



Published in final edited form as:

*J Appl Dev Psychol.* 2021 ; 74: . doi:10.1016/j.appdev.2021.101265.

## School Readiness and Achievement in Early Elementary School: Moderation by Students' Temperament

Carlos Valiente<sup>1</sup>, Leah D. Doane<sup>2</sup>, Sierra Clifford<sup>2</sup>, Kevin J. Grimm<sup>2</sup>, Kathryn Lemery-Chalfant<sup>2</sup>

<sup>1</sup>Arizona State University, T. Denny Sanford School of Social and Family Dynamics

<sup>2</sup>Arizona State University, Department of Psychology

### Abstract

The goals of this study were to examine the longitudinal relations between school readiness and reading and math achievement and to test if these relations were moderated by temperament. The sample included socio-economically and ethnically diverse twins ( $N=551$ ). Parents reported on school readiness when children were five years old. Teachers reported on temperament (effortful control, anger, and shyness) three years later. Standardized measures of reading and math were obtained when children were eight years old. Effortful control and shyness moderated the effect of school readiness on reading. Prediction of reading from school readiness was strongest when students were high in effortful control and low in shyness. Effortful control and shyness predicted math beyond school readiness. There were no relations involving anger. Findings demonstrate that temperament can potentiate the relations between school readiness and reading and highlight the importance of promoting school readiness and effortful control, while decreasing shyness.

### Keywords

School readiness; Temperament; Academic Achievement

---

Children's performance during the early academic years provides an important foundation for later success in academic, social, and economic domains (Vitaro et al., 2014). Given the importance of the first few years of formal schooling, significant scholarly attention has been devoted to identifying characteristics that either advance or hinder reading and math achievement during this timeframe. According to a human capital perspective and

---

corresponding author: Valiente, valiente@asu.edu; 480.727.7569.

Author Statement

**Carlos Valiente:** Conceptualization, Methodology, Formal Analysis, Writing – Original Draft, Funding Acquisition

**Leah D. Doane:** Conceptualization, Methodology, Investigation, Writing – Review & Editing, Project Administration, Funding Acquisition

**Sierra Clifford:** Investigation, Writing – Original Draft, Visualization

**Kevin J. Grimm:** Formal Analysis, Data Curation, Writing – Review & Editing

**Kathryn Lemery-Chalfant:** Conceptualization, Methodology, Investigation, Writing – Review & Editing, Project Administration, Funding Acquisition

**Publisher's Disclaimer:** This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

temperament theorists, the extent to which children are ready to learn when they enter formal schooling is an important contributor to later success in the academic domain (Blair & Raver, 2015; Heckman, 2000). Although there is support for these ideas, there are suggestions from empirical and theoretical literatures that the relations between school readiness and achievement may be amplified or attenuated based on students' temperament (Cunha & Heckman, 2007; Heckman, 2000; Rothbart & Bates, 2006). Evidence of moderation can explain some of the conditions which enhance, or reduce, the relations between school readiness and achievement. Rigorously testing if temperament moderates the relations between school readiness and later achievement is important given evidence that relations between school readiness and later achievement are modest, and sometimes subject to fadeout (Bailey et al., 2017; Duncan et al., 2007; La Paro & Pianta, 2000). Findings from this study can be used to inform policy, education, and intervention programs of ways to support young children's experiences prior to formal schooling.

Developing a better understanding of ways to foster students' achievement is critical given the significant academic challenges faced by many students. According to the National Science Board (2018), only 40% of fourth graders reached proficiency in mathematics and a separate report on reading indicated that only 37% of fourth graders were proficient in reading (The Nations Report Card, 2018). Further, the percentages of students at levels of proficiency or higher declines as they progress through high school. If academic problems persist and result in the student not earning a high school diploma, there is increased risk for a host of negative outcomes (e.g., unemployment, underemployment, criminal behavior, Vitaro et al., 2014). Efforts to reduce these negative outcomes often have roots in the premise that experiences prior to the start of formal schooling play a significant role in either promoting or hindering academic achievement (Boivin & Bierman, 2014).

## School Readiness and Academic Achievement

There are many potential ways to conceptualize and define school readiness. Illustratively, components of school readiness sometimes include age, cognitive abilities, health, communication abilities, attitudes regarding school, social and emotional competence, and pre-mathematics and pre-language abilities (Boivin & Bierman, 2014; NAEYC, 2009; Snow, 2006). Informed by this scholarship, Boivin and Bierman (2014) defined school readiness as, "basic skills that children need to possess at school entry in order to adapt successfully to the school environment and to learn and achieve at a satisfying level" (p. 5). We focus on the academic component of school readiness due to evidence that this component is often related to students' achievement (Duncan et al., 2007; La Paro & Pianta, 2000). The academic component involves skills such as listening comprehension, phonological and print awareness, identification/recognition skills, and counting (Duncan et al., 2007; Zhou et al., 2010).

According to multiple research groups, when students enter kindergarten high in school readiness they likely have the necessary skills to engage in positive classroom interactions that further advance achievement (Cunha et al., 2006; Entwisle et al., 2005; La Paro & Pianta, 2000; Romano et al., 2010). The associations between school readiness and achievement can be understood from a human capital perspective. Working from this model,

Heckman (2000) argued, “Learning begets learning. Skills acquired early on make later learning easier” (p. 8). Consistent with these ideas, students high in school readiness are not only active contributors to their own academic success, but they may also evoke high-levels of positive feedback from teachers and peers, high-quality instruction, and they may be selected to participate in more advanced activities that provide further opportunities for accelerated growth in academics.

Many research teams have examined the relations between the academic indices of school readiness we consider and children’s later school achievement. Findings support the premise that this form of school readiness is often related to indices of reading and math achievement (Chew & Morris, 1989; Kurdek & Sinclair, 2000; Lemelin et al., 2007). Significant relations are often identified regardless of whether achievement is assessed by the teacher or a standardized assessment (La Paro & Pianta, 2000). Although these findings clearly indicate the value of working to help children be ready for school, longitudinal prediction of achievement from school readiness is generally only modest (Duncan et al., 2007; La Paro & Pianta, 2000). According to Boivin, Desrosiers, Lemelin, and Forget-Dubois (2014), the best available evidence is that academic school readiness accounts for only 25% of the variance in achievement measures and there is a need to understand the role of other factors. In addition, it is not uncommon for intervention programs designed to improve school readiness and achievement to initially obtain significant effects, but to later observe loss of the initial gains (Bailey et al., 2017; Bailey et al., 2016; Clements et al., 2013).

We argue that efforts to address these problems can be informed by considering fadeout experiences. Fadeout is the process whereby an initial asset decreases in value over time. A fadeout process might occur for school readiness and later achievement if other factors become increasingly important in the school setting or if the presence of risk factors undermine the potential contributions of school readiness. Likewise, working from human capital perspective, Cunha and Heckman (2007) introduced the notion of dynamic complementarity to suggest that skills acquired at one time point play a role in the impact of other skills on key outcomes. Using the variables considered here as an example, students’ temperament can boost (or potentially dampen) the relation between school readiness and later academic outcomes. These ideas are consistent with the perspective that development can be more fully understood by considering moderating processes (Luthar et al., 2000; Rothbart & Bates, 2006). Developing a greater understanding of processes that might enhance, or reduce, the relations between school readiness and achievement can aid efforts to help children’s educational experiences.

