children's externalizing problem behaviors from attentional and behavioral regulation and negative emotionality. *Child Development*, 71(5), 1367–1382. 10.1111/1467-8624.00233 [PubMed: 11108101]
- Friedman NP, Miyake A, Young SE, DeFries JC, Corley RP, & Hewitt JK (2008). Individual differences in executive functions are almost entirely genetic in origin. *Journal Of Experimental Psychology*, 137(2), 201. [PubMed: 18473654]
- Friedman NP, & Robbins TW (2022). The role of prefrontal cortex in cognitive control and executive function. *Neuropsychopharmacology*, 47(1), 72–89. [PubMed: 34408280]
- Gresham FM, & Elliott SN (1990). Social skills rating system (SSRS). American Guidance Service.
- Herd SA, Hazy TE, Chatham CH, Brant AM, & Friedman NP (2014). A neural network model of individual differences in task switching abilities. *Neuropsychologia*, 62, 375–389. [PubMed: 24791709]
- Howngwanishkul D, Happaney KR, Lee WS, & Zelazo PD (2005). Assessment of hot and cool executive function in young children: Age-related changes and individual differences. *Developmental Neuropsychology*, 28, 617–644. [https://doi.org/10.1207/s15326942dn2802\\_4](https://doi.org/10.1207/s15326942dn2802_4) [PubMed: 16144430]
- Ip KI, Jester JM, Sameroff A, & Olson SL (2019). Linking Research Domain Criteria (RDoC) constructs to developmental psychopathology: The role of self-regulation and emotion knowledge in the development of internalizing and externalizing growth trajectories from ages 3 to 10. *Development and Psychopathology*, 31(4), 1557–1574. 10.1017/S0954579418001323 [PubMed: 30719962]

