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Elementary Students' Effortful Control and Academic Achievement: The Mediating Role of Teacher-Student Relationship Quality

Maciel M. Hernández¹, Carlos Valiente², Nancy Eisenberg¹, Rebecca H. Berger², Tracy L. Spinrad², Sarah K. VanSchyndel¹, Kassondra M. Silva², Jody Southworth², and Marilyn S. Thompson²

¹Department of Psychology, Arizona State University

²T. Denny Sanford School of Social and Family Dynamics, Arizona State University

Abstract

This study evaluated the association between effortful control in kindergarten and academic achievement one year later ($N = 301$), and whether teacher–student closeness and conflict in kindergarten mediated the association. Parents, teachers, and observers reported on children's effortful control, and teachers reported on their perceived levels of closeness and conflict with students. Students completed the passage comprehension and applied problems subtests of the Woodcock–Johnson tests of achievement, as well as a behavioral measure of effortful control. Analytical models predicting academic achievement were estimated using a structural equation model framework. Effortful control positively predicted academic achievement even when controlling for prior achievement and other covariates. Mediation hypotheses were tested in a separate model; effortful control positively predicted teacher–student closeness and strongly, negatively predicted teacher–student conflict. Teacher–student closeness and effortful control, but not teacher–student conflict, had small, positive associations with academic achievement. Effortful control also indirectly predicted higher academic achievement through its positive effect on teacher–student closeness and via its positive relation to early academic achievement. The findings suggest that teacher–student closeness is one mechanism by which effortful control is associated with academic achievement. Effortful control was also a consistent predictor of academic achievement, beyond prior achievement levels and controlling for teacher–student closeness and conflict, with implications for intervention programs on fostering regulation and achievement concurrently.

Correspondence concerning this article should be addressed to Maciel M. Hernández, Department of Psychology, P.O. Box 871104, Arizona State University, Tempe, AZ 85287-1104. maciel.hernandez@asu.edu.

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Keywords

academic achievement; effortful control; elementary school; kindergarten; teacher–student relationship quality

Children's behavioral and social adjustment in kindergarten both have implications for their academic trajectories (Denham et al., 2012; Rimm-Kauffman & Pianta, 2000), and self-regulatory abilities in particular are believed to be relevant to tasks performed in academic settings (Blair & Raver, 2015; Rothbart & Jones, 1998). Examining potential predictors of early academic adjustment and potential mechanisms that inform that process is important given sustained effects of early academic achievement across development (Duncan et al., 2007). The first goal of this study was to examine the extent to which effortful control in the fall of kindergarten predicted higher academic achievement in the spring of first grade. We also examined whether teacher–student closeness and conflict in the spring of kindergarten mediated the association between effortful control in the fall of kindergarten and academic achievement in the spring of first grade. Rigorously testing if, and why, effortful control is related to later achievement is critical for advancing theory and current methods used to improve students' academic development.

We focus on effortful control – the ability to willfully shift attention, focus attention, and adaptively activate and inhibit behavior (Rothbart & Bates, 2006) – which is considered an attentionally-based self-regulatory component of temperament (Eisenberg, Spinrad, & Eggum, 2010; Rothbart, Ahadi, Hershey, & Fisher, 2001). Measures of effortful control include behavioral tasks (such as the knock tap task, gift wrap task, etc.) and adult reports of child behaviors (measuring inhibitory control and attention abilities [e.g., Children's Behavior Questionnaire, CBQ; Rothbart et al., 2001] or inattention measures [e.g., Health and Behavior Questionnaire, HBQ; Armstrong & Goldstein, 2003]), which assess an individual's abilities to modulate reactivity, via attention and inhibitory control (Rothbart et al., 2001). Effortful control rapidly develops in early childhood and has implications for development in other domains.

The transition into kindergarten and then first grade represents a developmental period that creates challenges for some children. For example, this is a critical time when children's effortful control abilities are still developing and when there are increased expectations for self-regulation at school (Li-Grining, 2007; Ponitz, McClelland, Matthews, & Morrison, 2009; Rothbart & Jones, 1998). Furthermore, the transition from kindergarten to first grade is marked by increased time in seatwork, teacher-directed instruction, and less instructional support (e.g., discussing ideas and potential solutions to tasks and activities, allowing children to take on responsibility; La Paro, Rimm-Kaufman, & Pianta, 2006). One way to ease the transition to school demands is the development of close, low conflict relationships in school that support children's adjustment (Eisenberg, Valiente, & Eggum, 2010).

As described in the following sections, in the present study, we identified potential mediators of the association between effortful control and academic achievement based on the heuristic model presented by Eisenberg, Valiente, and Eggum (2010). We proposed that the formation of close, low conflict, teacher-student relationships mediates the relation between effortful

control and academic achievement, in part because children who are high in effortful control may more easily develop positive relationships with teachers in school, which would facilitate an easier transition to the changing demands of new classroom environments. In subsequent sections, we describe theory and empirical research literature addressing the relations among effortful control, academic achievement, and the teacher–student relationship in the early years of formal schooling.

Relations between Children's Effortful Control and Academic Achievement

Researchers have hypothesized that effortful control directly predicts academic achievement via multiple mechanisms (Blair & Raver, 2015; Eisenberg, Valiente, & Eggum, 2010). Theorists have argued that children who are better able to regulate their emotions and behavior, in part due to their level of effortful control, may help curb emotional distress that otherwise reduces cognitive resources needed for learning (Blair, 2002; Pekrun, 2006). Effortful control abilities are also proposed to promote planning, problem solving, and goal-directed behaviors (Blair & Raver, 2015), and thus positively predict adjustment and performance in school. For example, following directions and paying attention in class are aided by a child's abilities to focus on instructed tasks and inhibit distractions.

There is some empirical evidence that effortful control predicts concurrent academic achievement (see meta-analysis of concurrent studies by Allan, Hume, Allan, Farrington, & Lonigan, 2014). For example, preschoolers' behavioral regulation (assessed with the Head-Toes-Knees-Shoulders task which requires attention, working memory, and inhibiting dominant responses to perform a non-dominant demand; Diamond, 2002) predicted concurrent academic achievement, controlling for earlier levels of achievement and behavioral regulation (McClelland et al., 2007). There is also some longitudinal evidence for the association between effortful control (e.g., assessed with a variety of behavioral measures of inhibitory control and set shifting) and academic achievement (Clark, Pritchard, & Woodward, 2010; McClelland et al., 2014; Morris et al., 2013; Ponitz et al., 2009), although the use of control variables across studies has been inconsistent. For example, effortful control (measured with behavioral and adults' reports of inhibitory control and attentional focusing/shifting) in kindergarten positively predicted math and reading achievement in kindergarten or second grade (Cerdeña, Im, & Hughes, 2014; Valiente, Lemery-Chalfant, & Swanson, 2010), controlling for background variables (e.g., socioeconomic status [SES]) but not prior academic achievement. Conversely, effortful control in first or second grade (e.g., parent and teacher reports of attentional focusing and inhibitory control) predicted later achievement in fifth or sixth grade (i.e., four years later), controlling for earlier achievement (but no other background variables), among elementary school children (Zhou, Main, & Wang, 2010).