## Temperament and Academic Achievement

The accumulated evidence indicating that children’s temperament is important to their school-related behaviors and academic achievement suggests that components of temperament represent a potential set of variables that might amplify or undermine the relations between school readiness and achievement (Blair & Raver, 2015; Liew et al., 2019; Valiente, Swanson, & Eisenberg, 2012). Temperament is often defined as, “constitutionally based individual differences in reactivity and self-regulation, in the domains of affect, activity, and attention” (Rothbart & Bates, 2006, p.100). Reactivity involves the,

“arousability of motor, affective, and sensory response systems” (Rothbart et al., 2001, p. 1395), and is often assessed with measures of negative emotionality. Self-regulation, in contrast, often involves effortful control processes (i.e., attentional focusing, inhibitory control). In this study, we focus on three dimensions of temperament (anger, effortful control, and shyness) that have been associated with students’ school experiences and learning (Blair & Raver, 2015; Liew et al., 2019; Valiente, Swanson, & Eisenberg, 2012). According to Rothbart and Jones (1998), temperament is important in the school context because it plays a role in how students respond to learning opportunities and obstacles that frequently occur in the classroom setting.

The role of anger. Anger generally involves negative emotionality stemming from the blockage of goals or interruption of activities (Rothbart & Bates, 2006). Although not all findings are consistent, anger is generally negatively related to academic achievement (Hernández, Eisenberg, Valiente, Thompson, et al., 2018; Kwon et al., 2017). Given the disruptive nature of anger (Denham et al., 2012; Hernández et al., 2016; Rothbart & Bates, 2006), we predict that anger will moderate the relations between school readiness and academic achievement. Specifically, we expect school readiness to be positively related to academic achievement at low, but not high, levels of anger. This prediction stems from the evidence that anger interferes with high levels of academic achievement via reducing cognitive resources available for problem solving and classroom engagement (Blair, 2002; Bohn-Gettler & Rapp, 2014; Valiente, Swanson, & Lemery-Chalfant, 2012). Anger is also known to interfere with the quality of relationships with peers and teachers, and both types of relationships are important for success in the academic arena (Hernández, Eisenberg, et al., 2017). As a result, we believe that high-levels of anger will dampen the otherwise positive benefits of school readiness. In one of the few studies on this topic, Hernández et al. (2018) found that students’ 1<sup>st</sup> grade reading was highest with the combination of high prior reading and low negative emotion.

The role of effortful control. Rothbart and Bates (2006) define effortful control as “the efficiency of executive attention, including the ability to inhibit a dominant response and/or to activate a subdominant response, to plan, and to detect errors” (p. 129). Effortful control is widely viewed as the regulatory component of temperament, partly because attentional abilities and the capacity to appropriately inhibit and activate behaviors are central to effortful control and the regulation of emotion and behaviors (Eisenberg et al., 2010; Rothbart & Bates, 2006). Effortful control, and self-regulation more broadly, is viewed as an important component of emotional competence (Denham et al., 2003). In addition, effortful control is believed to be positively associated with academic achievement. Effortful control is often an asset in the educational context because it assists students in blocking out distractors (e.g., noises, misbehaving peers) and in regulating their emotions and behaviors in ways that advance relationships and learning. A large body of evidence indicates that effortful control is positively related to positive interactions with both peers and teachers (Hernández, Valiente, et al., 2017; Rothbart & Bates, 2006). Effortful control is also often positively related to emotional and behavioral indices of school engagement (Valiente et al., 2007; Valiente et al., 2008). Blair (2002) and Pekrun (2006) theorized that students who are able to regulate emotions are likely able to reduce emotional worry and stress that would otherwise interfere with cognitive processes needed for learning. Given the positive

outcomes frequently associated with effortful control, we expect school readiness to be positively related to achievement at high levels of effortful control. Children low in effortful control may experience difficulties in the school environment that limit the extent to which they can acquire additional academic skills (Rothbart & Bates, 2006). As a result, early school readiness skills may not necessarily beget later academic skills for children low in effortful control (Heckman, 2000). Thus, the relation between school readiness and achievement may be non-significant at low levels of effortful control.

The role of shyness. Shyness can be defined as “wariness in the face of social novelty and/or self-conscious behavior in situations of perceived social evaluation” (Rubin et al., 2009, p. 145), and it is sometimes negatively associated with learning and achievement (Hughes & Coplan, 2010; Zhang et al., 2017). For children prone towards high levels of shyness, even going to school may represent a challenge. Once in the classroom a shy student may experience academic difficulties because of low levels of emotional and behavioral engagement (Eggum-Wilkens et al., 2014) and a poor quality student-teacher relationship (Ladd & Burgess, 1999; Rudasill et al., 2006). In addition, shyness can interfere with appropriate verbal expressions, including asking questions (Smith Watts et al., 2014). Informed by these findings, and similar to our prediction involving anger, the challenging experiences associated with high-levels of shyness may limit the extent to which school readiness contributes to later achievement. We expect, therefore, school readiness to be positively related to achievement at low, but not high, levels of shyness.

## The Present Study

In the present study, we examined the longitudinal relations between five-year-olds’ Time 1 (T1) school readiness and their Time 2 (T2) academic achievement approximately three years later. We further tested if these relations were moderated by students’ temperament, assessed when they were eight-years-old. Identifying if children’s temperament moderates the relations between school readiness and achievement can highlight intervention points that can facilitate educators’ and parents’ ability to support children’s learning. Parents were asked to report on their children’s school readiness. To reduce problems with shared reporter variance, and to assess behaviors in school, we obtained teachers’ reports of students’ temperament. Children completed a standardized measure of achievement administered by study staff. To provide a robust test of our predictions, we controlled for gender, minority status (e.g., racial minority or non-Hispanic White), age, and socioeconomic status, because each of these variables are known predictors of achievement (Bradley & Corwyn, 2002; Crosnoe, 2006; Robinson & Lubienski, 2011). In addition, we tested our predictions within the context of a longitudinal study where school readiness was assessed approximately three years before achievement, prior to beginning Kindergarten. We expected school readiness to be positively related to both reading and math achievement. Further, based on the work of temperament theorists (Rothbart & Bates, 2006), and Cunha and Heckman’s (2007) discussion of dynamic complementarity, we expected prediction from school readiness to be strongest at high levels of effortful control, low levels of anger, and low levels of shyness.