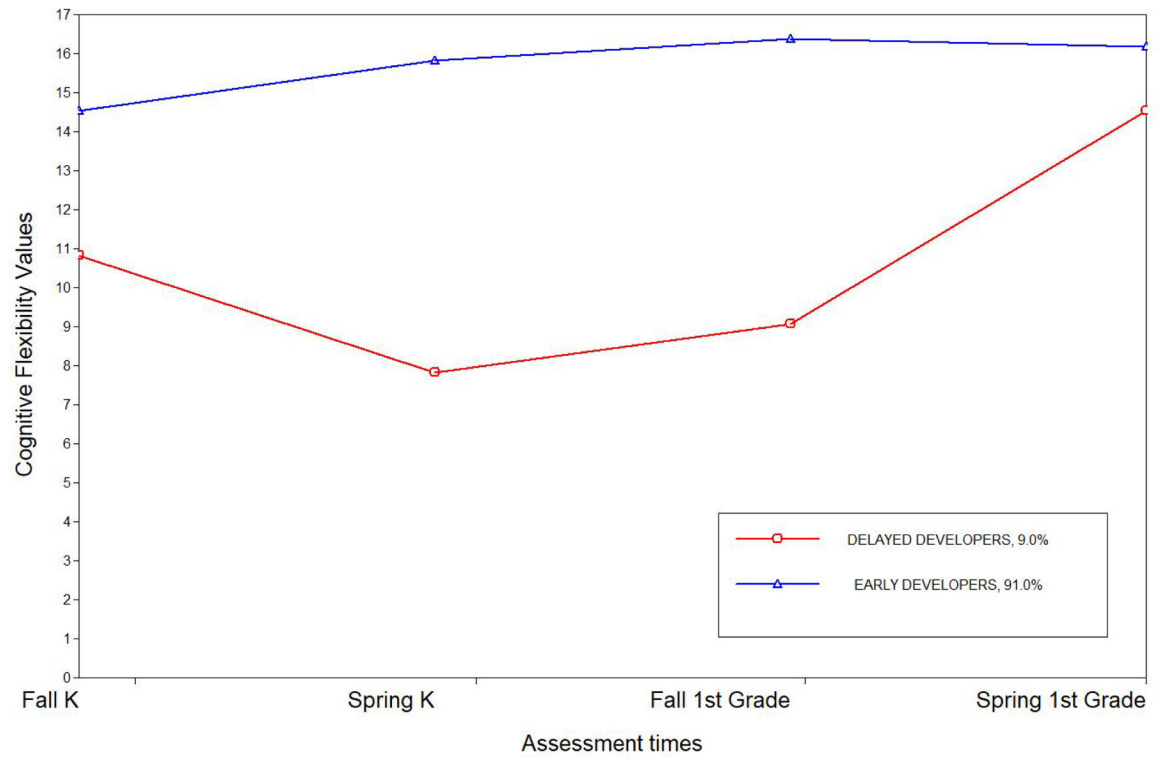
- Jacques S, & Zelazo PD (2005). On the possible roots of cognitive flexibility. In Homer BD & Tamis-LeMonda CS (Eds.), *The Development of Social Cognition and Communication* (pp. 53–81). Lawrence Erlbaum Associates Publishers. <https://psycnet.apa.org/record/2005-06810-003>
- Jung T, & Wickrama KAS (2008). An introduction to latent class growth analysis and growth mixture modeling. *Social and Personality Psychology Compass*, 2(1), 302–317. 10.1111/j.1751-9004.2007.00054.x
- Kauten R, & Barry CT (2020). Externalizing Behavior. In Zeigler-Hill V & Shackelford TK (Eds.), *Encyclopedia of Personality and Individual Differences* (pp. 1509–1512). Springer International Publishing. 10.1007/978-3-319-24612-3\_894
- Kertz SJ, Belden AC, Tillman R, & Luby J (2016). Cognitive control deficits in shifting and inhibition in preschool age children are associated with increased depression and anxiety over 7.5 years of development. *Journal of Abnormal Child Psychology*, 44(6), 1185–1196. 10.1007/s10802-015-0101-0 [PubMed: 26607383]
- Kiesel A, Steinhauser M, Wendt M, Falkenstein M, Jost K, Philipp AM, & Koch I (2010). Control and interference in task switching—a review. *Psychological Bulletin*, 136(5), 849–874. 10.1037/a0019842 [PubMed: 20804238]
- Kloo D, & Perner J (2005). Disentangling dimensions in the dimensional change card-sorting task. *Developmental Science*, 8(1), 44–56. 10.1111/j.1467-7687.2005.00392.x [PubMed: 15647066]
- Kloo D, Perner J, Aichhorn M, & Schmidhuber N (2010). Perspective taking and cognitive flexibility in the Dimensional Change Card Sorting (DCCS) task. *Cognitive Development*, 25(3), 208–217.
- Koster EHW, De Lissnyder E, Derakshan N, & De Raedt R (2011). Understanding depressive rumination from a cognitive science perspective: The impaired disengagement hypothesis. *Clinical Psychology Review*, 31(1), 138–145. 10.1016/j.cpr.2010.08.005 [PubMed: 20817334]