In a meta-analysis, Jacob and Parkinson (2015) found a moderate association between executive function (a construct closely linked with effortful control) and academic achievement but argued that this research area is fraught with limitations due to the over-reliance on primarily cross-sectional research designs and the exclusion of key covariates in analyses (e.g., background characteristics and IQ or prior achievement). Excluding key covariates in analyses that are associated with both the predictor and predicted variables,

such as prior academic achievement, could result in inflated associations (Ferguson, 2009). Indeed, prior achievement-related skills are very strong predictors of future academic achievement, as are socioeconomic background characteristics (Duncan et al., 2007). We argue that early self-regulatory skills are important for academic development early on in the school transition and test this possibility when controlling for earlier achievement and background covariates, addressing limitations in prior studies. Furthermore, controlling for background variables (e.g., socioeconomic status, age, sex, ethnicity) also provides a more appropriate test of the associations of interest by reducing third variable effects that could account for the relation. For example, in one study that included both prior achievement and background variables as covariates, inhibitory control (an aspect of effortful control) in first grade did not predict academic achievement in the second grade (Liew, Chen, & Hughes, 2010). Thus, there remain questions about the robustness of findings involving effortful control with academic achievement (Jacob & Parkinson, 2015).

Relations between Children's Effortful Control and Teacher-Student Relationship Quality

We know relatively little about the mechanisms underlying the association between effortful control and academic achievement. Thus, in this study, we also sought to understand possible social relationship mechanisms by which effortful control might relate to academic achievement. Specifically, we build on previous theory proposing that children's effortful control also predicts the quality of their relationship with their teachers in school (Eisenberg, Valiente, & Eggum, 2010), which in turn might mediate the relation of effortful control and school-related outcomes. Teachers may have an easier time connecting with children who are well-regulated because these children are likely to modulate and appropriately adapt their behaviors with peers and when engaged in academic activities (Eisenberg, Valiente, & Eggum, 2010).

Effortful control is often associated with better relationships with others, especially with positive peer relationships (Eisenberg, Eggum, Sallquist, & Edwards, 2010). As such, effortful control may also have positive associations with relationships with teachers (e.g., more closeness and less conflict; Eisenberg, Valiente, & Eggum, 2010), although there is less empirical support for this association, particularly with longitudinal data. School-based interventions targeting emotion regulation have demonstrated decreased disciplinary problems in school (Wyman et al., 2010), which likely affects the quality of social-learning interactions in the classroom with teachers and during academic tasks (Nesbitt, Farran, & Fuhs, 2015).

There is some empirical support (albeit based on a limited number of studies) for the association between effortful control and teacher-student relationship quality (typically, teacher-student relationship is reported by teachers; Diaz et al., in press; Valiente et al., 2011). Among kindergarteners, effortful control (i.e., observed and reported measures of attentional focusing and inhibitory control) predicted better teacher-student relationship quality assessed with a combined measure of conflict and closeness, controlling for SES and verbal intelligence (Valiente, Swanson, & Lemery-Chalfant, 2012). Likewise, Rudasill and

Rimm-Kaufman (2009) found parent-reported effortful control (i.e., inhibitory control and attentional focusing) in preschool predicted both teacher-student closeness and conflict in first grade, controlling for gender. Similarly, Portilla, Ballard, Adler, Boyce, and Obradovi (2014) found that children's inattention and impulsivity reported by parents (both measures of low effortful control) predicted higher teacher-student conflict and lower closeness in the transition from kindergarten to first grade, controlling for gender. Thus, some empirical evidence links children's effortful control with teacher-student relationship quality but only a couple of the studies offer longitudinal evidence with strong, consistent controls of background variables.

Relations between Teacher-Student Relationship Quality and Academic Achievement

Scholars have extensively studied the association between teacher-student relationships and children's school adjustment in elementary school (Sabol & Pianta, 2012). Attachment theory provides a basis for understanding the associations between teacher-student relationships and student academic achievement (Baumeister & Leary, 1995). Positive, high-quality relationships between children and their teachers can help students form a secure base in the educational environment, which often allows them to more effectively explore, engage, and learn academic material (Ladd & Burgess, 1999; McCormick, O'Connor, Cappella, & McClowry, 2013).

Several investigators have found positive associations between high quality teacher-student relationships and children's performance on standardized tests of achievement (Baker, 2006; Liew et al., 2010; Maldonado-Carreño & Votruba-Drzal, 2011; McCormick et al., 2013; O'Connor & McCartney, 2007) and on students' grade point average (Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008). Although these studies are helpful in understanding the relation between teacher-student relationships and academic achievement, they often do not capture the nuances that may be present when examining closeness and conflict as separate constructs (Sabol & Pianta, 2012). We were interested in investigating teacher-student closeness and conflict separately given some research showing differential prediction to school-related behaviors (Portilla et al., 2014; Rudasill & Rimm-Kaufman, 2009). For example, in a study of kindergarten children, Birch and Ladd (1997) found that teacher-rated closeness was positively related to student's concurrent performance on standardized tests of achievement; however, conflict was not related to student's achievement. The results of Birch and Ladd's (1997) study demonstrate a need to examine teacher-student closeness and conflict separately, rather than only one teacher-student relationship quality construct. Additionally, understanding which aspects of the teacher-student relationship relate to children's development can inform teacher professional development and school-based interventions addressing the relationship dynamics between teachers and students.

The longitudinal evidence presented in the literature on whether closeness and conflict in the teacher-student relationship predicts children's performance on standardized tests of achievement *over time* is inconsistent. Hughes (2011) found that teacher-reported supportive relationships in second grade were positively associated with student's performance on

standardized tests of achievement in third grade and that conflict (analyzed separately) was negatively associated with achievement. However, some short- and long-term longitudinal studies have found that teacher–student conflict in kindergarten was negatively associated with achievement, but the inverse association was not found for closeness (Hamre & Pianta, 2001; Ladd & Burgess, 2001; closeness was analyzed separately). Conversely, Pianta and Stuhlman (2004) found that preschool and kindergarten teachers' ratings of closeness and conflict with their students were not predictive of first grade teachers' ratings of students' achievement or achievement on standardized tests (controlling for earlier achievement). In the same study, first grade teachers' ratings of closeness were positively related to concurrent teacher-rated achievement and the reverse pattern was found for conflict; however, closeness and conflict did not predict achievement on standardized tests (Pianta & Stuhlman, 2004). These prior studies have typically controlled for background covariates but more longitudinal studies are needed to clarify if teacher-student closeness and conflict relate to academic achievement when controlling for prior achievement.

The Mediating Role of Teacher-Student Relationship Quality

Based on the aforementioned evidence, there are a number of reasons to expect prediction of academic achievement and teacher-student relationship quality from children's effortful control (Allan et al., 2014; Rudasill & Rimm-Kaufman, 2009; Valiente et al., 2011). Furthermore, the teacher-student relationship, often assessed with a composite of high closeness and low conflict, predicts academic achievement (O'Connor & McCartney, 2007), albeit there are some important caveats to this general finding (as discussed in the prior section). Thus, teacher-student relationship quality has been proposed as one mediating process in the association between effortful control and academic achievement (Eisenberg, Valiente, & Eggum, 2010). Specifically, having a close or low conflict teacher-student relationship may help facilitate the process by which effortful control is associated with academic achievement.

