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Bidirectional associations between executive function and social behavior across childhood: A registered report using a nationally representative sample

Blake Glatley
University of Michigan

Andrew Ribner
Chatham University

Sammy F. Ahmed
University of Rhode Island

Executive function (EF) refers to a set of cognitive skills involved in deliberate, goal-oriented behavior. Although research has established links between children's EF and aspects of their social skills, it remains unclear how EF skills are related to specific social behaviors, such as prosociality and social aggression. Additionally, the co-development of EF and social behavior during childhood is less understood. Therefore, the current registered report aimed to examine bidirectional associations between two EF skills - working memory and cognitive flexibility - and children's prosocial behavior and social aggression using the Early Childhood Longitudinal Study - Kindergarten Class of 2010-11 (ECLS-K:2011; N = 18,174). Based on Sameroff's Transactional Model of Human Development, we expected that EF and social behavior would be bidirectionally related from third-to-fifth grade (8 to 11 years old). We hypothesized that both working memory and cognitive flexibility would be positively associated with later prosocial behavior and negatively associated with later social aggression. Furthermore, we hypothesized that prosocial behavior would be positively associated with later EF skills and that social aggression would be negatively associated with later EF skills. Our results indicated that, at the between-person level, EF skills were positively associated with prosocial behavior and only working memory was negatively associated with social aggression. At the within-person level, we found no bidirectional associations between EF skills and social behaviors. However, we observed a small number of concurrent correlations between EF skills and social behaviors, along with a limited set of cross-lagged associations. Findings are discussed in the context of children's social development.

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Bidirectional associations between executive function and social behavior across childhood: A registered report using a nationally representative sample.

Blake Glatley*

University of Michigan

Andrew D. Ribner

Chatham University

Sammy F. Ahmed

University of Rhode Island

*Corresponding Author: glatley@umich.edu

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Abstract

Executive function (EF) refers to a set of cognitive skills involved in deliberate, goal-oriented behavior. Although research has established links between children's EF and aspects of their social skills, it remains unclear how EF skills are related to specific social behaviors, such as prosociality and social aggression. Additionally, the co-development of EF and social behavior during childhood is less understood. Therefore, the current registered report aimed to examine bidirectional associations between two EF skills - working memory and cognitive flexibility - and children's prosocial behavior and social aggression using the Early Childhood Longitudinal Study - Kindergarten Class of 2010-11 (ECLS-K:2011; N = 18,174). Based on Sameroff's Transactional Model of Human Development, we expected that EF and social behavior would be bidirectionally related from third-to-fifth grade (8 to 11 years old). We hypothesized that both working memory and cognitive flexibility would be positively associated with later prosocial behavior and negatively associated with later social aggression. Furthermore, we hypothesized that prosocial behavior would be positively associated with later EF skills and that social aggression would be negatively associated with later EF skills. Our results indicated that, at the between-person level, EF skills were positively associated with prosocial behavior and only working memory was negatively associated with social aggression. At the within-person level, we found no bidirectional associations between EF skills and social behaviors. However, we observed a small number of concurrent correlations between EF skills and social behaviors, along with a limited set of cross-lagged associations. Findings are discussed in the context of children's social development.

Keywords: Executive function, Working memory, Cognitive flexibility, Social behavior, Social aggression, Prosocial behavior, Bullying, Early childhood

Public Significance Statement: This study explores bidirectional associations between children's cognitive skills (executive functions) and subsequent social behaviors (prosociality and aggression) using longitudinal data from a nationally representative sample of U.S. children.

Bidirectional associations between executive function and social behavior across childhood: A registered report using a nationally representative sample.

Research across multiple disciplines has demonstrated the importance of executive function (EF) skills – including working memory, cognitive flexibility, and response inhibition – for children's social development (Ben-Asher et al., 2023; Moriguchi, 2014; Zhang & Peng, 2023). EF skills have been shown to influence parent-child (e.g., Lewis & Carpendale, 2009) as well as parent-teacher interactions (e.g., Berry, 2012), yet less research has focused on how EF skills might shape children's interactions with their peers. Indeed, research has shown that children with greater EF skills experience fewer problems with their peers and are less likely to use aggression to solve conflict (Holmes et al., 2016; O'Toole et al., 2017). However, several important questions regarding the link between EF and social behavior remain unanswered.

First, there is some evidence to suggest that specific EF skills, such as working memory and cognitive flexibility, are differentially related to children's social behavior, including prosocial behavior and social aggression (O'Toole et al., 2017). However, few studies have examined associations between separate EF skills and specific social behaviors. Additionally, the co-development of EF skills and social behaviors during late childhood and early adolescence - a period of rapid social and cognitive growth - is not well understood (Best et al., 2010, 2011). This gap has prompted calls for research focused on this developmental stage, emphasizing the need for further exploration of these trends (Chaku & Davis-Kean, 2024). Finally, only one study to date has used a nationally representative sample to examine the co-development of EF and broad social skills (i.e., self-control, interpersonal skills, internalizing & externalizing problem behaviors; Zhang & Peng, 2023), but none have focused specifically on prosocial behavior and social aggression. Therefore, the current study examines bidirectional associations between two

EF skills, working memory and cognitive flexibility, and children's prosocial behavior and social aggression from third-to-fifth grade (8 to 11 years old) using the Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011; N = 18,174).

Defining Executive Function

Executive function refers to a set of cognitive skills involved in deliberate, goal-oriented behavior and has been linked to academic and psychosocial functioning across the lifespan (Diamond, 2013). Although some scholars consider a wide range of cognitive processes as a part of the overarching EF construct, most agree that EF comprises three core skills: working memory, cognitive flexibility, and inhibition (Miyake et al., 2000; Diamond, 2013). Working memory refers to the ability to mentally store, manipulate, and retrieve sensory information while updating mental representations (Baddeley, 2003; Baddeley & Hitch, 1974). Cognitive flexibility, sometimes referred to as attention shifting, is the ability to change perspectives, adapt to changing demands or priorities, and involves shifting between multiple tasks, operations, or mental states (Monsell, 1996; Salthouse et al., 1998). The third core EF skill is inhibition which includes inhibitory control and attention control (Diamond, 2013; Posner & DiGirolamo, 1998). Inhibitory control refers to the ability to deliberately suppress automatic responses to environmental stimuli, enabling individuals to control impulses when faced with competing cognitive and behavioral options. Attention control is the ability to ignore distractions and concentrate on stimuli of interest (Cragg, 2016; Munakata et al., 2011).

Although considered distinguishable processes, EF skills work together to facilitate higher-order cognitive functions such as learning, planning, and problem solving (Zelazo, 2015). EF continues to develop into adulthood, however, its early development has been linked to a wide range of important outcomes, including concurrent and future academic achievement

(Ahmed et al., 2019; Waters et al., 2021), social-emotional development (Zhang & Peng, 2023), as well as a host of adult outcomes, including educational attainment, impulse control, and occupational status (Ahmed et al., 2021; Andersson & Bergmen, 2011; McClelland et al., 2013). In recent years, research interest has mounted on the role of EF skills for supporting the development of children's social functioning, especially as it relates to peer interactions and prosocial behavior. However, few studies to date have comprehensively examined associations between children's EF skills and specific social behavior, as opposed to the foundations for social interactions (i.e., moral development, false-belief understanding, & social learning; see Moriguchi, 2014, for review).

Executive Function and Social Behavior

As children enter school, they have greater opportunities for social interaction with non-parental adults and similar aged peers. This new social landscape places demands on children's EF skills. For example, children have to remember the social dynamics of their classroom, account for other children's feelings before they act, control their behavior to align with classroom norms, all of which require EF skills. As a result, EF skills can help children navigate the new social demands of the early school years. Available research suggests that EF skills are broadly related to children's social functioning, and although measurement of EF skills in the existing literature is varied, it is generally the case that greater EF skills are associated with more positive behavioral profiles. For instance, youth with greater composite EF skills experience fewer peer problems and report greater social cognition, which is conceptualized as one's ability to interpret social cues (Ben-Asher et al., 2023; Holmes et al., 2016). Moreover, research suggests that children's discrete EF skills can benefit from sustained social interactions, as they are able to practice the skills necessary to engage appropriately with non-parental adults

and peers (Lecce et al., 2020; Moriguchi, 2014). On the other hand, children who start school with underdeveloped EF skills may struggle to navigate classroom social dynamics, act impulsively without considering their peers' perspectives, and find it challenging to inhibit socially inappropriate behaviors (Lecce et al., 2020; Moriguchi, 2014).