- Lam CB, Lam CS, & Chung KKH (2022). Linking maternal involvement in child online learning to child adjustment during the COVID-19 pandemic: The moderating role of maternal mindfulness. *Journal of Social and Personal Relationships*, 39(6), 1759–1767. 10.1177/02654075211066617 [PubMed: 35664682]
- Liu J, Chen X, & Lewis G (2011). Childhood internalizing behaviour: analysis and implications. *Journal of Psychiatric and Mental Health Nursing*, 18(10), 884–894. 10.1111/j.1365-2850.2011.01743.x [PubMed: 22070805]
- Lo Y, Mendell NR, & Rubin DB (2001). Testing the number of components in a normal mixture. *Biometrika*, 88(3), 767–778. 10.1093/biomet/88.3.767
- Mephram KD, & Martinovic B (2017). Multilingualism and out-group acceptance: The mediating roles of cognitive flexibility and deprovincialization. *Journal of Language and Social Psychology*, 37(1), 51–73. 10.1177/0261927X17706944 [PubMed: 30369691]
- Mittal C, V G, Simpson JA, Sung S, & Young ES (2015). Cognitive adaptations to stressful environments: When childhood adversity enhances adult executive function. *Journal of Personality and Social Psychology*, 109, 604–621. [PubMed: 26414842]
- Miyake A, & Friedman NP (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science*, 21, 8–14. [PubMed: 22773897]
- Miyake A, Friedman NP, Emerson MJ, Witzki AH, Howerter A, & Wager TD (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41(1), 49–100. 10.1006/cogp.1999.0734 [PubMed: 10945922]
- Montroy JJ, Bowles RP, Skibbe LE, McClelland MM, & Morrison FJ (2016). The development of self-regulation across early childhood. *Developmental Psychology*, 52(11), 1744–1762. 10.1037/dev0000159 [PubMed: 27709999]
- Morgan PL, Farkas G, Hillemeier MM, Pun WH, & Maczuga S (2019). Kindergarten children’s executive functions predict their second-grade academic achievement and behavior. *Child Development*, 90(5), 1802–1816. 10.1111/cdev.13095 [PubMed: 29884983]
- Moriguchi Y, & Hiraki K (2013). Prefrontal cortex and executive function in young children: a review of NIRS studies. *Front. Hum. Neurosci*(7), 867. <https://doi.org/doi:10.3389/fnhum.2013.00867> [PubMed: 24381551]