## Method

### Participants

Study participants include 551 children who had some data (from one or both waves of data collection) on the focal constructs under consideration. Participants were involved in a birth cohort study of twins' physical and mental health (see Lemery-Chalfant et al., 2013; Lemery-Chalfant et al., 2019, for additional details). At T1, 49% of participants were male, and the average age was 5.19 ( $SD = .26$ ). Fifty-eight percent of participants were European American, 28% were Hispanic/Latino, 5% were African American, 7% were Asian American, 1% were Native American, and 1% were multiracial. The median family income at T1 was between \$80,000 and \$90,000, and 45.8% of the sample was considered living below middle class according to state-wide income-to-needs estimates from 2016. Mothers' and fathers' T1 education ranged from less than high school to a graduate or professional degree (7% of mothers and 17% of fathers had a high school education or less, 28% of mothers and 22% of fathers completed some college, and 65% of mothers and 61% of fathers earned at least a college degree). Most parents at T1 were married (81%), whereas 2% were separated, 5% were divorced, 1% were widowed, 5% were always single, 5% were in a partnership, and 1% reported "other status". Twenty-nine percent of twins were monozygotic, 37% were same-sex dizygotic, and 34% were opposite-sex dizygotic. Our sample demographics are representative of the state with respect to racial/ethnicity and socioeconomic status (United States Census Bureau, 2020).

We used independent samples *t*-tests or chi-square tests, selecting one twin per family, to examine family-level demographic differences between participants who had data at T1, but not T2. Families without T2 data did not differ significantly from those with T2 data on family socio-economic status, child age, or child race/ethnicity. Additional tests using all twins indicated that those without T2 data did not differ on child sex from those with T2 data, but those without T2 data were slightly lower in T1 school readiness ( $M = -.07$ ,  $SD = .74$ ) than those with T2 data ( $M = .04$ ,  $SD = .55$ ),  $t(397) = -1.72$ ,  $p = .086$ .

Our use of a twin data set to address research questions that do not require a twin sample is consistent with the work of other scholars and is a way to maximize the investment of public funds which support large-scale studies (Clifford et al., 2020; Doane et al., 2019). In addition, twins are representative of singletons across a wide variety of trait and developmental outcomes (Barnes & Boutwell, 2013), including early temperament (Goldsmith et al., 1999) and cognitive abilities (Posthuma et al., 2000), suggesting that results from the current study generalize to nontwin populations. Further, the descriptive statistics for the key variables analyzed here are very similar to published reports based on samples of singletons (Hernández, Eisenberg, Valiente, Spinrad, et al., 2018; Nystrom & Bengtsson, 2017; O'Donnell, 2008).

### Procedures

Data for this study come from assessments that occurred when twins were approximately five and eight years-old. At the five-year assessment, caregivers of 399 twins completed surveys the summer before the children started Kindergarten assessing twins' school



readiness and key covariates (in addition to other variables not considered here). Approximately three years later, families were contacted via telephone, e-mail, or mail and offered the opportunity to participate in an intensive assessment of family environment, daily health practices, physical health, and academic achievement, including two home visits. During one of the home visits, staff worked with 354 children to complete subtests from the Woodcock Johnson Tests of Achievement IV (Schrank et al., 2014) and obtained consent to ask teachers to report on children's temperament. Teachers who agreed to participate ( $N = 309$ ) reported on children's temperament. All procedures were approved by the Institutional Review Board of Arizona State University. Children's caregivers and teachers provided written consent and children provided verbal assent.

## Measures

T1 school readiness. When children were five-years old, parents reported on each twins' school readiness using seven items for each twin from the National Household Education Survey – School Readiness Survey (Hagedorn et al., 2008). The scale is appropriate for children between the ages of three and six, and the items assess skills critical to success in the early academic years. Five items assessed literacy (e.g., “How many times have you or someone in your family read to *Twin A* in the past week?”), one item assessed numeracy (e.g., “How high can *Twin A* count?”), and one item assessed children's identification abilities (specifically involving colors). The range of scores across the items could vary, and therefore, the items were standardized and then averaged to form an index of school readiness. The alpha across all items was .74. This index of school readiness is used in large scale projects and has been found to be reliable and valid (Hagedorn et al., 2008; O'Donnell, 2008).

T2 temperament. When children were eight-years old, teachers used an adapted version of the Temperament in Middle Childhood Questionnaire (TMCQ, Simonds, 2006; Simonds et al., 2007) to report on children's attention focusing, inhibitory control, anger, and shyness. As we have done in our prior research (Hernández, Valiente, et al., 2017), we slightly adapted items to make them appropriate for the school context (e.g., “Has an easy time waiting to open a present” was changed to “Has an easy time waiting for a fun activity.”). Attention focusing (e.g., “When working on an activity, has a hard time keeping his/her mind on it” (reversed), 7 items), inhibitory control (e.g., “Can stop him/herself when s/he is told to stop”, 8 items), anger (e.g., “Gets angry when s/he has trouble with work”, 7 items), and shyness (e.g., “Becomes self-conscious when around people”, 10 items) were reliably rated (alphas = .96, .80, .92, and .93, respectively). Items were rated on a 1 (Almost always untrue of your child) to 5 (Almost always true of your child) scale. Results from prior studies indicate that the TMCQ yields temperament data that are reliable and valid (Nystrom & Bengtsson, 2017; Simonds, 2006; Simonds et al., 2007). The attention focusing and inhibitory control scales were highly related,  $r(307) = .71, p < .01$ , and consistent with prior studies (Hernández, Eisenberg, et al., 2017), we averaged these scales to form an index of effortful control.

T2 math and reading achievement. During a home visit when children were approximately eight-years-old, children worked with a trained administrator to complete the picture

vocabulary, passage comprehension, and applied problems subtests from the Woodcock Johnson Tests of Achievement IV (Schrang et al., 2014). The subtests are among the most commonly used tests of achievement and subscales are consistently found to be reliable and valid (McGrew et al., 2014). In line with scoring recommendations from the publisher, we used the Woodcock Johnson scoring software to convert raw scores into W scores, which are interval-scale measures similar to standardized scores. The picture vocabulary and passage comprehension scales were highly related,  $r(350) = .59, p < .01$ , and were averaged to form an index of reading achievement. The applied problems subtest was used as an index of math achievement.

Covariates. Sex (0 = Male, 1 = Female), race (1 = Non-Hispanic White, 0 = other), age, and socioeconomic status (e.g., average of parent-reported household income and mothers' and fathers' education) were obtained from parents' surveys and were included as covariates.

## Results

Prior to testing the main hypotheses, we present a series of descriptive analyses and examine the zero-order correlations between the study variables. We then conducted a series of regressions in Mplus 8.0 (Muthén & Muthén, 1998–2017) to test if the relations between T1 school readiness and T2 achievement were moderated by T2 temperament. When significant interactions emerged, simple slopes were probed at 1 SD below and above the mean of temperament (i.e., effortful control, shyness, anger) using the simple slopes technique for nested data outlined by Preacher and colleagues (Preacher et al., 2006). In order to account for the lack of independence in the data stemming from the nested data structure (e.g., twins within families), all correlational analyses and regressions were estimated within Mplus while specifying Type=Complex. This specification controls for twin interdependence and allows us to use both twins in the model (Clifford et al., 2020; Miadich et al., 2019; Muthén & Muthén, 1998–2017). In addition, the MLR option was utilized to implement full information maximum likelihood (FIML) estimation in order to make use of all available data. We estimated a power analysis in G\*Power to ensure that we had adequate power to conduct the analyses. Given our  $N$  of 551, 7 predictors, and an effect of  $f^2 = .05$  (a relatively small effect), power is greater than .95 (Faul et al., 2009).