There are only a few empirical studies supporting the preliminary hypothesis that the teacher-student relationship functions as a mediator (Eisenberg, Valiente, & Eggum, 2010). For example, Silva et al. (2011) found that preschoolers' effortful control positively predicted teacher–student relationship quality (i.e., a composite of high closeness and low conflict), which in turn positively predicted school attitudes among children from low-income backgrounds within the same school year (without controls for earlier school attitudes). Similarly, Valiente et al. (2008) found that teacher–student relationship quality (i.e., composite of high closeness, low conflict) mediated the concurrent association between effortful control and achievement among elementary school children (7 to 12-year-olds). These two prior mediation studies examined teacher–student relationship quality as a unitary construct. Thus, we examined the mediating role of both teacher–student closeness and conflict to assess what aspect(s) of the teacher–student relationship may be the target for intervention and professional development training for early childhood educators.

The Present Study

In the present study, we examined whether effortful control in kindergarten predicted academic achievement in first grade, controlling for earlier achievement. We also examined whether teacher–student closeness and conflict in kindergarten individually mediated the proposed association between effortful control and academic achievement. We used multi-informant reports and a behavioral measure to assess effortful control, and standardized assessments of achievement to reduce shared method variance biases and provide a stronger test of study hypotheses. Furthermore, we used a longitudinal design based on variables assessed from kindergarten to first grade.

We controlled for socioeconomic status, sex, ethnicity, and age given their previous associations with effortful control (Li-Grining, 2007; Matthews, Ponitz, & Morrison, 2009; Wanless, McClelland, Tominey, & Acock, 2011), teacher–student relationship quality (Garner & Mahatmya, 2015; Jerome, Hamre, & Pianta, 2009; Silva et al., 2011), and academic achievement (Duncan et al., 2007; Valiente et al., 2011). Furthermore, as discussed previously, one major critique of previous research on the association between effortful control and academic achievement has been the failure to control in analyses for background variables that could otherwise yield inflated associations (Jacob & Parkinson, 2015). To maximize the utility of longitudinal models, as recommended by Jacob and Parkinson (2015), we included prior achievement as a key control variable in our main effect and mediation models. We expected effortful control in kindergarten to predict higher academic achievement in first grade. In addition, we expected effortful control to predict high teacher–student closeness, which in turn would predict high academic achievement. The reverse pattern of relations was expected for teacher–student conflict.

Method

Participants

Participants were recruited during kindergarten ($N = 301$; 52% girls; $M_{\text{age}} = 5.48$ years, $SD_{\text{age}} = 0.35$ years) from five schools in a southwestern metropolitan area in the United States (Hernández et al., 2016). Two cohorts of children were drawn from 26 classrooms at the beginning of the academic year (2012 for cohort 1 and 2013 for cohort 2). Of approximately 541 children in the 26 classrooms, parents of 301 of children provided consent for their child to participate in the study. The recruitment rate in this community study (301 children comprising 56% of the potential pool of participants) is typical of similar studies of young children (e.g., McClelland et al., 2007). The majority of participating students were in the same schools in both kindergarten and first grade, with the exception of 48 students who moved to other schools in the greater area.

Participating children were from various ethnic backgrounds (53% Hispanic, 34% White, 3% Asian, 2% American Indian/Alaska Native backgrounds, 2% Black, 1% Other, 6% Unknown [percentages are rounded]) and had parents with varied education levels (30% of mothers and 39% of fathers completed high school or less, 31% of mothers and 24% of fathers attended some college, and 39% of mothers and 37% of fathers graduated from college) and family income (average: \$50,000 to \$69,999; range: > \$9,999 to \$100,000+).

Participants were generally representative of the student racial background composition from the schools where recruitment occurred (47% Hispanic, 37% White, 3% Asian, 2% American Indian/Alaska Native backgrounds, 8% Black, 3% two or more races [percentages are rounded]). In the schools, 56% of students qualified for free or reduced lunch at the beginning of the study, meeting 130% poverty level [free meal equivalent to \$36,283 annual income for a family of five in 2014-2015] or 185% poverty level [reduced price equivalent to \$51,634 annual income for a family of five in 2014-2015]). This rate was similar to the percentage (57%) of students qualifying for free or reduced lunch at the state level.

Procedure

The main measures included parents', teachers', and observers' ratings of children's effortful control, a computerized assessment of a continuous performance task (a behavioral index of effortful control), teachers' ratings of teacher-student closeness and conflict, and standardized assessments of academic achievement. Teachers received a questionnaire for each participating child during the fall and spring semesters of kindergarten (100% [fall] and 95% [spring] response rate). Parents received a questionnaire for each participating child during the fall semester of kindergarten (79% response rate). Teachers and parents were compensated \$15 and \$30, respectively, for each survey. Children received two small toys for their participation.

Prior to rating child interactions in participating schools, observers received several weeks of training. At the end of the observational period, typically lasting nine to twelve weeks, observers rated children's effortful control on a questionnaire. A separate group of research assistants administered standardized assessments of achievement in designated rooms (to minimize distraction) in the latter part of the spring semesters of kindergarten and first grade. These research assistants attended two 2.5-hour trainings per week for five weeks before data collection started. During these training sessions, research assistants received instruction on how to administer the standardized assessments as described in the Woodcock-Johnson III Examiner's Manual (Mather & Woodcock, 2001).

Measures

Academic achievement (spring of kindergarten and first grade)—Academic achievement was assessed with the Woodcock-Johnson III Tests of Achievement (Woodcock, McGrew, & Mather, 2001). In the spring semesters of kindergarten and first grade, students completed the passage comprehension (i.e., reading) and applied problems (i.e., math) subtests in either English or Spanish. One child in kindergarten completed both assessments in Spanish and one child in first grade completed the passage comprehension assessment in Spanish. Raw test scores were converted to W-scores representing equal-interval units in a Rasch scale. Passage comprehension and applied problem scores were correlated in kindergarten ($r = .53$) and first grade ($r = .58$). These scores were averaged to create separate kindergarten and first grade academic achievement manifest variables used in subsequent analyses.

Teacher-student closeness and conflict (spring of kindergarten)—During mid-spring semester of kindergarten, teachers were asked to report on their closeness (8 items, e.g., “I share an affectionate, warm relationship with this child,” $\alpha = .81$) and conflict (7 items, e.g., “This child and I always seem to be struggling with each other,” $\alpha = .90$; see Pianta, Steinberg, & Rollins, 1995) with participants in their classroom using a scale from 1 (*definitely does not apply*) to 5 (*definitely applies*). This measure has been used in previous studies, showing strong psychometric properties and stability over time (Birch & Ladd, 1997; Portilla et al., 2014). Items from the teacher-student closeness scale were randomly assigned and averaged to create three parcel indicators for a teacher–student closeness latent factor. Similarly, items from the teacher-student conflict scale were randomly assigned and averaged to create three parcel indicators for a teacher-student conflict latent factor. Parceling helps increase the reliability of latent variables (Kishton & Widaman, 1994; Little, Cunningham, Shahar, & Widaman, 2002), as well as reduces the number of parameter estimates and indicator-to-sample ratio (Little, Rhemtulla, Gibson, & Schoemann, 2013).