- Moriguchi Y, Sakata Y, Ishibashi M, & Ishikawa Y (2015). Teaching others rule-use improves executive function and prefrontal activations in young children [10.3389/fpsyg.2015.00894]. *Frontiers in Psychology*, 6(894), 1–9. <https://www.frontiersin.org/article/10.3389/fpsyg.2015.00894> [PubMed: 25688217]
- Mulas F, Capilla A, Fernández S, Etchepareborda MC, Campo P, Maestú F, Fernández A, Castellanos FX, & Ortiz T (2006). Shifting-Related Brain Magnetic Activity in Attention-Deficit/Hyperactivity Disorder. *Biological Psychiatry*, 59(4), 373–379. [PubMed: 16154541]
- Muthén LK, & Muthén BO (1998–2017). *Mplus User's Guide* (8th ed.). Muthén & Muthén. [https://www.statmodel.com/download/usersguide/MplusUserGuideVer\\_8.pdf](https://www.statmodel.com/download/usersguide/MplusUserGuideVer_8.pdf)
- Nelson TD, James TD, Nelson JM, Tomaso CC, & Espy KA (2022). Executive control throughout elementary school: Factor structure and associations with early childhood executive control. *Developmental Psychology*, 58(4), 730. [PubMed: 35343719]
- Nguyen T, & Duncan GJ (2019). Kindergarten components of executive function and third grade achievement: A national study. *Early Childhood Research Quarterly*, 46(Q1), 49–61. 10.1016/j.ecresq.2018.05.006
- Patwardhan I, Nelson TD, McClelland MM, & Mason WA (2021). Childhood cognitive flexibility and externalizing and internalizing behavior problems: Examination of prospective bidirectional associations. *Research on Child and Adolescent Psychopathology*, 49, 413–427. 10.1007/s10802-020-00757-x [PubMed: 33404943]
- Pauli-Pott U, & Becker K (2011). Neuropsychological basic deficits in preschoolers at risk for ADHD: A meta-analysis. *Clinical Psychology Review*, 31(4), 626–637. <https://doi.org/10.1016/j.cpr.2011.02.005> [PubMed: 21482321]
- Pinsonneault M, Parent S, Castellanos Ryan N, & Séguin J (2015). Low intelligence and poor executive function as risk factors for externalizing spectrum disorders. In Beauchaine TP & Hinshaw S (Eds.), *The Oxford Handbook of Externalizing Spectrum Disorders* (pp. 375–400). Oxford University Press. 10.1093/oxfordhb/9780199324675.013.14
- Quiñones-Camacho LE, Fishburn FA, Camach MC, Wakschlag LS, & Perlman SB (2019). Cognitive flexibility-related prefrontal activation in preschoolers: A biological approach to temperamental effortful control. *Developmental Cognitive Neuroscience*, 38.
- Raaijmakers MAJ, Smidts DP, Sergeant JA, Maassen GH, Posthumus JA, van Engeland H, & Matthys W (2008). Executive functions in preschool children with aggressive behavior: Impairments in inhibitory control. *Journal of Abnormal Child Psychology*, 36(7), 1097–1107. 10.1007/s10802-008-9235-7 [PubMed: 18437548]
- Reid JL, & Ready DD (2022). Heterogeneity in the development of executive function: Evidence from nationally representative data. *Early Education and Development*, 33(2), 243–267. <https://doi.org/10.1080/10409289.2020.1866949>
- Rimm-Kaufman SE, Pianta RC, & Cox MJ (2000). Teachers' judgments of problems in the transition to kindergarten. *Early Childhood Research Quarterly*, 15(2), 147–166. 10.1016/S0885-2006(00)00049-1
- Romero-López M, Pichardo M-C, Ingoglia S, & Justicia F (2018). The role of executive function in social competence and behavioural problems in childhood education. *Anales de Psicología / Annals of Psychology*, 34(3), 490–499. 10.6018/analesps.34.3.307391
- Schlueter E, Davidov E, & Schmidt P (2017). Applying autoregressive cross-lagged and latent growth curve models to a three-wave panel study. 315–336.
- Schoemaker K, Mulder H, Deković M, & Matthys W (2013). Executive functions in preschool children with externalizing behavior problems: A meta-analysis. *Journal of Abnormal Child Psychology*, 41(3), 457–471. 10.1007/s10802-012-9684-x [PubMed: 23054130]
- Shallice T, Broadbent DE, & Weiskrantz L (1982). Specific impairments of planning. *Philosophical Transactions of the Royal Society of London. B, Biological Sciences*, 298(1089), 199–209. 10.1098/rstb.1982.0082 [PubMed: 6125971]
- Spiegler O, & Leyendecker B (2017). Balanced cultural identities promote cognitive flexibility among immigrant children. *Frontiers in Psychology*, 8(1579). 10.3389/fpsyg.2017.01579