Although this growing body of research provides insight into the relevance of EF skills for social development, few studies have examined the unique contribution of separate EF components to different aspects of social functioning. Only one study to date has examined specific EF skills and their relation to observed social behaviors, in which they found that working memory was significantly associated with children's relational aggression and prosocial behavior (O'Toole et al., 2017). However, this study examined these associations with a relatively small and cross-sectional sample ($N = 107$). Therefore, the current study utilizes a nationally representative sample to understand how specific EF skills (working memory & cognitive flexibility) may differentially relate to children's use of social aggression and prosocial behavior with their classroom peers and how these associations co-develop over time.

Co-development of Executive Function and Social Behavior

EF skills have long been considered foundational for children's social functioning as they allow individuals to regulate their thoughts and actions to facilitate appropriate social behavior (Holmes et al., 2016; Moriguchi, 2014; Morgan & Lilienfeld, 2000). While children's EF skills undergo significant development during early schooling (Ahmed et al., 2022; Best et al., 2011), they also encounter increased interactions with same aged peers and non-kin adults, placing demands on their social and cognitive abilities (Prencipe et al., 2011). Research has shown that children who exhibit lower working memory scores are viewed by their peers as less socially competent, more aggressive (McQuade et al., 2013), and those who score lower on composite

measure of EF are viewed as less desirable social partners overall (Wang & Feng, 2024). Although links between children's measures of individual and composite EF skills and social functioning have been well established (Morgan & Lilienfeld, 2000), little work to date has examined the bidirectional associations between separate EF skills and children's observed social behavior, such as social aggression and prosocial behavior. Although it appears that children's EF skills are broadly important for their social functioning, it remains unclear how sustained social interactions impact their EF development.

As children increasingly interact with peers, their social behavior begins to vary greatly with some children demonstrating more prosocial behavior than others (Girard et al., 2011). Children who engage in more prosocial behavior are more often accepted by their peers whereas young children who act aggressively are disliked by peers (Lease et al., 2002). As such, children's use of prosocial behavior, or lack thereof, is likely to shape their subsequent social experiences. The transactional model of development argues that children continually interact with their environment and through sustained interactions, both the child and environment shape one another over time (e.g., Sameroff, 2009). Using this theoretical framework to understand EF and social development, it can be expected that children who engage with their peers in a prosocial manner may be more widely accepted by their peers, ultimately allowing them greater opportunities for social interaction. As a result, these children may be afforded more social opportunities to refine their cognitive regulation skills, such as EF, needed to appropriately engage with peers. Alternatively, children who engage more aggressively with their peers may face greater rejection, ultimately leading to fewer opportunities to refine EF abilities needed for appropriate social interaction. Previous findings regarding EF skills and peer acceptance have been mixed, with some studies finding small but significant positive associations (Lecce et al.,

2020; Wang & Feng, 2024) whereas other studies find null associations (O'Toole et al., 2017). Given this inconsistency, focusing more closely on children's social behaviors, rather than perceived acceptance, may offer clearer insight into how EF skills relate to children's social experiences.

To date, a handful of studies have examined bidirectional links between children's EF skills and social functioning. For example, using a nationally representative sample of U.S children, Zhang and Peng (2023) reported bidirectional associations between children's latent EF skills and social emotional functioning (i.e., self-control, interpersonal skills, & internalizing/externalizing behaviors). Additionally, in a sample of early adolescents, Ben-Asher and colleagues (2023) demonstrated longitudinal reciprocal relations between adolescents' composite EF skills and social functioning (i.e., social cognition, motivation, awareness, & communication). However, the extent to which separate EF skills and children's use of social aggression and prosocial behavior are reciprocally related to each other over time is less understood.

Current Study

Data from a nationally representative sample of school-age children (Early Childhood Longitudinal Study, Kindergarten Class of 2010-11; ECLS-K 2011) will be used to investigate bidirectional associations between EF skills and social behavior during the early school years. Specifically, we examined associations between children's EF skills (i.e., working memory and cognitive flexibility) and prosocial behavior and social aggression from third to fifth grade (8 to 11 years old) using random-intercepts cross lagged panel modeling (RI-CLPM; Hamaker et al., 2015). The present study has three major goals. The first goal is to replicate associations between EF skills and social behavior reported in previous studies (Ben-Asher et al., 2023; Holmes et al.,

2016; McQuade et al., 2013; O'Toole et al., 2017) using a nationally representative data set. Although previous research has examined longitudinal associations between EF skills and broad social emotional functioning in a nationally representative data set (Zhang & Peng, 2023), no studies have done so specifically with prosocial behavior and social aggression. Additionally, previous research has found that children with greater EF skills tend to exhibit fewer antisocial behaviors and greater interpersonal competence during early and middle childhood (e.g., O'Toole et al., 2017). However, how these constructs are related among older children is less understood. Therefore, the present study will also extend associations between EF and children's social behavior to late childhood and adolescence using a large, nationally representative sample.

The second goal of this study is to examine associations between two separate EF components - working memory and cognitive flexibility - and children's social aggression and prosocial behavior. Based on previous findings, we hypothesize that these specific EF skills would be differentially associated with children's social behavior. Previous research has demonstrated that children with lower scores on working memory assessments were rated by teachers as being less socially competent, more often rejected by peers, and more physically and relationally aggressive (McQuade et al., 2013). Further, some evidence has suggested that greater working memory is associated with more prosocial behaviors (O'Toole et al., 2017). Based on this research, we expect children's working memory will be positively associated with prosocial behavior and negatively associated with socially aggressive behavior. Although previous evidence is sparse, we expect a similar pattern of association to emerge for cognitive flexibility based on previous research using other EF skills and social behavior (e.g., working memory; Ciairano et al., 2006; McQuade et al., 2013; O'Toole et al., 2017). Additionally, cognitive flexibility involves the ability to flexibly adapt to shifting demands or priorities, which could

help children adjust their behavior in challenging social settings, facilitate perspective taking, and lead to greater social understanding (Bock et al., 2015). Therefore, we hypothesize that cognitive flexibility will be positively associated with prosocial behavior and negatively associated with socially aggressive behavior.

The third and final goal of the current study is to understand how EF skills and social behaviors co-develop over time. To date, only two studies have examined cross-lagged associations between children's EF skills and social behaviors. In their 2020 article, Lecce and colleagues found only unidirectional associations, with peer acceptance positively predicting subsequent working memory (and not vice-versa), ultimately suggesting more opportunities to interact with peers might be promotive of children's working memory development. Furthermore, Ben-Asher et al. (2023) found that EF skills were bidirectionally associated with social functioning during adolescence. Together, these findings suggest that EF skills and social behavior co-develop across childhood and adolescence and that children with greater social competence can experience greater opportunities for socialization, which can further support their EF development (Lecce et al., 2020). As such we expect that bidirectional associations will emerge between children's social behaviors (i.e., prosocial behavior and social aggression) and EF skills (i.e., working memory and cognitive flexibility). Specifically, we hypothesize that both working memory and cognitive flexibility will be positively associated with later prosocial behavior and negatively associated with later social aggression. Furthermore, based on the transactional model of development (Sameroff, 2009), as well as empirical research demonstrating that social skills prospectively predict children's EF skills, we hypothesize that prosocial behavior will be positively associated with later EF skills and that social aggression will be negatively associated with later EF skills.

Method

Participants

The Early Childhood Longitudinal Study, Kindergarten Class of 2010–2011 (ECLS-K:2011; N = 18,174) was used to examine bidirectional associations between EF and social behavior. The ECLS-K is a prospective longitudinal study sponsored by the National Center for Education Statistics (NCES) within the Institute of Education Sciences of the U.S. Department of Education. Participants included a nationally representative sample of public and private school students, their teachers, schools, care providers, and families (Tourangeau et al., 2015). The present study will examine a sample of children who were tested during the spring of third (Mage = 109.0 months old), spring of fourth (Mage = 120.9 months old), and spring of fifth grade (Mage = 133.0 months old), when children's social behavior was measured.