Effortful control (fall of kindergarten)—The effortful control subscales of attention focusing, inhibitory control, and attention shifting were rated with the Children’s Behavioral Questionnaire (CBQ; Putnam & Rothbart, 2006; Putnam, Rothbart, & Gartstein, 2008) at the end of fall semester of kindergarten by parents and teachers. Two to three observers who had observed children at school for nine to twelve weeks in kindergarten also rated the attention focusing and inhibitory control subscales. The attention focusing subscale included items on the “capacity to maintain attentional focus on task-related channels” (Rothbart et al., 2001, p. 1406) (e.g., “When drawing or coloring in a book, shows strong concentration,” $\alpha = .81$ [parent, 13 items], $\alpha = .93$ [teacher, 11 items], $\alpha = .95$ [observer, 5 items]). The inhibitory control subscale included items on the “capacity to plan and to suppress inappropriate approach responses under instructions or in novel or uncertain situations” (Rothbart et al., 2001, p. 1406) (e.g., “Is good at following instructions,” $\alpha = .81$ [parent, 13 items], $\alpha = .93$ [teacher, 13 items], $\alpha = .92$ [observer, 4 items]). The attention shifting subscale included items on the ability to shift attention from one task to another (Putnam et al., 2008, p. 389) (e.g., “Can easily leave off working on a project if asked,” $\alpha = .84$ [parent, 12 items], $\alpha = .94$ [teacher, 12 items]). All subscales were reported on a scale from 1 (*extremely false*) to 7 (*extremely true*).

For teacher- and observer-reported scales, some items in the CBQ were modified to reflect appropriate wording for children’s behavior in the classroom (e.g., “Tends to become sad if the family’s plans don’t work out” was modified to “Tends to become sad if plans don’t work out” in the current study). Furthermore, items for the teacher- and observer-reported scales included only those that were relevant to the context of observation in school. Observers did not fill out the attention shifting subscale, and only filled out the attention focusing and inhibitory control subscales, because most of the items in the attention shifting subscale were not relevant to the observer’s role in the classroom (e.g., “Sometimes doesn’t seem to hear me when I talk to her/him” or “It is hard to get her/his attention when s/he is concentrating on something.”) Furthermore, the number of items from the attention focusing and inhibitory control scales for observers was shortened to five and four items, respectively, to reduce the workload for the observers (who rated multiple children). Previous studies

have used teachers' reports of the CBQ (e.g., Eisenberg et al., 1997; Eisenberg et al., 2007), supporting the use of the measure in the school context, and observer reports of similar temperament-related measures (e.g., Taylor et al., 2013 used observer reports of attention and persistence).

The items from the subscales were significantly correlated within parent ($r_s = .42-.65$), teacher ($r_s = .75-.85$), and observer reports ($r = .89$, between attention focusing and inhibitory control). Scores for attention focusing, inhibitory control, and attention shifting were averaged to create separate parent- and teacher-reported effortful control scores. Likewise, attention focusing ($r_s = .32-.39$) and inhibitory control subscale scores ($r_s = .29-.45$) were significantly correlated across the two to three observers and therefore averaged across observers, and then these two subscales were subsequently averaged to create a single observer-reported effortful control score.

A computer-administered continuous performance task (CPT) was used as an indicator of effortful control (NICHD Early Child Care Research Network, 2003; Sulik, Eisenberg, Silva, Spinrad, & Kupfer, 2013). Children sat in front of a computer and were asked to press the space bar on the keyboard as soon as the target stimulus (i.e., fish) appeared on the screen. Eighty pictures of different objects (e.g., boat, flower) were randomly presented on the screen, as were 44 presentations of the target stimulus and 220 presentations of non-target stimuli. Stimuli appeared on the screen for 0.5 s with 1.5 s intervals between stimuli. To get the trial correct, children needed to press the space bar immediately upon seeing the target stimulus. All children had a sufficient number of trials (75% of trials) to be included in analyses. We used signal detection theory to score performance (Wickens, 2002). For each trial where a fish appeared, a score of 1 was assigned for a hit of the space bar or 0 was assigned for a missed press of the space bar. For each trial where a fish did not appear, the score of 1 was assigned for a correct rejection (i.e., no press of space bar) or 0 for a false alarm (i.e., pressed space bar). The proportion of correct hits for the trials with a fish and the proportion of incorrect hits for the trials without a fish (i.e., false alarms) were computed, and these proportions were converted into z scores. The difference between these two z scores was computed, labeled the detectability score, which allows the comparison of the means of the two distributions in a standard deviation metric. This detectability score represents how well children behaviorally discriminate between fish and no-fish trials during the sustained attention task, and was used as an indicator of effortful control. Effortful control measures from parents' reports, teachers' reports, observers' reports, and the laboratory detectability score from the continuous performance task were positively correlated ($r_s = .25$ to $.56$, $p_s < .001$, see Table 1).

Covariates (fall of kindergarten)—Age, Hispanic status (1 = *Hispanic*, 0 = *non-Hispanic*), gender (1 = *boy*, 0 = *girl*), and socioeconomic status were used as control variables.¹ Socioeconomic status was computed by averaging the z scores of family income and parents' education, $r(230) = .67$, $p < .001$.

¹Cohort did not relate to the outcome study variables and did not modify the pattern of results. In auxiliary analyses, we tested for group differences between boys and girls and found that the pattern of results reported in the final models was equivalent across sex. Similarly, moderation tests showed that the models were equivalent across Hispanic status.

Results

Descriptive Statistics and Correlations

Table 1 provides the descriptive statistics and correlations among the variables used in the present study. Parent-reported, teacher-reported, and observer-reported effortful control measures, along with the continuous performance measure, were positively correlated with academic achievement measures (except applied problems in first grade). Parent-reported and teacher-reported effortful control measures were positively correlated with teacher-student closeness (marginally significant for parent-reported effortful control). All four measures of effortful control were negatively correlated with teacher-student conflict. Teacher-student closeness was positively correlated with academic achievement measures in first grade, whereas teacher-student conflict was negatively correlated with academic achievement in kindergarten and first grade. The percentage of missing data ranged from 0 to 22% (the higher percent was only for parents' reports). Eighty-three percent of children who began the study in kindergarten participated in first grade. Children who had missing data, compared to those who had complete data, did not differ on background covariates, based on *t* tests, with one exception; children who did not participate in the first grade assessment were from lower socioeconomic backgrounds, $t(299) = 3.07, p < .05$.

Preliminary Analyses

Before testing our proposed models, we evaluated the measurement model for the study variables in a structural equation model (SEM) using *Mplus* v7.11 (Muthén & Muthén, 1998-2014). To account for the clustering of data by kindergarten classroom and missing data, we used the 'Type = Complex' command and full information maximum likelihood (FIML) estimation with robust standard errors (MLR). Using FIML, all possible cases ($N = 301$) were included in the analytic sample. The confirmatory factor analysis with latent variables (i.e., effortful control, teacher-student closeness, teacher-student conflict) and their respective measures, as well as manifest focal variables of interest (i.e., academic achievement in kindergarten and first grade), showed acceptable fit to the data: MLR $\chi^2(74) = 172.397, p < .001, CFI = .94, RMSEA = .07, 90\% CI [.05, .08]$. All unstandardized and standardized factor loadings were statistically significant. Effortful control in the fall of kindergarten had four indicators (i.e., parent-reported, teacher-reported, and observer-reported effortful control, and CPT; standardized factor loadings from .39-.80). Teacher-student conflict in the spring of kindergarten included three parcels as indicators (standardized factor loadings ranged from .68-.93). Teacher-student closeness in the spring of kindergarten had three parcels as indicators (standardized factor loadings ranged from .76-.82).