The descriptive statistics and zero-order correlations are presented in Table 1. The variables did not display a level of skewness or kurtosis that would bias findings (Tabachnick & Fidell, 2007). Girls were higher in T2 effortful control and lower in T2 anger and T2 math than boys. Being non-Hispanic White was positively related to T1 SES, T1 school readiness, and T2 reading. T1 SES was positively related to T1 school readiness, T2 reading and T2 math achievement, and negatively related to T2 shyness. T1 school readiness and T2 effortful control were positively related to each other and to the measures of T2 reading and T2 math achievement. T2 shyness, but not T2 anger, was negatively related to both T2 math and T2 reading achievement.

We estimated six regressions to test whether temperament moderated the relations between school readiness and reading or math achievement. In each model, we mean centered the continuous variables in line with the recommendations provided by Aiken and West (1991).



As shown in Table 2, in each model, T1 school readiness was positively related to T2 reading and T2 math achievement. Further, T2 effortful control was significantly positively related to both measures of T2 achievement, whereas T2 shyness was negatively related to these outcomes. T2 anger was not significantly related to either index of T2 achievement. Of interest, the interaction between T1 school readiness and T2 effortful control was significant for T2 reading. As depicted in Figure 1, the positive relation between T1 school readiness and T2 reading was significant at high ( $b = 8.52, p < .01$ ) and mean ( $b = 5.85, p < .01$ ), but not low ( $b = 3.19, ns$ ), levels of T2 effortful control. Regions of significance tests demonstrated that the positive relation between T1 school readiness and T2 reading was significant for T2 effortful control values above unstandardized values of  $-.72$ , which includes 81% of the sample. In addition, there was a significant interaction between T1 school readiness and T2 shyness on T2 reading. Findings shown in Figure 2 illustrate that the positive relation between T1 school readiness and T2 reading was significant at low ( $b = 9.25, p < .01$ ) and mean levels of T2 shyness ( $b = 6.17, p = .01$ ), but not significant at high levels of T2 shyness ( $b = 3.10, ns$ ). Regions of significance tests demonstrated that the positive relation between T1 school readiness and T2 reading was significant at T2 shyness values below unstandardized values of  $.62$ , which includes 78% of the sample.

## Discussion

The chief aim of this study was to test if children's temperament (i.e., their anger, effortful control, and shyness) moderated the longitudinal relations between school readiness and academic achievement. Addressing this aim represents an important way to fill the gap in the literature regarding why relations between school readiness and later achievement are typically only of a modest magnitude and why some intervention effects on school readiness fade out (Bailey et al., 2016; Boivin et al., 2014; Clements et al., 2013). Based on the premise that temperament plays a role in how students respond to obstacles in the school environment, we expected school readiness to be positively related to math and reading achievement primarily when students were high in effortful control or low in anger or shyness. Using longitudinal data collected from multiple reporters and methods, T1 school readiness when children were five-years-old was consistently related to high levels of T2 reading and math achievement assessed approximately three years later. In addition, T2 effortful control was positively related to T2 reading and math achievement; the reverse pattern was identified for T2 shyness. In partial support of the theoretical arguments advanced above, we found that students' T2 effortful control and T2 shyness moderated the effects of T1 school readiness on T2 reading, such that prediction from T1 school readiness was strongest for students' high in effortful control and low in shyness.

Consistent with expectations, T1 school readiness was positively related to T2 reading and math achievement. This pattern is consistent with prior literature (Duncan et al., 2007; La Paro & Pianta, 2000) and the human capital perspective that early assets lead to the accumulation of additional assets (i.e., the Matthew effect, Heckman, 2000). The findings also highlight the importance of activities designed to help children enter into formal schooling with the skills they need in order to achieve at high levels. The authors of the NAEYC (1995) report noted that children's school readiness is most likely to be realized when there is a high-level of coordination between children, families, and schools. However,

because approximately 65% of children between the ages of 3 and 5 are enrolled in pre-school programs, the role of getting students ready for elementary school is increasingly involving pre-school teachers and administrators (U.S. Department of Commerce, 2017). Additional work is needed to identify constructive and efficient ways for pre-school teachers and families to work together to prepare children who enter their classrooms from a variety of backgrounds to be ready for formal schooling.

Our findings also highlight the importance of identifying subgroups of children for whom school readiness abilities prior to kindergarten are more or less predictive of achievement in middle childhood. Consistent with expectations, T2 effortful control moderated the longitudinal relations between T1 school readiness and T2 reading achievement. As shown in Figure 1, the highest levels of achievement were observed when students were high in both school readiness and effortful control. This pattern is consistent with the hypothesis that the benefits often associated with school readiness are most likely to be realized when students are able to effectively manage their behaviors, attention, and emotions (Li-Grining et al., 2014) and with Rothbart and Bates' (2006) argument that temperament is likely to moderate the effects of other processes on measures of adjustment. Effortful control may foster quality relationships with teachers and peers, as well as patterns of school engagement, that allow for the positive benefits of school readiness to be realized. In contrast, when students are low in effortful control, the advantages typically afforded by school readiness may become muted because of the disruptions associated with dysregulated emotions and behaviors.

T2 shyness also moderated the effect of T1 school readiness on T2 reading achievement. As shown in Figure 2, T1 school readiness predicted T2 reading when students were low and average, but not high, in T2 shyness. Based on extant literature, we suspect that when students are high in shyness the potential positive effects of school readiness may not be realized as a result of disrupted relationships with peers and teachers. Findings from the broader temperament literature indicate that shyness is negatively related to peer acceptance and popularity (Eggum-Wilkens et al., 2014; Zhang et al., 2017). Likewise, children prone towards shyness are less likely to initiate interactions with teachers and they may be hesitant to participate in learning opportunities (Rudasill & Rimm-Kaufman, 2009; Valiente, Swanson, & Lemery-Chalfant, 2012). As a result, shy students may not receive the educational assistance they need. Given the social and academic risks associated with high levels of shyness (Evans, 2010; Rubin et al., 2009), efforts should be made to help students prone towards shyness to effectively engage in social interactions.

It is interesting that we identified a pattern of interaction for reading, but not math. When math was the outcome, both effortful control and shyness provided unique prediction beyond school readiness. We suspect that differences in the way reading and math are taught during early elementary school are germane to understanding this pattern. Reading, in contrast to mathematics instruction, more often involves small group instruction where the teacher groups students by reading ability. Students are then often required to read out loud in the group setting, and if the student is high in shyness, they may find this process quite difficult and they may not take full advantage of the learning opportunity. Likewise, low levels of effortful control may be particularly disruptive in the small group setting, especially if the

teacher is not directly working with that particular group. In both cases, the otherwise positive effects of school readiness on reading may not be fully realized as a result of students' low effortful control and high shyness. Because mathematics instruction typically involves instruction to the entire classroom and then more independent study (e.g., with manipulatives), temperament (and associated behaviors) may not play a significant role in altering relations between school readiness and math achievement. Explicitly testing this post-hoc explanation is a promising means for better understanding the roles of school readiness, effortful control, and shyness in students' academic achievement.