- Stange JP, Alloy LB, & Fresco DM (2017). Inflexibility as a vulnerability to depression: A systematic qualitative review. *Clinical Psychology: Science and Practice*, 24(3), 245–276. 10.1111/cpsp.12201 [PubMed: 29038622]
- Toplak M, West RF, & Stanovich KE (2013). Practitioners review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 54(2), 131–143. [PubMed: 23057693]
- Tourangeau K, Nord C, Lê T, Sorongon AG, Hagedorn MC, Daly P, & Narjarian M (2015). Kindergarten data file and electronic codebook: Public version. National Center for Education Statistics.
- Tremblay RE (2000). The development of aggressive behaviour during childhood: What have we learned in the past century? *International Journal of Behavioral Development*, 24(2), 129–141. 10.1080/016502500383232
- Uddin LQ (2021). Cognitive and behavioural flexibility: Neural mechanisms and clinical considerations. *Nature Reviews Neuroscience*, 22(3), 167–179. [PubMed: 33536614]
- van Bers BMCW, Visser I, & Raijmakers M (2014). Preschoolers learn to switch with causally related feedback. *Journal of Experimental Child Psychology*, 126, 91–102. 10.1016/j.jecp.2014.03.007 [PubMed: 24892884]
- Visu-Petra L, & Marcus O (2019). Cognitive (in)flexibility: potential risk factor for internalizing psychopathology across development? In Buchwald P, Moore KA, Kaniasty K, & Arenas-Landgrave P (Eds.), *Stress and Anxiety - Contributors of the STAR Award Winners* (pp. 125–136). Logos Verlag Berlin.
- Wager TD, Jonides J, & Reading S (2004). Neuroimaging studies of shifting attention: a meta-analysis. *NeuroImage*, 22(4), 1679–1693. 10.1016/j.neuroimage.2004.03.052 [PubMed: 15275924]
- Wiebe SA, Sheffield T, Nelson JM, Clark CAC, Chevalier N, & Espy KA (2011). The structure of executive function in 3-year-olds. *Journal of Experimental Child Psychology*, 108(3), 436–452. 10.1016/j.jecp.2010.08.008 [PubMed: 20884004]
- Willoughby MT, Magnus B, Vernon-Feagans L, & Blair CB (2017). Developmental Delays in Executive Function from 3 to 5 Years of Age Predict Kindergarten Academic Readiness. *Journal of Learning Disabilities*, 50(4), 359–372. 10.1177/0022219415619754 [PubMed: 26755570]
- Willoughby MT, R.J. W, & C.B. B (2011). Contributions of modern measurement theory to measuring executive function in early childhood: An empirical demonstration. *Journal of Experimental Child Psychology*, 108(3), 414–435. [PubMed: 20553690]
- Zelazo PD (2006). The Dimensional Change Card Sort (DCCS): A method of assessing executive function in children. *Nature Protocols*, 1(1), 297–301. 10.1038/nprot.2006.46 [PubMed: 17406248]
- Zelazo PD, Anderson JE, Richler J, Wallner-Allen K, Beaumont JL, & Weintraub S (2013). II. NIH Toolbox Cognition Battery (CB): Measuring executive function and attention. *Monographs of the Society for Research in Child Development*, 78(4), 16–33. 10.1111/mono.12032 [PubMed: 23952200]
- Zelazo PD, Jacques S, Burack J, & Frye D (2002). The relation between theory of mind and rule use: evidence from persons with autism-spectrum disorders. *Inf. Child Dev. (Special Issue: Executive functions and development)*, 11, 171–195.
- Zeytinoglu S, Calkins SD, & Leerkes EM (2018). Maternal emotional support but not cognitive support during problem-solving predicts increases in cognitive flexibility in early childhood. *International Journal of Behavioral Development*, 43(1), 12–23. 10.1177/0165025418757706 [PubMed: 31036983]
- Zhou Q, Hofer C, Eisenberg N, Reiser M, Spinard TL, & Fabes RA (2007). The developmental trajectories of attention focusing, attentional and behavioral persistence, and externalizing problems during school-age years. *Developmental Psychology*, 43(2), 369. [PubMed: 17352545]