Main Effects Structural Model

The hypothesized main effects model was tested within an SEM framework (see Figure 1). Age, Hispanic status, male, and socioeconomic status were included as covariates. We regressed academic achievement (at first grade and kindergarten) on effortful control as well as the covariates and allowed all independent variables to correlate (i.e., the covariates and effortful control); first grade achievement was also regressed on kindergarten achievement.

The main effects model showed adequate fit, MLR $\chi^2(20) = 32.18, p = .04, CFI = .98, RMSEA = .05, 90\% CI [.01, .07]$. Effortful control positively predicted academic achievement in first grade, standardized beta coefficient (b^*) = .19, $p = .002$, controlling for academic achievement in kindergarten (see Figure 1) and other covariates. Effortful control also positively predicted academic achievement in kindergarten, $b^* = .35, p < .001$. Academic achievement in kindergarten predicted academic achievement in first grade, $b^* = .63, p < .001$.

There were some relations between the covariates and focal variables. Age, $b^* = .00, p = 1.0$, and Hispanic status, $b^* = -.10, p = .06$, did not predict academic achievement in kindergarten. However these variables were related to academic achievement in first grade; older children, $b^* = -.09, p = .01$, and Hispanic children, $b^* = -.14, p = .003$, had lower academic achievement in first grade. Boys had higher academic achievement in kindergarten, $b^* = .12, p = .03$, and first grade, $b^* = .11, p = .001$. Socioeconomic background was positively associated with academic achievement in kindergarten, $b^* = .37, p < .001$, and first grade, $b^* = .07, p = .05$.

Mediated Effects Structural Model

Figure 2 displays standardized parameter estimates for an SEM model identifying the associations between effortful control and academic achievement via teacher–student relationship closeness and conflict, controlling for earlier levels of academic achievement and other covariates. Covariates (i.e., age, Hispanic status, sex, socioeconomic status) were included but are not depicted to ease interpretation; we regressed academic achievement (at first grade and kindergarten), teacher–student conflict, and teacher–student closeness on the covariates and allowed the covariates to correlate with each other and with effortful control. The mediation model showed adequate fit, MLR $\chi^2(74) = 172.40, p < .001, CFI = .93, RMSEA = .07, 90\% CI [.05, .08]$. Effortful control negatively predicted teacher–student conflict, $b^* = -.77, p < .001$, and positively predicted teacher–student closeness, $b^* = .28, p = .01$, and academic achievement in kindergarten, $b^* = .35, p < .001$. Teacher–student closeness, $b^* = .11, p = .02$, and effortful control, $b^* = .24, p = .02$, positively predicted academic achievement in first grade. In contrast, teacher–student conflict did not significantly predict academic achievement in first grade, $b^* = .11, p = .25$. Covariates predicted academic achievement in kindergarten and first grade in a similar pattern as Model 1 (i.e., the main effects model). Furthermore, older children had higher teacher–student conflict than younger children, $b^* = .16, p = .003$, and boys had lower teacher–student conflict than girls, $b^* = -.13, p = .03$. Teacher–student conflict had an unexpected positive correlation with kindergarten academic achievement. However, this positive relation is between the *residuals* of teacher–student conflict and kindergarten academic achievement once effortful control and other covariates are controlled. Although inconsistent with the negative bivariate correlations documented in Table 1, such an effect is feasible in an SEM such as the one modeled (Kline, 2011; MacKinnon, Krull, & Lockwood, 2000), and thus should not be discounted but should be interpreted only within the context of all variables in the study. The bivariate correlation is, thus, the best description of the solitary association between teacher–student conflict and kindergarten academic achievement.

Indirect effects were tested with R mediation (see Tofighi & MacKinnon, 2011). These tests revealed that effortful control indirectly predicted higher academic achievement in first grade, via its effects on teacher–student closeness $b^* = .03$, $p = .03$, and academic achievement in kindergarten, $b^* = .22$, $p < .001$.

Discussion

Using a longitudinal design, the present study tested (1) whether effortful control in the fall of kindergarten predicted later academic achievement in the spring of first grade and (2) if teacher–student closeness and conflict in the spring of kindergarten mediated the association between effortful control in the fall of kindergarten and academic achievement in the spring of first grade. This study provided a rigorous test of the associations given that we statistically controlled for earlier levels of academic achievement as well as other demographic variables. Furthermore, the study included multiple reporter methods of assessment, reducing shared method variance bias. Additionally, the ethnic backgrounds of study participants were generally representative of those in the schools where recruitment took place (53% of study participants being of Hispanic heritage), providing generalizability of results to a diverse population. However, African American students were underrepresented compared to the schools' and national estimates, warranting future research at a national level.

Effortful Control and Academic Achievement

Children with higher levels of effortful control in kindergarten had significantly higher academic achievement in first grade, even when controlling for kindergarten academic achievement. This finding is consistent with prior theoretical propositions (Blair & Raver, 2015; Eisenberg, Valiente, & Eggum, 2010) and empirical research (e.g., Allan et al., 2014; Cerda et al., 2014; Valiente et al., 2010; Zhou et al., 2010), and contrary to some null findings (e.g., Liew et al., 2010). Although the effect was relatively small (i.e., $b^* = .19$), an effect size of this magnitude is similar to other studies in this research area (Jacob & Parkinson, 2015), and small effects sizes have practical implications for social science data (Ferguson, 2009). Given the population estimates of passage comprehension and applied problems, a one-standard deviation change in EC would equate to about a 5.2-point increase in passage comprehension and about a 4.3-point increase in applied problems (this being based on population estimates from 7-year-olds, as reported in the exam's technical manual; McGrew & Woodcock, 2001). This increase in academic achievement would be especially critical for children who are at the lower end of achievement, and could be the difference between being classified low average or average, for example. Effortful control is but one of many factors associated with academic achievement and could potentially have an increased association together with other variables and in a cascade of effects on academic functioning. Examining potential moderators of this association will be an important future step. These findings, although not a substitute for findings from experimental studies, represent an important advancement because we include statistical controls for prior levels of academic achievement and other covariates. Thus, the potential impact of interventions designed to foster effortful control and promote academic achievement should not be discredited on the basis of prior, primarily concurrent studies that have lacked strong

statistical controls (Jacob & Parkinson, 2015). That is, the study's findings contribute to our understanding of how effortful control and academic achievement relate, and further research testing the study's hypotheses would help in the development of this research area. Although findings in this study could use further replication, the implications of this study suggest that programs that focus and invest in both early achievement skills and effortful control abilities would promote child academic development. We also argue that the role of effortful control on academic achievement should be interpreted within the context of other proximal processes occurring in the classroom. When we considered potential mechanisms in the association between effortful control and academic achievement, a nuanced process emerged.