As shown in Table 2, it is the case that both effortful control and shyness are significantly related to math achievement, even beyond the effects of school readiness. The finding for effortful control is consistent with prior work and is likely maintained as a result of cognitive, motivational, regulatory, and relational benefits associated with high levels of effortful control (Zhou et al., 2010). A robust body of evidence indicates that shyness is a risk factor for social-emotional problems such as peer rejection, loneliness, and depression (Rubin et al., 2009), and the findings presented here indicate that shy children are also likely to experience challenges in the academic domain. It is possible that the relations between shyness and math achievement are mediated by the socio-emotional constructs listed above, and future longitudinal research should focus on delineating the nature of these potential relations. In addition, because students prone towards shyness are often self-conscious or easily embarrassed, they may be hesitant to seek assistance from their teacher and consequently they may miss out on quality student-teacher interactions (Zee & Roorda, 2018). Consistent with this idea, there is evidence from a meta-analysis that shyness is negatively related to student-teacher closeness and positively related to student-teacher conflict (Nurmi, 2012). The relations between shyness and achievement are somewhat inconsistent in the literature (especially when compared to effortful control) and may vary based on the reporter or index of achievement (Hughes & Coplan, 2010; Zhang et al., 2017). The differential pattern of relations based on methodology for shyness suggests that advancements to this line of research will likely need to incorporate the perspective of multiple reporters and methods.

Unexpectedly, T2 anger did not emerge as a significant predictor of T2 achievement and it did not interact with T1 school readiness. The lack of a significant direct effect is somewhat surprising and is inconsistent with some prior literature (Hernández et al., 2016; Valiente et al., 2010). Although we can only speculate on why significant relations were not identified, it is possible that the infrequent occurrence of anger (i.e., mean of 1.82 on a 1–5 scale) limited prediction. The use of additional methodologies, including scan observations (Hernández et al., 2016), may yield data which are more representative of daily experiences and may identify expressions of anger that are more predictive of achievement. It could also be the case that the relations between anger and achievement are not direct, but are indirect via relationships with others (e.g., teachers and peers) and students' school engagement (Kwon et al., 2017; Zhou et al., 2010), or moderated by regulatory abilities (Valiente et al., 2010; Valiente, Swanson, & Eisenberg, 2012).

## Limitations and Future Directions

Despite a number of strengths, including the use of a longitudinal design and the use of different reporters for the primary predictors, the study is not without limitations. First, the data were correlational so firm conclusions about direction of causation cannot be made. Second, although school readiness is often considered a multifaceted construct involving students' health, social, and cognitive processes, our assessment focused on the literacy and mathematics components. It will be important for future work to more closely examine the health and social aspects of school readiness. Third, it is possible that child characteristics (e.g., problem behaviors, school engagement, other indices of emotional competence such as social competence, emotion knowledge) or classroom processes (e.g., instructional support, level of chaos) not considered in the current study are relevant to the associations between school readiness and achievement. Fourth, we were unable to fully evaluate fadeout due to only having one measurement occasion for achievement. Multiple assessments of achievement would more fully allow for an analytic description of fadeout and processes that reduce or amplify its occurrence as children progress through elementary school.

## Implications for Policy and Practice

The findings presented here have important implications for educators and scholars interested in promoting early academic achievement. First, at a broad level, the findings presented here affirm the importance of helping students be ready to learn when they enter the formal school environment. Consistent with Heckman's theoretical work, students who enter elementary school with important literacy and numeracy skills are likely to do well academically as they progress through formal schooling (Heckman, 2000). Students' academic achievement is likely to be enhanced when parents, teachers, researchers, and policy makers work together to offer high-quality cost effective school readiness programs. There is evidence that this approach can yield positive child outcomes (Boivin & Bierman, 2014; Peters & Howell-Moneta, 2014).

Importantly, however, based on the novel findings presented here, the effect on reading is dependent on children's effortful control and shyness. As a result, students' reading achievement is likely to be advanced by efforts to improve effortful control and decrease shyness. There are indications that such changes are possible. For example, findings from several intervention studies provide evidence that young children's effortful control (and related abilities) and interactions with others can be improved via interventions delivered in the home or school context (Hentges et al., 2020; O'Connor et al., 2014b; PATHS@ Education Worldwide, 2018; Raver et al., 2009; Raver et al., 2011; Riggs et al., 2006). Results from a recent study suggest that adding a self-regulation component to a school readiness program can improve math and literacy outcomes (Duncan et al., 2018). There is also evidence that socio-emotional interventions provide social and academic benefits to shy children (see Coplan & Rudasill, 2016, for a review; O'Connor et al., 2014a). Cumulatively, these findings are consistent with Cunha and Heckman's (2007) perspective that initial assets (i.e., school readiness) are more productive when they are supplemented with additional assets (i.e., high effortful control, low shyness). Consequently, efforts to advance students' reading achievement are most likely to be effective when their academic school

readiness is supported along with programs that work to positively impact effortful control and shyness.

## Acknowledgments

Work on this paper was partially supported by the Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health under Award Number R01 HD079520. Initial funding was also provided by the Challenged Child Project and Seed Grant Program, via the T. Denny Sanford School of Social and Family Dynamics at Arizona State University. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

## References

- Aiken L, & West SG (1991). *Multiple regression: Testing and interpreting interactions*. Sage.
- Bailey D, Duncan GJ, Odgers CL, & Yu W (2017). Persistence and fadeout in the impacts of child and adolescent interventions. *Journal of Research on Educational Effectiveness*, 10(1), 7–39. 10.1080/19345747.2016.1232459 [PubMed: 29371909]
- Bailey DH, Nguyen T, Jenkins JM, Domina T, Clements DH, & Sarama JS (2016). Fadeout in an early mathematics intervention: Constraining content or preexisting differences? *Developmental Psychology*, 52(9), 1457–1469. 10.1037/dev0000188 [PubMed: 27505700]
- Barnes JC, & Boutwell BB (2013). A demonstration of the generalizability of twin-based research on antisocial behavior. *Behavior Genetics*, 43(2), 120–131. 10.1007/s10519-012-9580-8 [PubMed: 23274656]
- Blair C (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist*, 57(2), 111–127. 10.1037/0003-066X.57.2.111
- Blair C, & Raver CC (2015). School readiness and self-regulation: A developmental psychobiological approach. *Annual Review of Psychology*, 66, 711–731. 10.1146/annurev-psych-010814-015221
- Bohn-Gettler CM, & Rapp DN (2014). Emotion during reading and writing. In Pekrun R & Linnenbrink-Garcia L (Eds.), *International handbook of emotions in education* (pp. 437–457). Routledge/Taylor & Francis Group.
- Boivin M, & Bierman KL (2014). School readiness: Introduction to a multifaceted and developmental construct. In Boivin M & Bierman KL (Eds.), *Promoting school readiness and early learning: Implications of developmental research for practice* (pp. 3–14). Guilford Press.
- Boivin M, Desrosiers H, Lemelin J-P, & Forget-Dubois N (2014). Assessing the predictive validity and early determinants of school readiness using a population-based approach. In Boivin M & Bierman KL (Eds.), *Promoting school readiness and early learning: Implications of developmental research for practice* (pp. 46–72). The Guilford Press.
- Bradley RH, & Corwyn RF (2002). Socioeconomic status and child development. *Annual Review of Psychology*, 53(0066–4308, 0066–4308), 371–399. 10.1146/annurev.psych.53.100901.135233
- Chew AL, & Morris JD (1989). Predicting later academic achievement from kindergarten scores on the Metropolitan Readiness Tests and the Lollipop Test. *Educational and Psychological Measurement*, 49(2), 461–465. 10.1177/0013164489492019
- Clements DH, Sarama J, Wolfe CB, & Spitler ME (2013). Longitudinal evaluation of a scale-up model for teaching mathematics with trajectories and technologies: Persistence of effects in the third year. *American Educational Research Journal*, 50(4), 812–850. 10.3102/0002831212469270
- Clifford S, Doane LD, Breitenstein R, Grimm KJ, & Lemery-Chalfant K (2020). Effortful control moderates the relation between electronic-media use and objective sleep indicators in childhood. *Psychological Science*, 31(7), 822–834. 10.1177/0956797620919432 [PubMed: 32558622]
- Coplan RJ, & Rudasill KM (2016). *Quiet at School: An Educator's Guide to Shy Children*. Teachers College Press.
- Crosnoe R (2006). *Mexican Roots, American Schools: Helping Mexican Immigrant Children Succeed*. Stanford University Press.