Participants in the ECLS-K:2011 come from diverse racial/ethnic backgrounds: 46.7% non-Hispanic White, 23.1% Hispanic, 13.2% African American, 8.5% Asian, 1.5% American Indian/Alaska Native or Native Hawaiian/Pacific Islander, and 4.6% two or more races. Children were split roughly equally with respect to sex (49% female). Eighty-seven percent of students in this sample attended public school and 8.6% were enrolled in private school at the beginning of third grade (8 to 9 years old). Approximately 8% of children had an individualized instruction program (IEP), and 18.5% of children came from homes where English was not the primary language spoken. Sampling weights provided by NCES ensured that the final sample was representative of the U.S. population of students during the 2010–2011 school year (Tourangeau et al., 2017). Since the ECLS-K is a publicly available and de-identified data set, the present study was considered exempt from human subjects research approval by the Institutional Review Board at [Blinded] [IRB # 2139620-1].

Measures

Cognitive Flexibility

Cognitive flexibility was assessed using the Dimensional Change Card Sort (DCCS). Children are asked to sort a series of pictures by color, and then again by shape, assessing children's ability to flexibly shift between different task rules (Zelazo, 2006). Notably, the ECLS-K:2011 administers two different versions of the DCCS: a physical version during kindergarten and first grade (children are ~7 years old) and a more difficult computerized version beginning in the fall of second grade (children are ~8 years old). The computerized version, used in the present study, intermixes sorting rules, with one rule appearing more frequently to establish a response tendency. Scores were calculated as a measure of both accuracy and reaction times from trials where children were presented with the less common sorting rule using an algorithm derived in the NIH Toolbox (Slotkin et al., 2012; Zelazo et al., 2013). Scores range from 0 to 10 and weight is given to accuracy (0 to 5 units) and reaction time (0 to 5 units) when being computed. Accuracy is prioritized, with children achieving 80% accuracy or less having their overall score calculated solely based on their accuracy. If the child's accuracy rate is above 80%, the computed score is based on a combination of accuracy and reaction time. The DCCS demonstrates excellent test–retest reliability (Intraclass correlation [ICC] = .92) and temporal stability, indicating high construct stability over time (Zelazo et al., 2013). Studies have validated the DCCS, demonstrating high convergence with tests of fluid reasoning, as well as discriminant validity to measures of receptive vocabulary across childhood and into adolescence (Zelazo et al., 2013). This study utilizes DCCS scores collected in the spring of third, fourth, and fifth grade (ages 8–11).

Working Memory

The Numbers Reversed subtest of the Woodcock Johnson Tests of Achievement (WJ-NR) measures working memory. Children are presented with lists of numbers and asked to repeat the numbers back in reverse order (Mather & Schank, 2001). Students begin with five two-number sequences; if a student incorrectly repeats three consecutive two-number sequences, the assessment is discontinued. In each subsequent round, the sequences increase by one digit, up to a maximum of eight-number sequences. In each round, the discontinue rule of three consecutive incorrect answers applies; otherwise the assessment continues until a student completes all number sequences. Scores were recorded into W scores. W score metrics are on an equal-interval scale and allow for direct comparison of the achievement of one student against another and are appropriate for longitudinal analysis as they are sensitive to change over time (Mather & Jaffe, 2016; Woodcock et al., 2001). The Numbers Reversed task demonstrates high split-half reliability (a = .84 to .93), is associated with commonly used working memory measures [for example, r = .64 with Stanford-Binet Intelligence Scale, Fourth Edition (SB-IV; Thorndike et al., 1986)], and is predictive of measures of academic achievement (Morgan et al., 2019). The current study uses scores collected in the spring of third, fourth and fifth grade (ages 9-11).

Prosocial Behavior

Teachers reported on their perceptions of children's prosocial behavior using 5 items adapted from the Child Behavior Scale (CBS; Ladd & Profilet, 1996). Teachers indicated the degree to which they perceived each child in their classroom exhibiting prosocial behaviors with peers. Teachers responded on a 3-point Likert scale (1 = doesn't apply (child seldom displays the behavior) to 3 = certainly applies (child often displays the behavior)) to items such as "This child is kind towards peers" and "This child is cooperative with peers" (Valeski, 2000). The Prosocial subscale of the CBS demonstrates strong reliability (a = .91 to .92) and temporal stability from

the fall to spring of an academic year (r = .62 to .65; Ladd & Profilet, 1996). This study utilizes teacher-reported scores from children's third, fourth, and fifth grade classrooms (ages 8–11).

Social Aggression

Teachers reported on their perceptions of children's use of victimizing behavior towards their peers using 4 items adapted from a 21-item scale by Espelage and Holt (2001). Victimizing behavior is chronic or frequent use of aggression towards peers over time (Bukowski & Sippola, 2001), therefore we conceptualize this outcome as social aggression to align with terminology used in previous research in this area (McQuade et al., 2013; O'Toole et al., 2017). Teachers indicated the frequency with which each child in their classroom victimized peers in the past month on questions such as "[Student] teased other students" and "[Student] spread rumors about others". Response options include "Never," "1 or 2 times," "3 or 4 times," "5 or 6 times," and "7 or more times.". These items have demonstrated high reliability (a = .87; Espelage & Holt, 2001). The current study uses teacher-reported scores from children's third, fourth, and fifth grade classrooms (ages 8-11).

Covariates

Information about children's and families' demographic characteristics were gathered from interviews and parent and teacher questionnaires. Demographic data concerning children's biological sex, age, primary language spoken, parent/guardian education, income, and occupation were collected from parents during kindergarten interviews. The socioeconomic status (SES) of child's family was treated as a composite score consisting of (1) female guardian's education level; (2) male guardian's education level; (3) female guardian's occupation; (4) male guardian's occupation; and (5) total household income ranging from -3.00 to 3.00, with larger values representing higher incomes. Children's race and ethnicity was collected via parent

surveys and coded as White, non-Hispanic; Black, non-Hispanic; Hispanic; Asian; or Other. Disability status was measured using children's individualized education program (IEP), reported by special education teachers during the spring of second grade (Tourangeau et al., 2015). Children's language ability was measured using scores on a ECLS-K developed language screener administered during the spring of first grade.

Data Analysis

To establish our constructs and their consistency of measurement over time, we test the longitudinal measurement invariance of teacher-reported prosocial behavior and social aggression scales across the three time points. We will first test two separate latent variable models using a confirmatory factor analysis (CFA) with all items in each the prosocial and aggressive behavior scale in the third grade wave. Model fit will then be examined using the Chi-Square Test of Model Fit, Comparative Fit Index (CFI) > .90, Tucker Lewis Index (TLI) > .90, Root Mean Square Error of Approximation (RMSEA) < .08 (Brown, 2015). In the event of a model that does not adequately fit the data, modification indices will be examined. Once a well-fitting latent model for each construct is established in third grade, we will test measurement invariance. Following recommendations by Putnick and Bornstein (2016), we conduct a series of increasingly restrictive CFAs using the [CONFIGURAL METRIC SCALAR] option in Mplus to test whether the same model structure fits the data adequately at each 3rd, 4th, and 5th grade. Non-invariance will be determined based on relative model fit indicators and a significant chi-square difference test (indicating that fixing model parameters worsened model fit).

Once well-fitting and consistent latent variables are established, we will examine bidirectional associations between children's EF skills and social behavior using a random

intercepts, cross-lagged panel model (RI-CLPM; Hamaker et al., 2015). Unlike the standard cross-lagged panel model, RI-CLPM allows for the examination of autoregressive and cross-lagged regression parameters, as well as the isolation of stable, between-person variance from time-varying, within-person variance. The random intercept permits time-invariant construct stability, allowing the examination of cross-lagged associations at the within-person level (Hamaker et al., 2015). The first step of the RI-CLPM consists of extracting between-person factors from the repeated measures of cognitive flexibility, working memory, and social behavior by generating random intercepts and allowing them to covary. Step two consists of estimating autoregressive (i.e., within-person carry-over effect) as well as cross-lagged paths (i.e., reciprocal associations) at the within-person centered factors, while covarying the within-person components (and innovation residuals) of cognitive flexibility, working memory, and social behavior at the first wave (Hamaker et al., 2015). After estimating these unconditional models, we will include demographic and child-level covariates (i.e., sex, age, SES, race/ethnicity, IEP status, non-English home language, and language ability) as predictors of the mean-centered within-person factors (Mulder & Hamaker, 2021). The RI-CLPM conceptual models for EF and prosocial behavior and social aggression are included in the supplementary materials as figures S1 and S2, respectively. These social behavior outcomes are modeled separately as prosocial behavior and social aggression have historically been conceptualized as independent constructs that represent distinct characteristics of an individual's behavior (Eron & Huesmann, 1984; Kokko et al., 2006). All analyses were conducted in MPlus (Muthen & Muthen, v.8.11).