The Mediating Role of Teacher–Student Relationship Quality

The hypothesis that teacher–student closeness and teacher–student conflict both would mediate the association between effortful control and academic achievement was partially supported. One of the prerequisites for the proposed mediation was that effortful control would predict teacher–student closeness and conflict, which was supported in our analytical model using longitudinal data. Only a couple of studies have examined this association across time (Portilla et al., 2014; Rudasill & Rimm-Kaufman, 2009). Interestingly, effortful control predicted teacher-student conflict at a larger magnitude than teacher-student closeness in the model, consistent with the zero-order correlations. Rudasill et al. (2010) found that difficult temperament (which included measures of low effortful control) predicted teacher-student conflict, but not closeness, among older children, which is somewhat consistent with the current findings in that effortful control was a stronger predictor of teacher–student conflict than closeness. Thus, children who are particularly low in effortful control may be more likely to encounter difficulties with teachers in school. Children's problematic interactions with teachers likely reflect deficits in children's overt self-regulatory behaviors, whereas children's close interactions with teachers could be less associated with children's self-regulatory behaviors. Additional factors, including teacher characteristics (Zinsser, Denham, Curby, & Shewark, 2015) or children's approach behaviors (Rudasill & Rimm-Kaufman, 2009), may help explain how children's effortful control relates to teacher–student closeness and conflict. As mentioned previously, we investigated teacher-student closeness and conflict separately, as opposed to a composite of the two, because we were interested in examining their unique prediction in our proposed model and prior research suggested varying correlates for these two dimensions (Portilla et al., 2014; Rudasill et al., 2010). Given our findings, future research should be conducted to clarify what aspects of the teacher–student relationship are predictive and whether predictions hold across domains. Additionally, person-centered analyses can further clarify the association between teacher-student conflict and academic achievement. Furthermore, we note that teacher-student closeness and conflict were measured from the teacher's perspective. Thus, the findings need be considered as such, and future research should make use of observer or child reports of the quality of teacher–student relationship as they may vary.

Similar to findings from Birch and Ladd (1997), only teacher-student closeness uniquely predicted academic achievement, controlling for earlier achievement levels. Thus, even though teacher-student closeness and conflict tended to be correlated with first grade

achievement, teacher-student closeness – but not teacher–student conflict – was a significant mediator in the proposed models. Consistent with the need-to-belong hypothesis which proposes that having an attachment to others is a basic necessity (Baumeister & Leary, 1995), children who form positive bonds with teachers may adjust better to academic demands. Thus, based on the need for attachment to others, teacher–student closeness may serve as motivation for academic competency more than teacher–student conflict acts as a deterrent. Likewise, from a self-determination perspective (La Guardia & Patrick, 2008; Ryan & Deci, 2000), students have a basic need for relatedness in addition to autonomy and competence. Perhaps a close student-teacher relationship, more so than one prone to conflict, meets this need and is most associated with later measures of success in the academic domain. Alternatively, teacher–student conflict may be associated with achievement only when not taking into account children's effortful control and their closeness to the teacher. In auxiliary analyses, we found that teacher-student conflict negatively predicted academic achievement ($b^* = -.08, p = .05$; albeit in small magnitude), only when both effortful control and teacher-student closeness were not included in the same model. Thus, not including effortful control and teacher-student closeness would yield less accurate results with respect to conflict. These results have implications for promoting teacher-student relationship closeness as a means to foster high academic achievement at an early point in schooling. However, the effect size of teacher-student closeness mediating the association between effortful control and academic achievement was small when analyses controlled for prior achievement and other covariates. The finding that effortful control was associated with academic achievement was a stronger result in the study.

Our results provide preliminary support for the importance of fostering positive teacher-student interactions to enhance children's academic experiences. There is some empirical evidence for the effectiveness of interventions aimed to enhance the teacher-student relationship among adolescents (Gehlbach et al., 2016) and the present study's findings suggest similar intervention research on improving teacher-student interactions with younger children may be quite useful. Furthermore, academic achievement in kindergarten also mediated the association between effortful control and later academic achievement, emphasizing the importance of addressing academic development early in students' schooling.

Limitations and Future Directions

Despite a number of strengths, there are limitations that should be considered when interpreting the findings. We used FIML to account for missing data; however, children who did not participate in the first grade assessment of academic achievement were from lower socioeconomic backgrounds. Thus, results should be interpreted cautiously, as some findings may have been underestimated. In addition, only teachers reported on their level of conflict and closeness with a student, which provides a limited perspective on the teacher-student relationship and a limitation of some shared method variance. Based on some auxiliary analyses, some of the relation from effortful control to teacher–student closeness was partly a result of shared experiences in school between teacher and student, or teacher perceptions of both effortful control and their relationships with students.² Thus, there is a need to further evaluate the role of teacher–student relationship quality in the association between

effortful control and academic achievement across multiple assessments and reporters. This limitation can be overcome by direct observations of teacher instruction, behaviors in the classroom, and interactions with students, which may help give a nuanced perspective on the association between children's effortful control and the teacher–student relationship; for example, the quality of instruction may foster children's regulatory behaviors more broadly in the classroom (Rimm-Kauffman, Curby, Grimm, Nathanson, & Brock, 2009). Similarly, teachers' interaction styles in the classroom (such as behavioral and psychological control) have been associated with children's academic achievement (Viljaranta et al., 2015). Furthermore, studies examining more predictors of teacher-student closeness would benefit from our understanding of the process in this study, especially given that the variables in the study explained a small amount of the variance in teacher-student closeness.

Future studies should examine possible bidirectional or cascading associations between the teacher-student relationship and achievement. For instance, it is possible that students with higher initial academic ability have fewer problems with teachers because they have a stronger skillset to excel in social and academic tasks (Hernández et al., 2016; Jerome et al., 2009; Justice, Cottone, Mashburn, & Rimm-Kaufman, 2008). The temporal ordering of the present study's variables precluded our ability to examine this possibility given that prior academic achievement and teacher-student relationship measures were assessed concurrently. Future research with more waves of data could overcome this limitation and provide a more refined view of the longitudinal associations between the teacher–student relationship and academic achievement with a person-centered framework.

We were interested in examining the association between key variables in the transition from kindergarten to first grade, given shifting classroom demands. The processes we describe may be a part of cascading mechanisms in early childhood and before formal schooling. For example, infant temperament, which includes regulatory processes, predicts children's social behaviors in kindergarten (Rimm-Kauffman & Kagan, 2005). Furthermore, there is some evidence that positive social relationships with parents might promote children's self-regulation (Eisenberg, Cumberland, & Spinrad, 1998; Morris, Silk, Steinberg, Myers, & Robinson, 2007; Spinrad et al., 2004; Spinrad et al., 2012). Thus, future research examining the home-to-school transition and both parent-child and teacher-child relationship dynamics would help clarify how effortful control functions in school.