- Cunha F, & Heckman JJ (2007). The technology of skill formation. *The American Economic Review*, 97(2), 31–47. <http://www.jstor.org/stable/30034418>
- Cunha F, Heckman JJ, Lochner L, & Masterov D (2006). Interpreting the evidence on life cycle skill formation. In Hanushek E & Welch F (Eds.), *Handbook of the economics of education* (pp. 307–451). Elsevier.
- Denham SA, Bassett HH, Thayer SK, Mincic MS, Sirotkin YS, & Zinsser K (2012). Observing preschoolers' social-emotional behavior: Structure, foundations, and prediction of early school success. *The Journal of Genetic Psychology: Research and Theory on Human Development*, 173(3), 246–278. 10.1080/00221325.2011.597457
- Denham SA, Blair KA, DeMulder E, Levitas J, Sawyer K, Auerbach Major S, & Queenan P (2003). Preschool emotional competence: Pathway to social competence. *Child Development*, 74(1), 238–256. 10.1111/1467-8624.00533 [PubMed: 12625448]
- Doane LD, Breitenstein RS, Beekman C, Clifford S, Smith TJ, & Lemery-Chalfant K (2019). Early life socioeconomic disparities in children's sleep: The mediating role of the current home environment. *Journal of Youth and Adolescence*, 48(1), 56–70. 10.1007/s10964-018-0917-3 [PubMed: 30121716]
- Duncan GJ, Dowsett CJ, Claessens A, Magnuson K, Huston AC, Klebanov P, Pagani LS, Feinstein L, Engel M, Brooks-Gunn J, Sexton H, Duckworth K, & Japel C (2007). School readiness and later achievement. *Developmental Psychology*, 43(6), 1428–1446. 10.1037/0012-1649.43.6.1428 [PubMed: 18020822]
- Duncan RJ, Schmitt SA, Burke M, & McClelland MM (2018). Combining a kindergarten readiness summer program with a self-regulation intervention improves school readiness. *Early Childhood Research Quarterly*, 42, 291–300. 10.1016/j.ecresq.2017.10.012 [PubMed: 33967383]
- Eggum-Wilkens ND, Valiente C, Swanson J, & Lemery-Chalfant K (2014). Children's shyness, popularity, school liking, cooperative participation, and internalizing problems in the early school years. *Early Childhood Research Quarterly*, 29(1), 85–94. 10.1016/j.ecresq.2013.10.002
- Eisenberg N, Valiente C, & Eggum ND (2010). Self-regulation and school readiness. *Early Education and Development*, 21, 681–698. 10.1080/10409289.2010.497451 [PubMed: 21234283]
- Entwisle DR, Alexander KL, & Olson LS (2005). First grade and educational attainment by age 22: A new story. *American Journal of Sociology*, 110(5), 1458–1502. 10.1086/428444
- Evans MA (2010). Language performance, academic performance, and signs of shyness: A comprehensive review. In Rubin KH & Coplan RJ (Eds.), *The development of shyness and social withdrawal* (pp. 179–212). Guilford Press.
- Faul F, Erdfelder E, Buchner A, & Lang AG (2009). Statistical power analyses using G\*Power 3.1: tests for correlation and regression analyses. *Behavior Research Methods*, 41(4), 1149–1160. 10.3758/BRM.41.4.1149 [PubMed: 19897823]
- Goldsmith HH, Lemery KS, Buss KA, & Campos JJ (1999). Genetic analyses of focal aspects of infant temperament. *Developmental Psychology*, 35(4), 972–985. 10.1037/0012-1649.35.4.972 [PubMed: 10442866]
- Hagedorn M, Roth SB, O'Donnell K, Smith S, & Mulligan G (2008). *National Household Education Surveys of 2007: Data File User's Manual, Volume I*. (NCES 2008–046).
- Heckman JJ (2000). Policies to foster human capital. *Research in Economics*, 54(1), 3–56. 10.1006/rec.1999.0225
- Hentges RF, Weaver Krug CM, Shaw DS, Wilson MN, Dishion TJ, & Lemery-Chalfant K (2020). The long-term indirect effect of the early Family Check-Up intervention on adolescent internalizing and externalizing symptoms via inhibitory control. *Development and Psychopathology*, 32(4), 1544–1554. 10.1017/S0954579419001482 [PubMed: 31896379]
- Hernández MM, Eisenberg N, Valiente C, Spinrad TL, Johns SK, Berger RH, Silva KM, Diaz A, Gal-Szabo DE, Thompson MS, & Southworth J (2018). Self-regulation and academic measures across the early elementary school grades: Examining longitudinal and bidirectional associations. *Early Education and Development*, 29(7), 914–938. 10.1080/10409289.2018.1496722 [PubMed: 31997874]