Sampling Weights

A population sampling weight designed by the National Center for Educational Statistics (NCES) will be applied to the analyses to make the data representative of all children enrolled in kindergarten in the United States during the 2010-11 school year. This population sampling weight also adjusts for differential nonresponse patterns that can lead to biased regression estimates (Tourangeau et al., 2017). Specifically, we will apply sampling weight W9C79P_9T790, which will make our analytic sample representative of the U.S. population and will adjust for differential nonresponse for child-and-teacher level assessments during third, fourth, and fifth grade, as well as parent questionnaire data from fall and spring of kindergarten (Tourangeau et al., 2017).

Transparency and Openness

The full ECLS-K data set is openly available at https://nces.ed.gov/ecls/dataproducts.asp. The present study is a registered report, as such, its design and analyses were not pre-registered in an independent repository but were documented as a part of the registered report. All scripts and output files will be made available on Open Science Framework upon acceptance.

Deviations from Registered Analysis Plan

Following the acceptance of Stage 1 of the Registered Report, the authors realized that minor, yet necessary analytical deviations needed to be made to best accommodate the ECLS-K:2011 data. Originally, no indication was provided of how the social (prosocial and aggressive behavior) variables would be operationalized. To best accommodate the data utilized from multiple waves of data, items were used to create formative latent variables. This operationalization allowed for measurement invariance tests to be conducted, informing any additional constraints in the final model. Changes are reflected in the Data Analysis section.

Results

Descriptive Statistics

Means, standard deviations, and ranges for main model indicators are presented in Table 1. Pearson's bivariate correlations are presented in Table 2. All study variables were significantly correlated with each other at a level of $p < .001$, likely due to the large sample size (N = 18,174). Correlations indicate that measures of the same construct were relatively stable across waves, prosocial behavior (r = .499 to .528), social aggression (r = .558 to .665), working memory (r = .606 to .673) and cognitive flexibility (r = .456 to .531). Small correlations were demonstrated between prosocial behavior and working memory (r = .121 to .164) as well as cognitive flexibility (r = .061 to .115) over time. Similarly small negative correlations were found between social aggression and working memory (r = -.097 to -.140), as well as cognitive flexibility (r = -.059 to -.093). Finally, large correlations were demonstrated between prosocial behavior and social aggression (r = -.410 to -.725), as well as working memory and cognitive flexibility (r = .268 to .316). Model covariates are presented in Table 3.

Measurement Invariance Across Time

We first tested two separate freely estimated CFAs in which a one-factor model was fit for each prosocial behavior and social aggression in third grade. The model for prosocial behavior did not fit the data well, $\chi^2(5) = 1011.122$, $p < .001$, CFI = .831, TLI = .662, RMSEA = .130 90% CI[.123, .137]. To improve model fit, we consulted modification indices which suggested that allowing for correlated residuals among two sets of items: "is cooperative with peers" and "is kind toward peers" as well as "seems concerned when other children are distressed" and "offers help or comfort when other children are upset." Given teachers may interpret these two sets of items as similar to one another (works well with peers; attends to peers when they are upset), it is likely their ratings would be related; thus correlations among residuals

were introduced. This resulted in substantially improved model fit wherein the data fit the model well, χ^2 (3) = 27.112, p < .001, CFI = .996, TLI = .986, RMSEA = .026 (90% CI[.018, .035]). The freely estimated model for social aggression fit the data well, χ^2 (2) = 5.167, p = .076, CFI = .999, TLI = .998, RMSEA = .012 (90% CI[.000, .024]).

Measurement invariance was then tested to establish consistency of factor structure from third grade to the subsequent two years. Tests indicated configural invariance across time for both prosocial behavior (χ^2 (df = 9) = 87.000) and social aggression (χ^2 (df = 6) = 8.107). Constraining factor loadings to equality (metric invariance) did not significantly worsen model fit compared to the configural model for both prosocial behavior ($\Delta\chi^2$ (df = 17) = 12.972, p = 0.119) and social aggression ($\Delta\chi^2$ (df = 12) = 6.313, p = 0.387). Additional constraints on item intercepts (scalar invariance) significantly reduced the model fit for prosocial behavior ($\Delta\chi^2$ (df = 25) = 52.586, p < .001), but not for social aggression ($\Delta\chi^2$ (df = 18) = 23.942, p = 0.12), suggesting that item intercepts are equal across waves for social aggression but not prosocial behavior. As we were primarily interested in the factor structure and not concerned with comparing means, we proceeded with this degree of partial invariance. The resulting partially invariant factors were used in RI-CLPM models.

RI-CLPM Between-Person Findings

The overall model for prosocial behavior (χ^2 (390) = 1529.529, p < .001; CFI = .970; TLI = .963; SRMR = .029; RMESA = .018 90% CI[.017,.019]) and social aggression (χ^2 (303) = 1261.428, p < .001; CFI = .972; TLI = .964; SRMR = .024; RMESA = .019 90% CI[.018,.020]) demonstrated good model fit. Figures 1 and 2 display the standardized factor loadings and covariances for the between-factor model for prosocial behavior and social aggression, respectively. The standardized factor loadings for the between-person, random intercepts for

prosocial behavior (β = .57 - .60), social aggression (β = .65 - .67), working memory (β = .69 - .73), and cognitive flexibility (β = .57 - .66) were positive and statistically significant, suggesting varying levels of trait-like stability from third grade to fifth grade across constructs. Additionally, statistically significant random intercepts indicate that there were stable differences at the person-level means of prosocial behavior, social aggression, working memory, and cognitive flexibility over time. Covariances between the random intercepts in the prosocial behavior model suggest that children with higher working memory also had higher cognitive flexibility scores (β = .43, SE = .03, $p < .001$) and displayed more prosocial behavior (β = .17, SE = .03, $p < .001$). A positive association was also found between cognitive flexibility and prosocial behavior (β = .17, SE = .04, $p < .001$). In the social aggression model, covariances between the random intercepts suggest that children with higher working memory also had higher cognitive flexibility scores (β = .43, SE = .03, $p < .001$) and displayed less social aggression (β = -.08, SE = .03, $p = .006$). No significant covariance was found between cognitive flexibility and social aggression.

RI-CLPM Within-Person Findings

We first present within-person autoregressive estimates for each construct, reflecting change over time relative to the between-person factor. The within-person autoregressive effects for prosocial behavior (β = .03 - .09) and social aggression (β = .06 - .09) were generally not significant across the three time points, with the exception of prosocial behavior from Time 2 to Time 3 (β = .09, SE = .04, p = .034). However, we observed significant autoregressive estimates at the within-person level for working memory from Time 2 to Time 3 (β = .14, SE = .03, $p = .000$) and for cognitive flexibility from Time 1 to Time 2 (β = .16, SE = .04, $p = .000$). After accounting for the within-person carry-over effect, we observed cross-lagged relations in both models. In the prosocial behavior model, we observed a positive relation between cognitive

flexibility at T1 and working memory at T2 (β = .06, SE = .03, p = .031) and a negative relation between prosocial behavior at T2 and cognitive flexibility at T3 (β = -.07, SE = .03, p = .045). In the social aggression model, we again observed a positive relation between cognitive flexibility at T1 and working memory at T2 (β = .06, SE = .03, p = .036) and a negative relation between social aggression at T2 and working memory at T3 (β = -.07, SE = .03, p = .028). Although unexpected, we found no bidirectional associations.

Our results suggest a unidirectional relation between cognitive flexibility and working memory from the fall of third grade to the fall of fourth grade, in both models. Additionally, these results suggest a unidirectional relation between prosocial behavior and cognitive flexibility, as well as social aggression and working memory from the fall of fourth grade to the fall of fifth grade (see figures 1 & 2).

Discussion

The purpose of the current study was to examine bidirectional associations between children's EF and their social behaviors, specifically prosocial behavior and social aggression, in a nationally representative sample of third, fourth, and fifth grade students (ages 8 to 11). We estimated two random intercept cross-lagged panel models that each included two EF components (working memory and cognitive flexibility) and one domain of children's social behavior. Our findings revealed a complex pattern of associations between children's EF skills and social behaviors. First, we found considerable trait-like stability in working memory, cognitive flexibility, prosocial behavior, and social aggression from third to fifth grade. Specifically, the between-person effects (i.e., random intercepts) suggest that individual differences in children's EF and social behavior are maintained across grade levels. Additionally, the within-person estimates revealed a negative association between prosocial behavior in fourth

grade and cognitive flexibility in fifth grade such that lower levels of prosocial behavior related to higher cognitive flexibility scores and a negative association between social aggression in fourth grade and working memory in fifth grade such that lower levels of social aggression related to higher working memory scores. We consider both the theoretical and practical implications of these findings and what these results suggest about mutualistic processes in cognitive and social development during late childhood.