One additional limitation of this study was our inability to examine bidirectional effects given the timing of data collection. For example, Bohlmann, Maier, and Palacios (2015) found a bidirectional association between effortful control and expressive language in the transition from preschool to kindergarten (but not across preschool), which has implications for later academic achievement. Similarly, Swanson, Valiente, Lemery-Chalfant, Bradley, and Eggum-Wilkens (2014) reported that math achievement (assessed in the spring term of

²In order to examine if reporter bias could account for the pattern of results, we also modeled the effortful control latent variable with parent-reported inhibitory control, attention focusing, attention shifting, and the continuous performance task score as indicators (dropping the teacher-reported indicators for both effortful control); thus, teachers' reports were not indicators of both effortful control and teacher-student closeness and conflict in this model. The pattern of results remained the same, albeit the path from effortful control to teacher–student closeness weakened ($b^* = .151, p = .076$) suggesting the possibility and limitation of some shared method variance in the original analytic approach reported.

kindergarten) predicted parent-reported effortful control (assessed in the fall term of first grade) in the transition from kindergarten to first grade, and vice versa from first to second grade. Future research should consider similar bidirectional pathways between effortful control and academic-related skills, as this has implications for the development of prevention programs designed to improve both academic and behavioral adjustment. Additionally, in this study, teacher-student closeness in kindergarten might have predicted academic achievement in first grade because early experiences in school set the stage for positive interactions in school, perhaps having spillover influences on first grade experiences. Pianta and Stuhlman (2004) found that only first grade (and not kindergarten) teacher-student closeness and conflict predicted first grade teachers' reports of achievement. Thus, future research examining the stability of teacher-student closeness and conflict and their associations with academic outcomes would be useful for enriching developmentally based theoretical frameworks.

Future research examining other classroom-specific child behaviors that may mediate the association between effortful control and achievement, such as active engagement in learning tasks (Nesbitt et al., 2015), will help clarify various proximal processes involved. Furthermore, examining a range of academic adjustment measures, including creativity and critical thinking, will contribute to our understanding of the role of regulatory processes and social relationships in school in a variety of academic competencies.

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Research Highlights

- Effortful control in kindergarten predicts higher academic achievement in kindergarten and first grade.
- Effortful control predicts higher teacher-student closeness and lower conflict.
- Teacher-student closeness, but not conflict, predicts academic achievement in first grade.
- Teacher-student closeness mediates the association between effortful control and academic achievement in first grade.

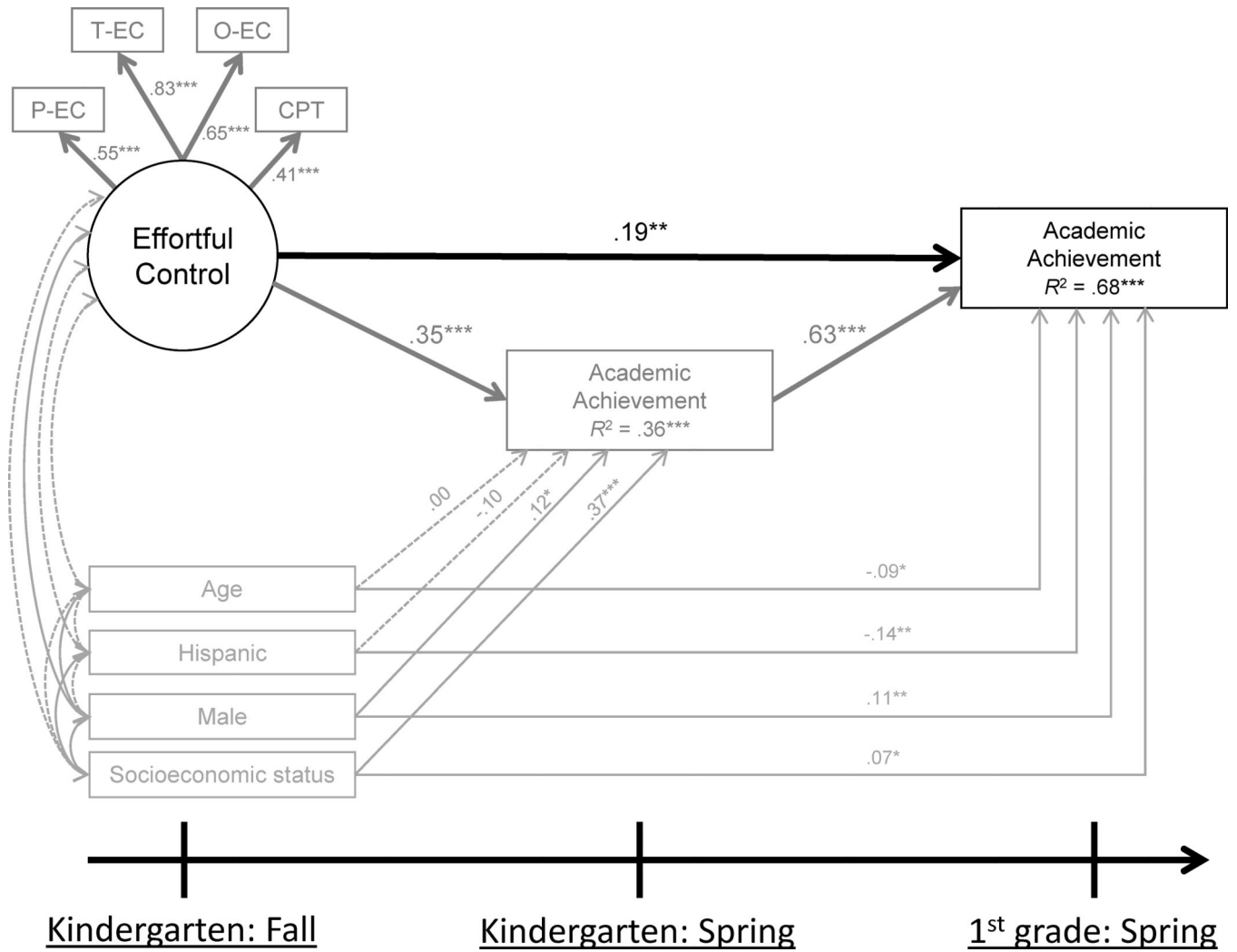


Figure 1. Effortful control predicting academic achievement in first grade, controlling for academic achievement in kindergarten and other covariates (i.e., age, Hispanic, male, socioeconomic status). Coefficients and factor loadings are standardized. P-EC = parent-reported effortful control; T-EC = teacher-reported effortful control; O-EC = observer-reported effortful control; CPT = continuous performance task score [†] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