- Hernández MM, Eisenberg N, Valiente C, Spinrad TL, VanSchyndel SK, Diaz A, Silva KM, Berger RH, & Southworth J (2017). Observed emotions as predictors of quality of kindergartners' social relationships. *Social Development*, 26(1), 21–39. 10.1111/sode.12179 [PubMed: 29861553]
- Hernández MM, Eisenberg N, Valiente C, Thompson MS, Spinrad TL, Grimm KJ, VanSchyndel SK, Berger RH, Silva KM, Pina AA, Southworth J, & Gal DE (2018). Trajectories of the expression of negative emotion from kindergarten to first grade: Associations with academic outcomes. *Journal of Educational Psychology*, 110(3), 324–337. 10.1037/edu0000213 [PubMed: 29861505]
- Hernández MM, Eisenberg N, Valiente C, VanSchyndel SK, Spinrad TL, Silva KM, Berger RH, Diaz A, Terrell N, Thompson MS, & Southworth J (2016). Emotional expression in school context, social relationships, and academic adjustment in kindergarten. *Emotion*, 16(4), 553–566. 10.1037/emo0000147 [PubMed: 26751629]
- Hernández MM, Valiente C, Eisenberg N, Berger RH, Spinrad TL, VanSchyndel SK, Silva KM, Southworth J, & Thompson MS (2017). Elementary students' effortful control and academic achievement: The mediating role of teacher-student relationship quality. *Early Child Research Quarterly*, 40, 98–109. 10.1016/j.ecresq.2016.10.004
- Hughes K, & Coplan RJ (2010). Exploring processes linking shyness and academic achievement in childhood. *School Psychology Quarterly*, 25(4), 213–222. 10.1037/a0022070
- Kurdek LA, & Sinclair RJ (2000). Psychological, family, and peer predictors of academic outcomes in first- through fifth-grade children. *Journal of Educational Psychology*, 92(3), 449–457. 10.1037/0022-0663.92.3.449
- Kwon K, Hanrahan AR, & Kupzyk KA (2017). Emotional expressivity and emotion regulation: Relation to academic functioning among elementary school children. *School Psychology Quarterly*, 32(1), 75–88. 10.1037/spq0000166 [PubMed: 27845519]
- La Paro KM, & Pianta RC (2000). Predicting children's competence in the early school years: A meta-analytic review. *Review of Educational Research*, 70(4), 443–484. 10.3102/00346543070004443
- Ladd GW, & Burgess KB (1999). Charting the relationship trajectories of aggressive, withdrawn, and aggressive/withdrawn children during early grade school. *Child Development*, 70(4), 910–929. 10.1111/1467-8624.00066 [PubMed: 10446726]
- Lemelin J-P, Boivin M, Forget-Dubois N, Dionne G, Séguin JR, Brendgen M, Vitaro F, Tremblay RE, & Pérusse D (2007). The genetic-environmental etiology of cognitive school readiness and later academic achievement in early childhood. *Child Development*, 78(6), 1855–1869. 10.1111/j.1467-8624.2007.01103.x [PubMed: 17988326]
- Lemery-Chalfant K, Clifford S, McDonald K, O'Brien TC, & Valiente C (2013). Arizona Twin Project: a focus on early resilience. *Twin Research and Human Genetics*, 16(1), 404–411. 10.1017/thg.2012.107 [PubMed: 23394195]
- Lemery-Chalfant K, Oro V, Rea-Sandin G, Miadich S, Lecarie E, Clifford S, Doane LD, & Davis MC (2019). Arizona Twin Project: Specificity in Risk and Resilience for Developmental Psychopathology and Health. *Twin Research and Human Genetics*, 22(6), 681–685. 10.1017/thg.2019.113 [PubMed: 31868161]
- Li-Grining CP, Lennon J, Marcus M, Flores V, & Haas K (2014). The development of self-regulatory skills and school readiness. In Boivin M & Bierman KL (Eds.), *Promoting school readiness and early learning: Implications of developmental research for practice* (pp. 211–230). Guilford Press.
- Liew J, Valiente C, Hernández MM, & Abrera D (2019). Self-regulation and reactivity, school-based relationships, and school engagement and achievement. In Whitebread D & McClelland M (Eds.), *SAGE Handbook on Developmental Psychology and Early Childhood Education* (pp. 42–62). University of Cambridge.
- Luthar SS, Cicchetti D, & Becker B (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development*, 71(3), 543–562. 10.1111/1467-8624.00164 [PubMed: 10953923]
- McGrew KS, LaForte EM, & Schrank FA (2014). *Technical Manual*. Woodcock-Johnson IV.
- Miadich SA, Doane LD, Davis MC, & Lemery-Chalfant K (2019). Early parental positive personality and stress: Longitudinal associations with children's sleep. *British Journal of Health Psychology*, 24(3), 629–650. 10.1111/bjhp.12372 [PubMed: 31004419]
- Muthén LK, & Muthén BO (1998–2017). *Mplus user's guide*. (8th ed.). Muthén & Muthén.

- NAEYC. (1995). School Readiness: A position statement of the National Association for the Education of Young Children. <https://www.naeyc.org/sites/default/files/globally-shared/downloads/PDFs/resources/position-statements/PSREADY98.PDF>
- NAEYC. (2009). Developmentally appropriate practice in early childhood programs serving children from birth through age 8. <https://www.naeyc.org/sites/default/files/globally-shared/downloads/PDFs/resources/position-statements/PSDAP.pdf>
- National Science Board. (2018). Science and Engineering Indicators 2018, NSB-2018-1. Alexandria, VA: National Science Foundation. Available at <https://www.nsf.gov/statistics/indicators/>.
- Nurmi J-E (2012). Students' characteristics and teacher-child relationships in instruction: A meta-analysis. *Educational Research Review*, 7(3), 177-197. 10.1016/j.edurev.2012.03.001
- Nystrom B, & Bengtsson H (2017). A psychometric evaluation of the Temperament in Middle Childhood Questionnaire (TMCQ) in a Swedish sample. *Scandinavian Journal of Psychology*, 58(6), 477-484. 10.1111/sjop.12393 [PubMed: 28983922]
- O'Connor EE, Cappella E, McCormick MP, & McClowry SG (2014a). Enhancing the academic development of shy children: A test of the efficacy of INSIGHTS. *School Psychology Review*, 43(3), 239-259. <https://psycnet.apa.org/record/2014-42948-001>
- O'Connor EE, Cappella E, McCormick MP, & McClowry SG (2014b). An examination of the efficacy of INSIGHTS in enhancing the academic and behavioral development of children in early grades. *Journal of Educational Psychology*, 106(4), 1156-1169. 10.1037/a0036615
- O'Donnell K (2008). Parents' Reports of the School Readiness of Young Children from the National Household Education Surveys Program of 2007 (NCES 2008-051).
- PATHS® Education Worldwide. (2018). <https://selworldwide.org>
- Pekrun R (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review*, 18(4), 315-341. 10.1007/s10648-006-9029-9
- Peters RD, & Howell-Moneta A (2014). Better beginnings, better futures: A comprehensive, community-based early child development project to facilitate transition to primary school and beyond. In Boivin M & Bierman KL (Eds.), *Promoting school readiness and early learning: Implications of developmental research for practice* (pp. 281-303). The Guilford Press.
- Posthuma D, De Geus EJ, Bleichrodt N, & Boomsma DI (2000). Twin-singleton differences in intelligence? *Twin Research and Human Genetics*, 3(2), 83-87. 10.1375/twin.3.2.83
- Preacher KJ, Curran PJ, & Bauer DJ (2006). Computational tools for probing interactions in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics*, 31(4), 437-448. 10.3102/10769986031004437
- Raver CC, Jones SM, Li-Grining C, Zhai F, Metzger MW, & Solomon B (2009). Targeting children's behavior problems in preschool classrooms: A cluster-randomized controlled trial. *Journal of Consulting and Clinical Psychology*, 77(2), 302-316. 10.1037/a0015302 [PubMed: 19309189]
- Raver CC, Li-Grining CP, Bub K, Jones S, M, Zhai F, & Pressler E (2011). CSRP's impact on low-income preschoolers' preacademic skills: Self-regulation as a mediating mechanism. *Child Development*, 82(1), 362-378. 10.1111/j.1467-8624.2010.01561.x [PubMed: 21291447]
- Riggs NR, Greenberg MT, Kusché CA, & Pentz MA (2006). The mediational role of neurocognition in the behavioral outcomes of a social-emotional prevention program in elementary school students: Effects of the PATHS curriculum. *Prevention Science*, 7(1), 91-102. 10.1007/s11121-005-0022-1 [PubMed: 16572300]
- Robinson JP, & Lubienski ST (2011). The development of gender achievement gaps in mathematics and reading during elementary and middle school: Examining direct cognitive assessments and teacher ratings. *American Educational Research Journal*, 48(2), 268-302. 10.3102/0002831210372249
- Romano E, Babchishin L, Pagani LS, & Kohen D (2010). School readiness and later achievement: Replication and extension using a nationwide Canadian survey. *Developmental Psychology*, 46(5), 995-1007. 10.1037/a0018880 [PubMed: 20822218]
- Rothbart MK, Ahadi SA, Hersey KL, & Fisher P (2001). Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. *Child Development*, 72(5), 1394-1408. 10.1111/1467-8624.00355 [PubMed: 11699677]