Between-Person Findings for EF and Social Behaviors

A unique aspect of the RI-CLPM is its ability to tease apart between-person from within-person variance, allowing for a more conservative and nuanced understanding of the association between EF and social behaviors over time (Hamaker et al., 2015). We found that both EF and social behaviors exhibited trait-like stability from third to fifth grade. The observed covariances among the random intercepts for executive function and social behaviors suggest that prosocial behavior was linked to working memory and cognitive flexibility whereas social aggression was only associated with working memory, and vice versa. That is, there were rank-order associations: Children who had higher means of prosocial behavior over time also had higher means in working memory and cognitive flexibility over time. Conversely, children who had higher means in social aggression exhibited lower means for working memory.

Our study is the first to use a RI-CLPM to examine longitudinal associations between EF and observed social behaviors in a large, nationally representative sample. While recent studies have explored bidirectional associations between children's EF skills and socioemotional functioning (Zhang & Peng, 2023) and broader social functioning (Ben-Asher et al., 2023), neither have explored associations with observed social behaviors. Our findings are broadly consistent with smaller cross-sectional studies showing that stronger working memory abilities

are linked to lower levels of aggression (McQuade et al., 2013) and higher levels of prosocial behavior (O'Toole et al., 2017), as well as research suggesting positive associations between cognitive flexibility and peer cooperation (Ciairano et al., 2006). Some work has demonstrated that cognitive flexibility is negatively associated with peer victimization experiences (Jenkins et al., 2018), however very little work has been done to explore the observed behavioral correlates of these individual EF skills. Our findings align well with the existing literature and build upon it by utilizing a nationally representative sample and employing a more rigorous statistical model to explore these associations. When considered alongside the existing literature, our findings support the general trend that children who have greater scores on EF tasks over time are more likely to be prosocial and children with lower scores on working memory tasks are likely to engage in socially aggressive behavior towards peers.

Within-Person Associations for EF and Social Behaviors

In both RI-CLPMs, we found few significant within-person associations. We observed small autoregressive effects among both EF skills and prosocial behaviors, suggesting that there was relative stability in these domains between academic years. The relatively small magnitude of autoregressive associations is consistent with prior investigations using similar analytic approaches within samples of younger children (Willoughby et al., 2019). We also found a small positive within-person correlation between cognitive flexibility and working memory in third grade, a negative correlation between social aggression and working memory in third grade, as well as a negative correlation between prosocial behavior and cognitive flexibility in fifth grade.

We also observed cross-lagged relations. Specifically, cognitive flexibility in third grade was predictive of children's working memory abilities in fourth grade. Furthermore, social aggression in fourth grade was negatively related to working memory ability in fifth grade. A

significant negative association was found between children's fourth grade prosocial behaviors and their fifth grade cognitive flexibility. Although we expected more within-person estimates to reach significance, the substantial variance captured by the random intercepts suggests that stable individual differences in children's EF and social behavior across time accounts for more variance than within-person fluctuations from third to fifth grade. Furthermore, substantial variance in children's EF and social behavior was explained by socioeconomic status (SES) in our models (see Table 3). Given that previous studies have also demonstrated the relevance of SES particularly for children's EF development (e.g., Lawson & Farah, 2018; Waters et al., 2021), future research would benefit from modeling these associations with a more explicit consideration of aspects of SES, such as parent education and income.

Of particular interest is the significant and negative relationship found among prosocial behavior and cognitive flexibility from the fourth to fifth grade. Although surprising, we suspect that these negative associations may be partially attributed to heterogeneity in baseline EF skills and social behaviors. Examining these associations across the full sample may have obscured nuanced associations between children's EF skills and social behaviors, particularly for those with high versus low baseline levels of EF. For example, Zhang and Peng (2023) similarly applied RI-CLPMs to the ECLS-K:2011 data and found reciprocal associations between EF skills and reading development only for students performing at higher academic levels relative to their peers. It is possible that a similar pattern of association exists for EF and social behavior. Therefore, future research would benefit from examining whether bidirectional associations between EF and social behavior differ across baseline EF skills and social behavior.

Another important finding that emerged was the differential within-person associations between dimensions of social behavior and EF components. Specifically, we found significant

associations between prosocial behavior and cognitive flexibility whereas only aggression was associated with working memory in this sample. This suggests that different dimensions of social behavior might support the development of EF skills in different ways across elementary school. It could be that keeping in mind and manipulating important social information related to social aggression is associated with working memory development, whereas children's ability to flexibly switch between perspectives and adapt to complex social norms is associated with cognitive flexibility (Bock et al., 2015; De Wilde et al., 2015). However, more research is needed to fully unpack the mechanisms underlying associations between aspects of social behavior, such as relational aggression and prosociality, and cognitive flexibility and working memory.

Bidirectional Associations Between EF and Social Behaviors

Unexpectedly, we found no evidence for bidirectional associations between either EF skill and prosocial behavior or social aggression at the within-person level. This ran contrary to our hypotheses, as well as findings from previous studies. For instance, among a sample of 99 adolescents, Ben-Asher and colleagues (2023) found bidirectional associations between aggregate EF skills and social functioning, specifically social cognition; however, it is worth noting that social functioning may look different in middle childhood versus adolescence. Additionally, among a sample of roughly 1,100 elementary-aged children, De Wilde and colleagues (2016) found bidirectional associations between children's working memory and conflict with their teachers, such that greater teacher-child conflict was predictive of lower working memory ability, subsequently predicting greater conflict with teachers. We suspect that our findings may diverge for a few reasons. First, we utilized a more rigorous statistical model with the RI-CLPM which builds upon traditional CLPMs by separating between- and within-person variance. While we do replicate these findings in the aggregate, our findings

suggest that much of the variance in these relations is attributable to the between-person level where we do see significant relations, resulting in largely non-significant within-person effects. That is, it may be that more trait-like characteristics relate to one another and that those relations are stable over time but that individual differences in the fluctuations of one characteristic are not associated with individual differences in another.

Second, we explored the role of specific EF skills rather than composite or latent EF measures, which is common in this field of research (for review, see Stucke & Doebel, 2024). It may be that when EF skills are aggregated, they are more powerfully predictive of various outcomes but when these skills are isolated, their predictive ability decreases (Willoughby & Blair, 2016). As such, future research would benefit from comparing models that use individual EF components versus composite EF variables to better understand how modeling specifications might influence associations between EF and social behavior. Finally, using teacher ratings of prosocial behavior and social aggression as proxies for broader social adjustment may obscure other aspects of children's social interactions that contribute to EF development, particularly in reciprocal ways. We suggest that further research explores directly measured or explicit social adjustment outcomes, such as peer acceptance or number of friends a student maintains, as it reciprocally relates to children's EF development.

Limitations and Future Directions

The current study strengthens the literature linking EF skills and social behavior by exploring longitudinal associations in a large, nationally representative sample and exploring the unique contributions of two different EF skills, working memory and cognitive flexibility. However, there are still a set of limitations of the current study that offer directions for future research. First, our inability to include response inhibition, often considered a central component

of EF (Diamond, 2013), was a major limitation of the current study. We chose to do so as the ECLS-K:2011 did not start collecting direct assessment of children's response inhibition skills until the fall of fourth grade. As our guiding research questions were aimed at exploring reciprocal relations among EF skills and social behavior using a methodologically robust approach, we required at least three waves of data, ultimately warranting our exclusion of response inhibition. However, we contend that response inhibition warrants greater attention, as it has been linked to children's externalizing problems (Utendale et al., 2011) and identified as a key component of bullying tendencies (Jia et al., 2024).