**Public Significance Statement**

The current study suggests that a small group of children that we characterized as delayed developers, who started kindergarten with lower cognitive flexibility abilities, had higher levels of internalizing and externalizing behavior problems in the second grade, compared to early developers, despite their improvements in cognitive flexibility throughout kindergarten and the first grade, and after controlling for socio-demographic covariates. The findings from our study expand existing research by conducting a rigorous test of the role that developmental trajectories of cognitive flexibility play in potentially increasing risk for internalizing and externalizing psychopathology.



**Figure 1.**  
Two-Class Solution For Development Of Cognitive Flexibility

Table 1

Descriptive Statistics And Correlations Of Analytic Variables

|                      | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       | 10     | 11    |
|----------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|-------|
| 1 CF Fall K          |         |         |         |         |         |         |         |         |         |        |       |
| 2 CF Spring K        | .309**  |         |         |         |         |         |         |         |         |        |       |
| 3 CF Fall G1         | .258**  | .316**  |         |         |         |         |         |         |         |        |       |
| 4 CF Spring G1       | .255**  | .276**  | .329**  |         |         |         |         |         |         |        |       |
| 5 Int. Problems G2   | -.086** | -.078** | -.082** | -.078** |         |         |         |         |         |        |       |
| 6 Ext. Problems G2   | -.070** | -.081** | -.083** | -.085** | .321**  |         |         |         |         |        |       |
| 7 Child Age (months) | .103**  | .049**  | .053**  | .047**  | .010    | .0015   |         |         |         |        |       |
| 8 Mom's Education    | .174**  | .161**  | .168**  | .168**  | -.091** | -.071** | -.021*  |         |         |        |       |
| 9 Family Income      | .174**  | .157**  | .167**  | .165**  | -.115** | -.129** | -.010   | .570**  |         |        |       |
| 10 Male              | -.046** | -.058** | -.047** | -.043** | .052**  | .219**  | .067**  | -.007   | 0.000   |        |       |
| 11 Spanish Speaking  | -.135** | -.106** | -.122** | -.094** | -.030** | -.054** | -.056** | -.330** | -.282** | -0.003 | 1     |
| Mean/ %              | 14.20   | 15.18   | 15.73   | 16.06   | 1.58    | 1.71    | 67.45   | 4.63    | 10.60   | 51.20% | 9.80% |
| SD                   | 3.33    | 2.79    | 2.39    | 2.32    | 0.52    | 0.61    | 4.48    | 1.89    | 5.59    |        |       |
| Range                | 0-18    | 0-18    | 0-18    | 0-18    | 1-4     | 1-4     | 45-94   | 1-8     | 1-18    | 0-1    | 0-1   |
| Valid N              | 15603   | 15128   | 4490    | 13199   | 11048   | 11111   | 15747   | 14213   | 11880   | 15790  | 15754 |

Note.

\*  $p < .05$ ;

\*\*  $p < .01$ ; CF = Cognitive Flexibility; Int. = Internalizing; Ext. = Externalizing

Table 2

Model Fit Indices for Latent Classes of Cognitive Flexibility

| Number of Classes | Log-likelihood | AIC    | SSA-BIC | VLMR-LRT p-value | Adjusted LMR-LRT p-value | Entropy |
|-------------------|----------------|--------|---------|------------------|--------------------------|---------|
| Quadratic LCGA    |                |        |         |                  |                          |         |
| 1                 | -118532        | 237077 | 237109  | n/a              | n/a                      | n/a     |
| 2                 | -111016        | 222054 | 222104  | 0                | 0                        | 0.984   |
| 3                 | -109097        | 218224 | 218292  | 0.096            | 0.100                    | 0.969   |

Note. AIC - Akaike Information Criterion, SSA-BIC - Sample-Size Adjusted Bayesian Information Criterion, LRT-Likelihood Ratio Test

Table 3

Model Fit Indices for Growth Mixture Models of Cognitive Flexibility

| Models                     | Test of -2ALL Difference |                    |            |                 |                         |                     |         | Model Fit Indices |        |        |           |         |
|----------------------------|--------------------------|--------------------|------------|-----------------|-------------------------|---------------------|---------|-------------------|--------|--------|-----------|---------|
|                            | Model H0 LL              | H0 LL Scale Factor | # Free Par | Diff in LL*(-2) | Diff Scaling Correction | Scaled Diff in -2LL | DF Diff | Exact P-Value     | AIC    | BIC    | SSA - BIC | Entropy |
| Two-class quadratic LCGA   | -111016                  | 6.17               | 11         |                 |                         |                     |         |                   | 222054 | 222139 | 222104    | 0.98    |
| Free intercept variance    | -112002                  | 5.29               | 13         | 1971            | 0.44                    | 4494                | 2       | 0.00              | 224029 | 224129 | 224088    | 0.97    |
| Free linear slope variance | -112331                  | 5.68               | 13         | 2630            | 3.03                    | 869                 | 2       | 0.00              | 224688 | 224788 | 224747    | 0.97    |