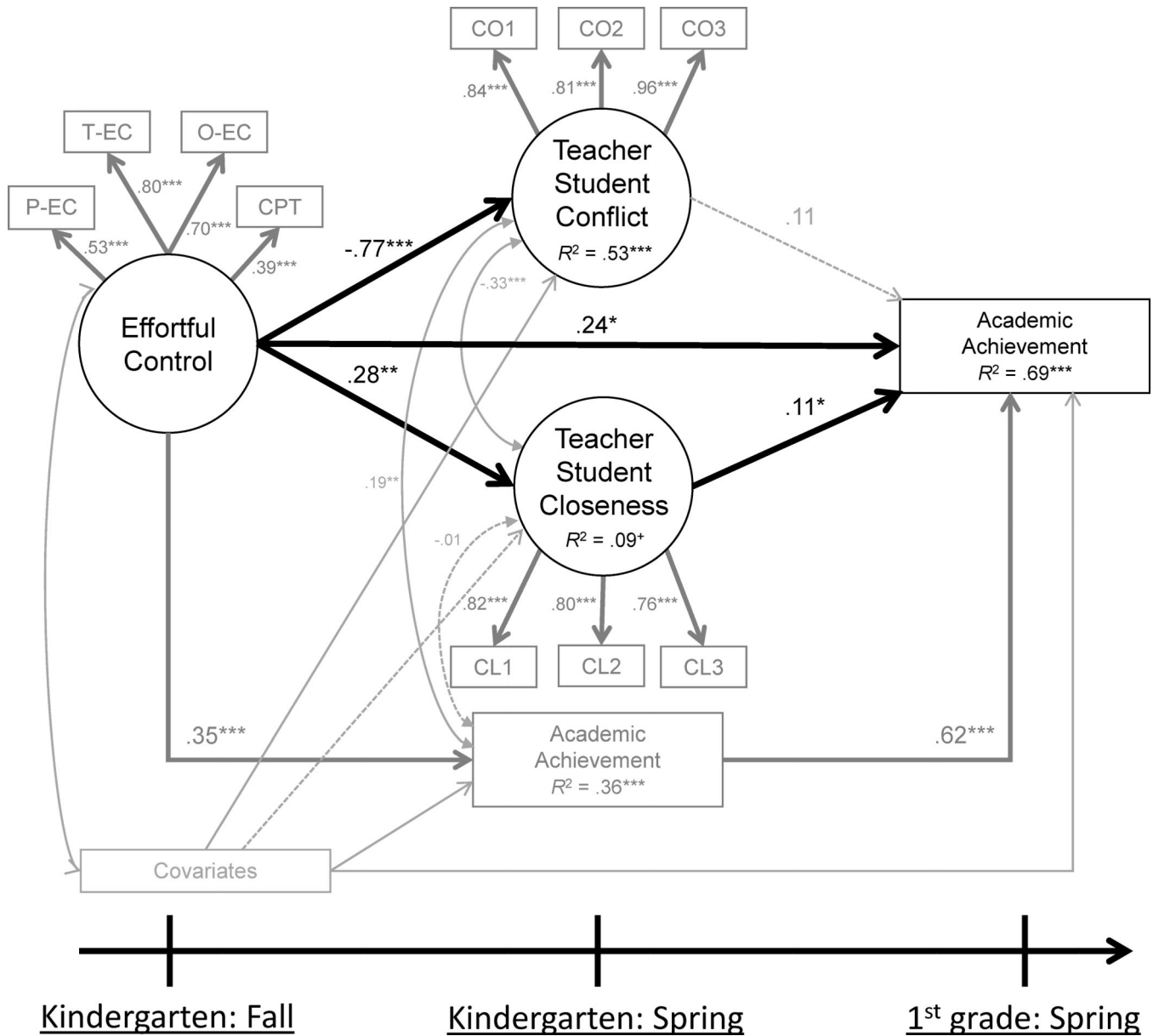


Figure 2. Effortful control, teacher–student relationship quality, and academic achievement from kindergarten to first grade, controlling for academic achievement in kindergarten and covariates child age, Hispanic status, male, and socioeconomic status. Coefficients and factor loadings are standardized. Nonsignificant paths are dashed. Specific covariates predicted academic achievement in kindergarten and first grade in a similar pattern as in Model 1. P-EC = parent-reported effortful control; T-EC = teacher-reported effortful control; O-EC = observer-reported effortful control; CPT = continuous performance task score; CO = teacher–student conflict parcel; CL = teacher–student closeness parcel. $^+p < .10$. $^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 1

Descriptive Statistics and Correlations among Study Variables (N = 301)

| | Source | Time | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|-------------------------------------|----------|------------|---------|---------|---------|----------|---------|--------|---------|---------|---------|---------|---------|------|---------|----------|
| Effortful control | | | | | | | | | | | | | | | | |
| 1. Effortful control | Parent | Fall K | --- | | | | | | | | | | | | | |
| 2. Effortful control | Teacher | Fall K | .46*** | --- | | | | | | | | | | | | |
| 3. Effortful control | Observer | Fall K | .34*** | .56*** | --- | | | | | | | | | | | |
| 4. Continuous performance | CPT | Fall K | .25*** | .30*** | .27*** | --- | | | | | | | | | | |
| Teacher-student relationship | | | | | | | | | | | | | | | | |
| 5. Teacher-student closeness | Teacher | Spring K | .12† | .27*** | .08 | .01 | --- | | | | | | | | | |
| 6. Teacher-student conflict | Teacher | Spring K | -.30*** | -.54*** | -.53*** | -.19*** | -.36*** | --- | | | | | | | | |
| Academic achievement | | | | | | | | | | | | | | | | |
| 7. Applied problems | WJ | Spring K | .21*** | .25*** | .20* | .27*** | .08 | -.14* | --- | | | | | | | |
| 8. Applied problems | WJ | Spring 1st | .13† | .24*** | .13* | .12† | .15* | -.14* | .09*** | --- | | | | | | |
| 9. Passage comprehension | WJ | Spring K | .15* | .27*** | .22*** | .19*** | .06 | -.14* | .53*** | .52*** | --- | | | | | |
| 10. Passage comprehension | WJ | Spring 1st | .22*** | .31*** | .17*** | .14* | .13* | -.17** | .54*** | .58*** | .62*** | --- | | | | |
| Covariates | | | | | | | | | | | | | | | | |
| 11. Age | Parent | Fall K | .06 | .12* | .08 | -.07 | .06 | .04 | .03 | -.02 | .02 | -.09 | --- | | | |
| 12. Male | Parent | Fall K | -.13* | -.16** | -.08 | -.22*** | -.10† | .03 | .16** | .24*** | .03 | .01 | .12* | --- | | |
| 13. Hispanic | Parent | Fall K | -.06 | -.02 | -.06 | .03 | -.04 | -.01 | -.27*** | .29*** | -.19*** | -.31*** | .11† | -.08 | --- | |
| 14. Socioeconomic status | Parent | Fall K | .11 | .12* | .12* | .18** | -.01 | -.05 | .46*** | .38*** | .39*** | .41*** | -.10† | .11† | -.38*** | --- |
| <i>M</i> | | | 4.83 | 4.80 | 5.32 | 2.94 | 4.38 | 1.55 | 442.84 | 461.72 | 428.53 | 464.67 | 5.48 | .49 | .57 | -0.04 |
| <i>SD</i> | | | .77 | 1.21 | .96 | .90 | .63 | .86 | 15.83 | 16.31 | 20.96 | 18.47 | .35 | .50 | .50 | 0.90 |
| <i>Possible min/max</i> | | | 1/7 | 1/7 | 1/7 | # | 1/5 | 1/5 | 500/2 | 500/2 | 500/2 | 500/2 | ## | 0/1 | 0/1 | # |
| <i>Actual min/max</i> | | | 2.7/6.7 | 1.4/7 | 1.4/6.9 | -.16/4.5 | 1.5/5 | 1/5 | 388/504 | 403/528 | 368/503 | 391/525 | 4.3/6.8 | 0/1 | 0/1 | -1.8/1.2 |

Note. Male (1 = boy; 0 = girl); Hispanic (1 = Hispanic, 0 = non-Hispanic); CPT = Continuous performance task; WJ = Woodcock-Johnson assessment; Fall K = fall, kindergarten; Spring K = spring, kindergarten; Spring 1st = spring, first grade; Min = minimum; Max = maximum. # There is no exact possible range for the difference or average of standardized variables. ## Age admission policies vary by schools, including family requests to enroll a child earlier or later than typical; a range of possible ages is not listed.

^aThe scale for each test is centered to a W score of 500, which is the average performance of 10-year-olds, but the range of possible scores is not listed in the Woodcock-Johnson III Tests of Achievement Technical Manual. † $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.