A second limitation concerns our use of teacher-rated social behaviors. The first issue concerns the measurement of these behaviors. Teachers were asked to rate each student on a range of behaviors, with options ranging from 1 (doesn't apply) to 3 (certainly applies). This response range may not be adequately addressing the behavioral profiles that children are exhibiting. Second, our reliance on teacher-rated social behaviors to assess longitudinal associations may present certain limitations. Since our analyses spanned three academic years, different teachers provided ratings of participants' social behaviors each year. Although measurement invariance analyses indicated partial measurement invariance, variability in raters may have influenced the observed associations. Finally, teachers are generally reliable reporters of student behavior, demonstrating agreement with student perspectives on youth who are popular and well-liked roughly 60-70% of the time (van den Berg et al., 2015). However, discrepancies between perspectives arise when students and teachers are asked to describe the behavioral characteristics of popular children (van den Berg et al., 2015). It has been argued that teachers generally have more positive perceptions of children because they do not see the negative behaviors that are more likely to take place in hallways, bathrooms, or the playground

(Coie et al., 1990). Using peer nominations and/or a combination of approaches that might also involve direct observation to assess children's behavior may offer a more comprehensive and methodologically robust approach, as greater consensus among peers is likely to provide a more accurate reflection of a child's actual behaviors (for an example, see De Wilde et al., 2016).

Third, we used these social behaviors as a way to understand children's social adjustment, arguing that children who were more prosocial would have more friends (Sebanc et al., 2003), which would allow them opportunities for more social interactions that would ultimately support their EF development. However, more explicit measures of children's social adjustment may be necessary. Future research should explore associations between EF skills and peer reports of social behavior, peer acceptance, and reciprocal friendship nominations. Although previous studies have done so (Lecce et al., 2020; O'Toole et al., 2017; Wang & Feng, 2024), they employ small sample sizes that may not be representative or sufficient enough to capture population-level trends.

Educational Implications

The present findings point to the importance of social relationships for EF development, which might have implications for educational practice. Specifically, research has highlighted the important role teachers play in facilitating the social dynamics of the classroom as it relates to the development of children's EF skills (Girard et al., 2011; Ahmed et al., 2026). For instance, recent teacher professional learning programs that have focused on strengthening teachers' understanding of children's EF development while also offering strategies for supporting these skills during everyday social interactions have shown promise in promoting children's EF skills during preschool (Ahmed et al., 2026; Muir et al., 2024). However, the effectiveness of these types of professional learning programs for elementary school teachers is less understood. One

such intervention has focused on teaching elementary school teachers and students skills for navigating emotionally charged situations. Findings suggest that children who participate in these lessons report significantly stronger social skills and behaviors linked to executive functioning, such as cognitive, emotional, and behavioral regulation (Garcia et al., 2024). The present study adds additional, although correlational, evidence that children's social behavior is associated with their EF development. However, additional research is needed to explore the ways in which supporting teachers can promote children's social skills in classroom settings and whether doing so can support children's EF growth across elementary school.

Conclusion

In the current study, we expanded on the scant literature exploring associations between EF skills and social behaviors by exploring these relations in a nationally representative sample (ECLS-K:2011) with a rigorous statistical method (RI-CLPM). Our results revealed substantial between-person differences in EF skills and social behaviors, but few within-person associations were statistically significant across time. Although the current findings diverge from previous research in this area, we argue that more research is needed to explore these nuanced relationships with large, nationally representative samples. Greater insight into the links between EF skills and children's social behaviors and adjustment can enable researchers and practitioners to more effectively identify ways to use peer relationships to promote EF development during childhood.

Table 1
Unimputed Means, Standard Deviations, Sample Size and Range for Model Indicators

Variables	*N*	*M*	*SE*	Min	Max	% Missing
Time 1 - Spring of Third Grade						
Prosocial Behavior	9135	1.61	0.78	1	5	0.03%
Social Aggression	9140	-2.38	1.29	1	3	0.03%
Working Memory	9160	49.06	0.03	40.30	60.30	0.01%
Cognitive Flexibility	9075	7.22	0.02	2	10	0.10%
Time 2 - Spring of Fourth Grade						
Prosocial Behavior	8250	0.82	0.64	1	5	9.98%
Social Aggression	8250	-0.72	1.22	1	3	10.00%
Working Memory	8620	49.80	0.03	40.30	58.80	5.99%
Cognitive Flexibility	8570	7.65	0.02	1.875	10	6.47%
Time 3 - Spring of Fifth Grade						
Prosocial Behavior	7740	1.79	0.70	1	5	15.57%
Social Aggression	7740	-2.40	1.65	1	3	15.52%
Working Memory	8170	50.39	0.03	40.30	58.80	10.90%
Cognitive Flexibility	8140	7.99	0.01	2	10	11.22%

Note. Sample sizes rounded to nearest 10 per National Center for Education Statistics requirement. Prosocial Behavior & Social Aggression = Mean Latent Score. Working Memory = W Score of Numbers Reversed test (Mather & Woodcock, 2001). Cognitive Flexibility = Combined score of Dimensional Change Card Sort (DCCS; Zelazo, 2006).

Table 2
Correlations for Main Study Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12
Time 1 - Spring of Third Grade												
1. Prosocial Behavior	-											
2. Social Aggression	**-.692**	-										
3. Working Memory	**.164**	**-.119**	-									
4. Cognitive Flexibility	**.115**	**-.085**	**.301**	-								
Time 2 - Spring of Fourth Grade												
5. Prosocial Behavior	**.499**	**-.458**	**.149**	**.098**	-							
6. Social Aggression	**-.444**	**.558**	**-.128**	**-.093**	**-.699**	-						
7. Working Memory	**.144**	**-.106**	**.630**	**.300**	**.156**	**-.128**	-					
8. Cognitive Flexibility	**.100**	**-.070**	**.296**	**.531**	**.099**	**-.113**	**.316**	-				
Time 3 - Spring of Fifth Grade												
9. Prosocial Behavior	**.472**	**-.410**	**.132**	**.098**	**.528**	**-.459**	**.139**	**.087**	-			
10. Social Aggression	**-.413**	**.665**	**-.099**	**-.077**	**-.454**	**.565**	**-.116**	**-.076**	**-.725**	-		
11. Working Memory	**.141**	**-.097**	**.606**	**.268**	**.146**	**-.140**	**.673**	**.286**	**.121**	**-.119**	-	
12. Cognitive Flexibility	**.104**	**-.064**	**.291**	**.456**	**.071**	**-.093**	**.300**	**.518**	**.061**	**-.059**	**.284**	-

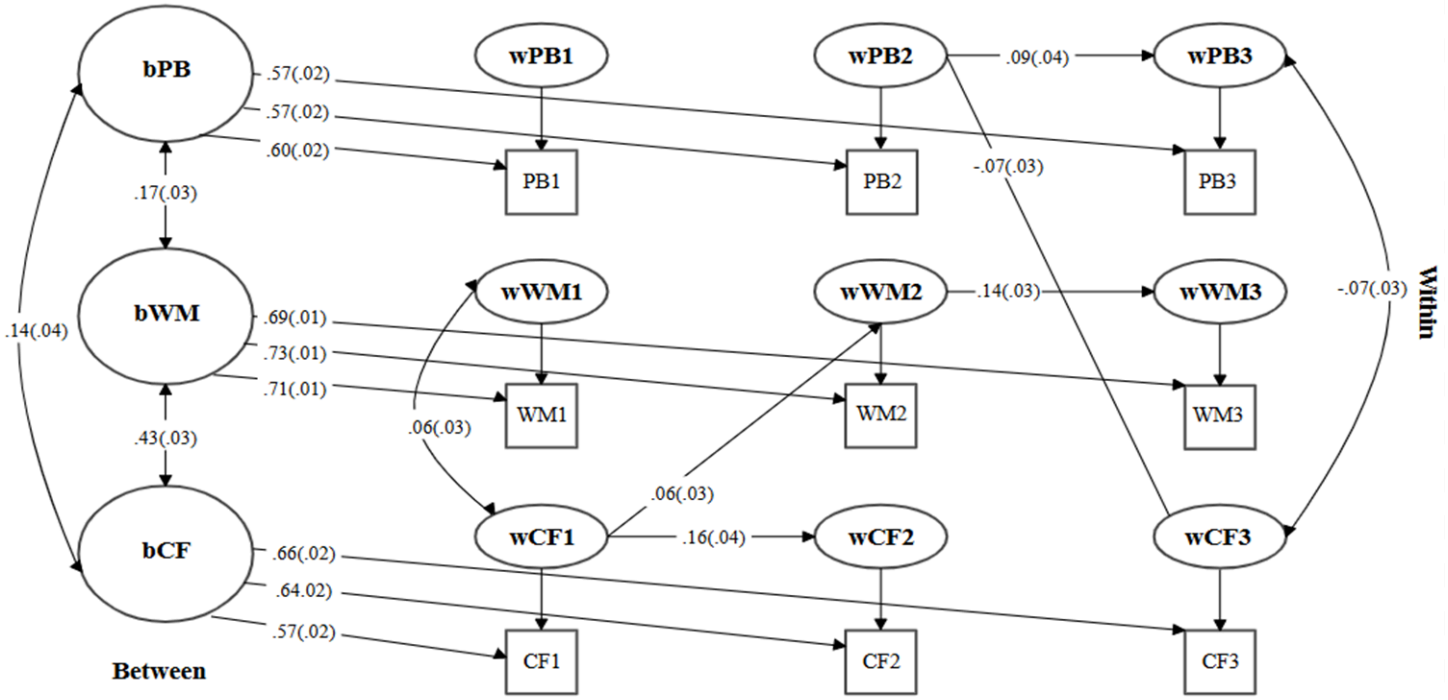
Note. Bold = $p \leq .001$ level. Prosocial Behavior & Social Aggression = Mean Latent Score. Working Memory = W Score of Numbers Reversed test (Mather & Woodcock, 2001). Cognitive Flexibility = Combined score of Dimensional Change Card Sort (DCCS; Zelazo, 2006).