**Table 4**  
Parameter Estimates of Two-Class Latent Growth Mixture Model for Cognitive Flexibility

|                                                                         | Early developers (91.05%) |      | Delayed developers (8.95%) |      | χ <sup>2</sup> |
|-------------------------------------------------------------------------|---------------------------|------|----------------------------|------|----------------|
|                                                                         | Est                       | SE   | Est                        | SE   |                |
| <u>Fixed Effects</u>                                                    |                           |      |                            |      |                |
| Intercept                                                               | 14.53***                  | 0.05 | 10.82***                   | 0.22 |                |
| Linear                                                                  | 1.67***                   | 0.06 | -5.10***                   | 0.38 |                |
| Quadratic                                                               | -0.38***                  | 0.02 | 2.11***                    | 0.11 |                |
| <u>Variance Domains</u>                                                 |                           |      |                            |      |                |
| Intercept Variance                                                      | 0                         | 0    | 0                          | 0    |                |
| Random Linear Time Slope Var                                            | 0.17***                   | 0.01 | 1.18***                    | 0.12 |                |
| Random Quadratic Time Slope Var                                         | 0                         | 0    | 0                          | 0    |                |
| <u>Residual variances</u>                                               |                           |      |                            |      |                |
| Residual Variance T1                                                    | 10.46***                  | 0.32 | 10.46***                   | 0.32 |                |
| Residual Variance T2                                                    | 2.09***                   | 0.06 | 2.09***                    | 0.06 |                |
| Residual Variance T3                                                    | 5.65***                   | 0.48 | 5.65***                    | 0.48 |                |
| Residual Variance T4                                                    | 3.03***                   | 0.21 | 3.03***                    | 0.21 |                |
| <u>Equality Tests Of Means Among Latent Classes Using BCH Procedure</u> |                           |      |                            |      |                |
| Externalizing Problems                                                  | 1.70                      | 0.01 | 1.86                       | 0.03 | 24.48***       |
| Internalizing Problems                                                  | 1.58                      | 0.01 | 1.70                       | 0.02 | 24.84***       |

Note.

\*\*\*  
p<0.001

Table 5

Results of The Linear Regression Models Predicting Child Externalizing and Internalizing Behavior Problems in the Spring of the Second Grade After Accounting For Latent Class Membership And Background Covariates

|                    | Externalizing Problems, N = 8789 |        |        |            |       |            | Internalizing Problems, N = 8745 |       |       |            |       |            |
|--------------------|----------------------------------|--------|--------|------------|-------|------------|----------------------------------|-------|-------|------------|-------|------------|
|                    | B                                | LL     | UL     | 95% CI (B) | β     | 95% CI (β) | B                                | LL    | UL    | 95% CI (B) | β     | 95% CI (β) |
| Intercept          | 1.79**                           | 1.49   | 2.10   | 2.91       | 2.40  | 3.43       | 1.70**                           | 1.52  | 1.92  | 3.26       | 2.88  | 3.71       |
| Delayed Developers | 0.11**                           | 0.05   | 0.17   | 0.05       | 0.02  | 0.07       | 0.11**                           | 0.05  | 0.16  | 0.06       | 0.03  | 0.08       |
| Child's Age        | 0                                | -0.01  | 0.01   | 0.00       | -0.04 | 0.03       | 0                                | 0.00  | 0.00  | 0.00       | -0.02 | 0.03       |
| Male               | 0.27**                           | 0.24   | 0.30   | 0.22       | 0.19  | 0.24       | 0.04**                           | 0.02  | 0.06  | 0.04       | 0.02  | 0.06       |
| Spanish Speaking   | -0.19**                          | -0.24  | -0.15  | -0.10      | -0.12 | -0.07      | -0.15**                          | -0.20 | -0.10 | -0.09      | -0.12 | -0.06      |
| Mom's Education    | -0.01                            | -0.02  | 0.01   | -0.02      | -0.06 | 0.02       | -0.02**                          | -0.03 | -0.01 | -0.06      | -0.10 | -0.02      |
| Family Income      | -0.02**                          | -0.019 | -0.014 | -0.15      | -0.17 | -0.13      | -0.01**                          | -0.01 | -0.01 | -0.10      | -0.13 | -0.07      |
| Residual variance  | 0.35**                           | 0.33   | 0.366  | 0.92       | 0.91  | 0.94       | 0.27**                           | 0.25  | 0.28  | 0.98       | 0.97  | 0.99       |

Note.

\* p<.05;  
\*\* p<.01.