Table 3
Standardized Regression Estimates Between Model Covariates and Random Intercepts

	Time 1				Time 2				Time 3			
	Prosocial Behavior	Social Aggression	Working Memory	Cognitive Flexibility	Prosocial Behavior	Social Aggression	Working Memory	Cognitive Flexibility	Prosocial Behavior	Social Aggression	Working Memory	Cognitive Flexibility
Covariates	β(SE)	β(SE)	β(SE)	β(SE)	β(SE)	β(SE)	β(SE)	β(SE)	β(SE)	β(SE)	β(SE)	β(SE)
Age	.02(.02)	-.05(.02)**	.04(.02)*	.08(.02)***	-.01(.02)	-.00(.02)	.00(.02)	.08(.02)***	.02(.02)	-.02(.02)	-.01(.02)	.056(.02)**
Female	.22(.02)***	-.15(.02)***	.00(.02)	-.01(.02)	.24(.02)***	-.16(.02)***	-.00(.01)	-.01(.02)	.26(.02)***	-.17(.02)***	-.01(.01)	-.02 (.02)
Hispanic	.01(.02)	.04(.02)*	.03(.02)	.03(.02)	.05(.02)*	.02(.02)	-.00(.02)	.04(.02)*	.03(.02)	.01(.02)	.01(.02)	-.00(.02)
Black	.23(.11)*	-.23(.09)*	.14(.07)*	.20(.07)**	.17(.09)*	-.17(.08)*	.19(.10)	.18(.12)	.20(.09)*	-.27(.10)**	.12(.07)	.23(.11)*
Asian	.11(.07)	-.02(.06)	.03(.05)	.04(.04)	.06(.06)	.01(.05)	.04(.06)	.03 (.08)	.12(.06)*	-.07(.07)	.00(.05)	.08(.07)
American Indian	.06(.05)	-.05 (.04)	.03(.03)	.03(.03)	.00(.04)	.00(.04)	.08(.05)	.01(.06)	.03(.04)	-.03(.05)	.07(.03)	.07(.05)
Pacific Islander	.01(.03)	-.01(.02)	.01(.02)	.01(.02)	-.01(.02)	-.00(.02)	.01(.03)	.03(.03)	.03(.03)	-.02(.03)	-.01(.02)	.03(.03)
Multiracial	-.09(.07)	.08(.06)	-.06(.05)	-.07(.05)	-.08 (.06)	.04(.06)	-.10(.06)	-.05(.08)	-.10(.06)	.11(.07)	-.05(.05)	-.12(.07)
White	.11(.12)	-.07(.10)	.07(.08)	.07(.08)	.03(.09)	.02(.09)	.13(.11)	.07(.13)	.09(.10)	-.11(.11)	.06(.08)	.18(.12)
Language Screener	-.01(.01)	.01(.01)	-.01(.01)	-.07(.02)***	.01(.01)	-.01(.01)	-.02(.01)	-.04(.02)*	-.02(.01)*	.01(.01)	-.01(.01)	-.02(.01)*
Home Language	-.00(.02)	.03(.02)	.01(.02)	-.00(.02)	-.02(.02)	.08(.02)***	.01(.02)	-.01(.02)	-.04(.02)	.07(.02)***	.01(.02)	-.03(.02)
IEP Status	.10(.02)***	-.03(.02)	.26(.02)***	.22(.02)***	.11(.02)***	-.06(.02)**	.24(.02)***	.19(.02)***	.07 (.02)***	-.04(.02)*	.25(.02)***	.20(.02)
SES	.14(.02)***	-.15(.02)***	.14(.02)***	.09(.02)***	.14(.02)***	-.18(.02)***	.17(.02)***	.09(.02)***	.15(.02)***	-.16(.02)***	.18(.02)***	.12(.02)***

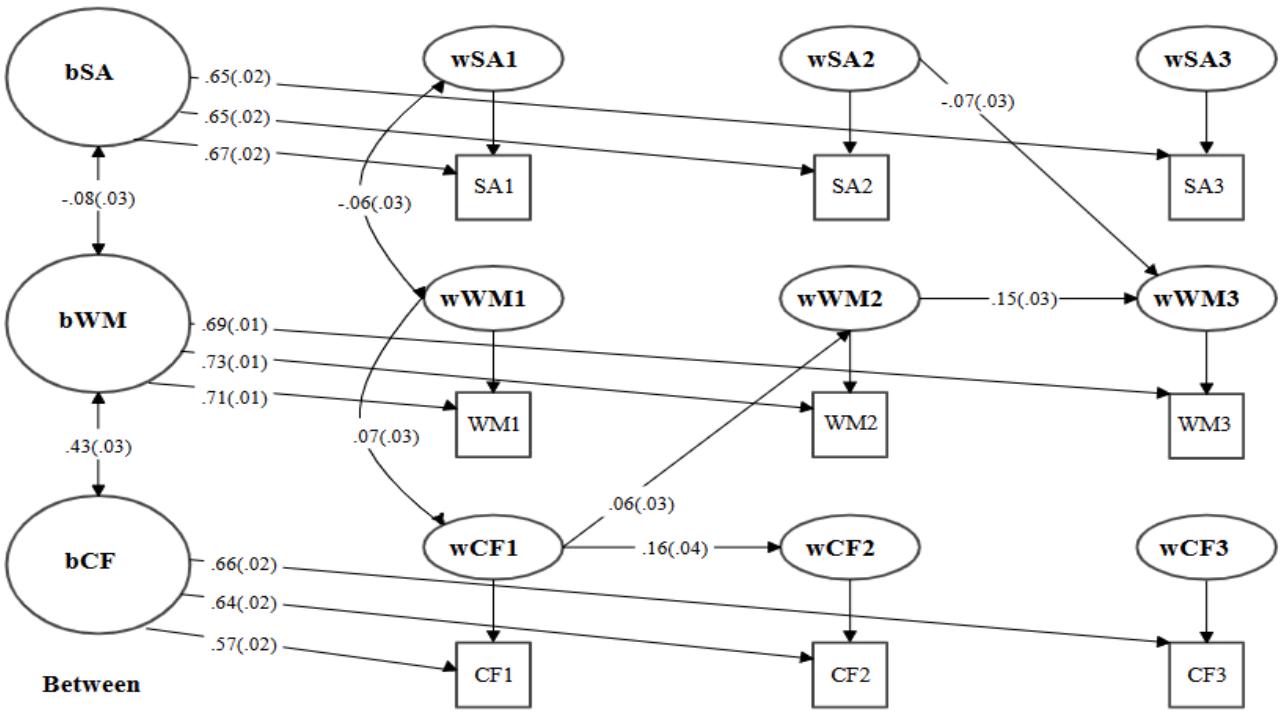
Note. Male = dummy coded sex variable: 0 = male, 1 = female. English language = primary language spoken at home: 1 = non-English, 2 = English, 3 = Multilingual. IEP Status = individualized educational plan status at spring of first grade: 0 = yes, 1 = no. SES = socioeconomic status composite score measured at the fall of kindergarten. *p < .05, **p < .01, ***p </= .001.

Figure 1. *Executive function and prosocial behavior RI-CLPM*



Note: bPB, bWM, and bCF are stable between-person random intercepts extracted from the repeated measures of prosocial behavior, working memory, and cognitive flexibility, respectively.
wPB, wWM, and wCF are within-person centered factors extracted from each timepoint.
Covariates (i.e., sex, age, SES, race/ethnicity, IEP status, English Language, and language ability) will be predictors of stable between-person factors.
Missing data will be imputed using multiple imputations by chained equations procedures to create 40 complete data sets.
ECLS-K sampling weights that accounts for child, parent and teacher level data will be included in this model.
MLR estimator - maximum likelihood parameter estimates with standard errors and a mean-adjusted chi-square test statistic.

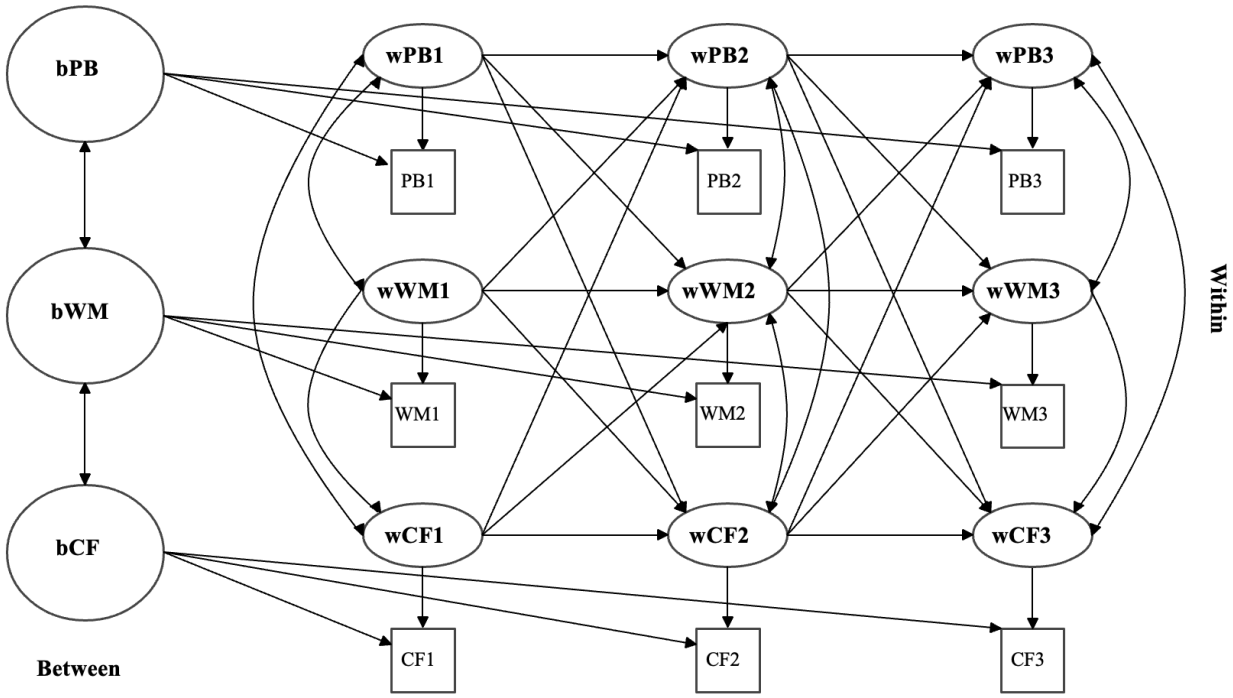
Figure 2. *Executive function and social aggression RI-CLPM*



Note: bPB, bWM, and bCF are stable between-person random intercepts extracted from the repeated measures of prosocial behavior, working memory, and cognitive flexibility, respectively.
wPB, wWM, and wCF are within-person centered factors extracted from each timepoint.
Covariates (i.e., sex, age, SES, race/ethnicity, IEP status, English Language, and language ability) will be predictors of stable between-person factors.
Missing data will be imputed using multiple imputations by chained equations procedures to create 40 complete data sets.
ECLS-K sampling weights that accounts for child, parent and teacher level data will be included in this model.
MLR estimator - maximum likelihood parameter estimates with standard errors and a mean-adjusted chi-square test statistic.

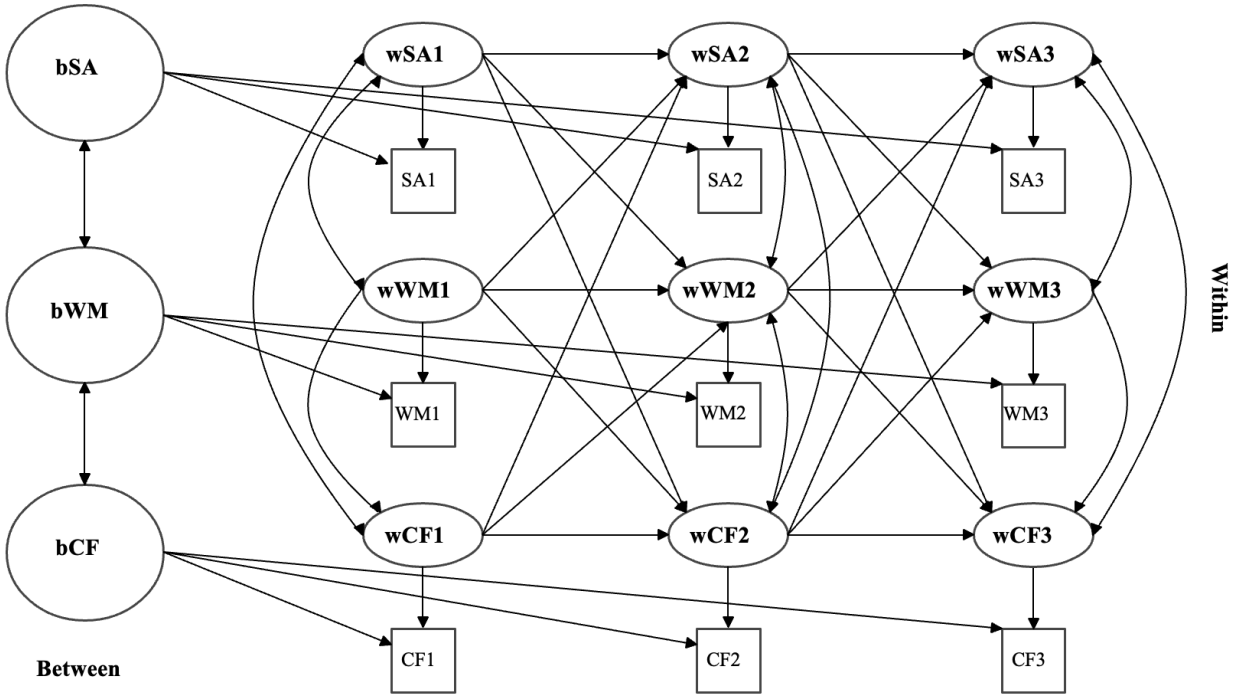
Supplementary Materials

Figure S1. *Executive function and prosocial behavior RI-CLPM conceptual model*



Note: bPB, bWM, and bCF are stable between-person random intercepts extracted from the repeated measures of prosocial behavior, working memory, and cognitive flexibility, respectively.
wPB, wWM, and wCF are within-person centered factors extracted from each timepoint.
Covariates (i.e., sex, age, SES, race/ethnicity, IEP status, English Language, and language ability) will be predictors of stable between-person factors.
Missing data will be imputed using multiple imputations by chained equations procedures to create 40 complete data sets.
ECLS-K sampling weights that accounts for child, parent and teacher level data will be included in this model.
MLR estimator - maximum likelihood parameter estimates with standard errors and a mean-adjusted chi-square test statistic.

Figure S2. *Executive function and social aggression RI-CLPM conceptual model*



Note: bSA, bWM, and bCF are stable between-person random intercepts extracted from the repeated measures of social aggression, working memory, and cognitive flexibility, respectively.
wSA, wWM, and wCF are within-person centered factors extracted from each timepoint.
Covariates (i.e., sex, age, SES, race/ethnicity, IEP status, English Language, and language ability) will be predictors of stable between-person factors.
Missing data will be imputed using multiple imputations by chained equations procedures to create 40 complete data sets.
ECLS-K sampling weights that accounts for child, parent and teacher level data will be included in this model.
MLR estimator - maximum likelihood parameter estimates with standard errors and a mean-adjusted chi-square test statistic.

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