- Rothbart MK, & Bates JE (2006). Temperament. In Damon W (Series Ed.) & Eisenberg N (Vol. Ed.). In *Handbook of child psychology*. Vol. 3. Social, emotional, personality development (6th ed.) (pp. 99–166). John Wiley & Sons.
- Rothbart MK, & Jones LB (1998). Temperament, self-regulation and education. *School Psychology Review*, 27(4), 479–491. 10.1080/02796015.1998.12085932
- Rubin KH, Coplan RJ, & Bowker JC (2009). Social withdrawal in childhood. *Annual Review of Psychology*, 60, 141–171. 10.1146/annurev.psych.60.110707.163642
- Rudasill KM, & Rimm-Kaufman SE (2009). Teacher-child relationship quality: The roles of child temperament and teacher-child interactions. *Early Childhood Research Quarterly*, 24(2), 107–120. 10.1016/j.ecresq.2008.12.003
- Rudasill KM, Rimm-Kaufman SE, Justice LM, & Pence K (2006). Temperament and language skills as predictors of teacher-child relationship quality in preschool. *Early Education and Development*, 17(2), 271–291. 10.1207/s15566935eed1702\_4
- Schrank FA, Mather N, & McGrew KS (2014). *Woodcock-Johnson IV Tests of Achievement*.
- Simonds J (2006). *The Role of Reward Sensitivity and Response Execution in Childhood Extraversion* [Unpublished doctoral dissertation]. University of Oregon.
- Simonds J, Kieras JE, Rueda MR, & Rothbart MK (2007). Effortful control, executive attention, and emotional regulation in 7–10-year-old children. *Cognitive Development*, 22(4), 474–488. 10.1016/j.cogdev.2007.08.009
- Smith Watts AK, Patel D, Corley RP, Friedman NP, Hewitt JK, Robinson JL, & Rhee SH (2014). Testing alternative hypotheses regarding the association between behavioral inhibition and language development in toddlerhood. *Child Development*, 85(4), 1569–1585. 10.1111/cdev.12219 [PubMed: 24499266]
- Snow KL (2006). Measuring school readiness: Conceptual and practical considerations. *Early Education and Development*, 17(1), 7–41. 10.1207/s15566935eed1701\_2
- Tabachnick BG, & Fidell LS (2007). *Using multivariate statistics* (5th ed.). Allyn & Bacon/Pearson Education.
- The Nations Report Card. (2018). National achievement-level results. [https://www.nationsreportcard.gov/reading\\_2017/nation/achievement/?grade=4](https://www.nationsreportcard.gov/reading_2017/nation/achievement/?grade=4)
- U.S. Department of Commerce. (2017). Census Bureau, Current Population Survey (CPS), October, 1970 through 2016. (This table was prepared August 2017.). [https://nces.ed.gov/programs/digest/d17/tables/dt17\\_202.10.asp](https://nces.ed.gov/programs/digest/d17/tables/dt17_202.10.asp)
- United States Census Bureau. (2020). Quick facts Arizona. <https://www.census.gov/quickfacts/AZ#qf-headnote-a>
- Valiente C, Lemery-Chalfant K, & Castro KS (2007). Children's effortful control and academic competence: Mediation through school liking. *Merrill-Palmer Quarterly*, 53(1), 1–25. 10.1353/mpq.2007.0006
- Valiente C, Lemery-Chalfant K, & Swanson J (2010). Prediction of kindergartners' academic achievement from their effortful control and emotionality: Evidence for direct and moderated relations. *Journal of Educational Psychology*, 102(3), 550–560. 10.1037/a0018992
- Valiente C, Lemery-Chalfant K, Swanson J, & Reiser M (2008). Prediction of children's academic competence from their effortful control, relationships, and classroom participation. *Journal of Educational Psychology*, 100(1), 67–77. 10.1037/0022-0663.100.1.67 [PubMed: 21212831]
- Valiente C, Swanson J, & Eisenberg N (2012). Linking students' emotions and academic achievement: When and why emotions matter. *Child Development Perspectives*, 6(2), 129–135. 10.1111/j.1750-8606.2011.00192.x [PubMed: 23115577]
- Valiente C, Swanson J, & Lemery-Chalfant KS (2012). Kindergartners' temperament, classroom engagement, and student-teacher relationship: Moderation by effortful control. *Social Development*, 21, 558–576. 10.1111/j.1467-9507.2011.00640.x
- Vitaro F, Brendgen M, & Tremblay RE (2014). Early predictors of high school completion: The developmental interplay between behavior, motivation, and academic performance. In Boivin M & Bierman KL (Eds.), *Promoting school readiness and early learning: Implications of developmental research for practice* (pp. 15–45). Guilford Press.

- Zee M, & Roorda DL (2018). Student–teacher relationships in elementary school: The unique role of shyness, anxiety, and emotional problems. *Learning and Individual Differences*, 67, 156–166. 10.1016/j.lindif.2018.08.006
- Zhang L, Eggum-Wilkens ND, Eisenberg N, & Spinrad TL (2017). Children’s shyness, peer acceptance, and academic achievement in the early school years. *Merrill-Palmer Quarterly*, 63(4), 458–484. 10.13110/merrpalmquar1982.63.4.0458
- Zhou Q, Main A, & Wang Y (2010). The relations of temperamental effortful control and anger/frustration to Chinese children’s academic achievement and social adjustment: A longitudinal study. *Journal of Educational Psychology*, 102(1), 180–196. 10.1037/a0015908

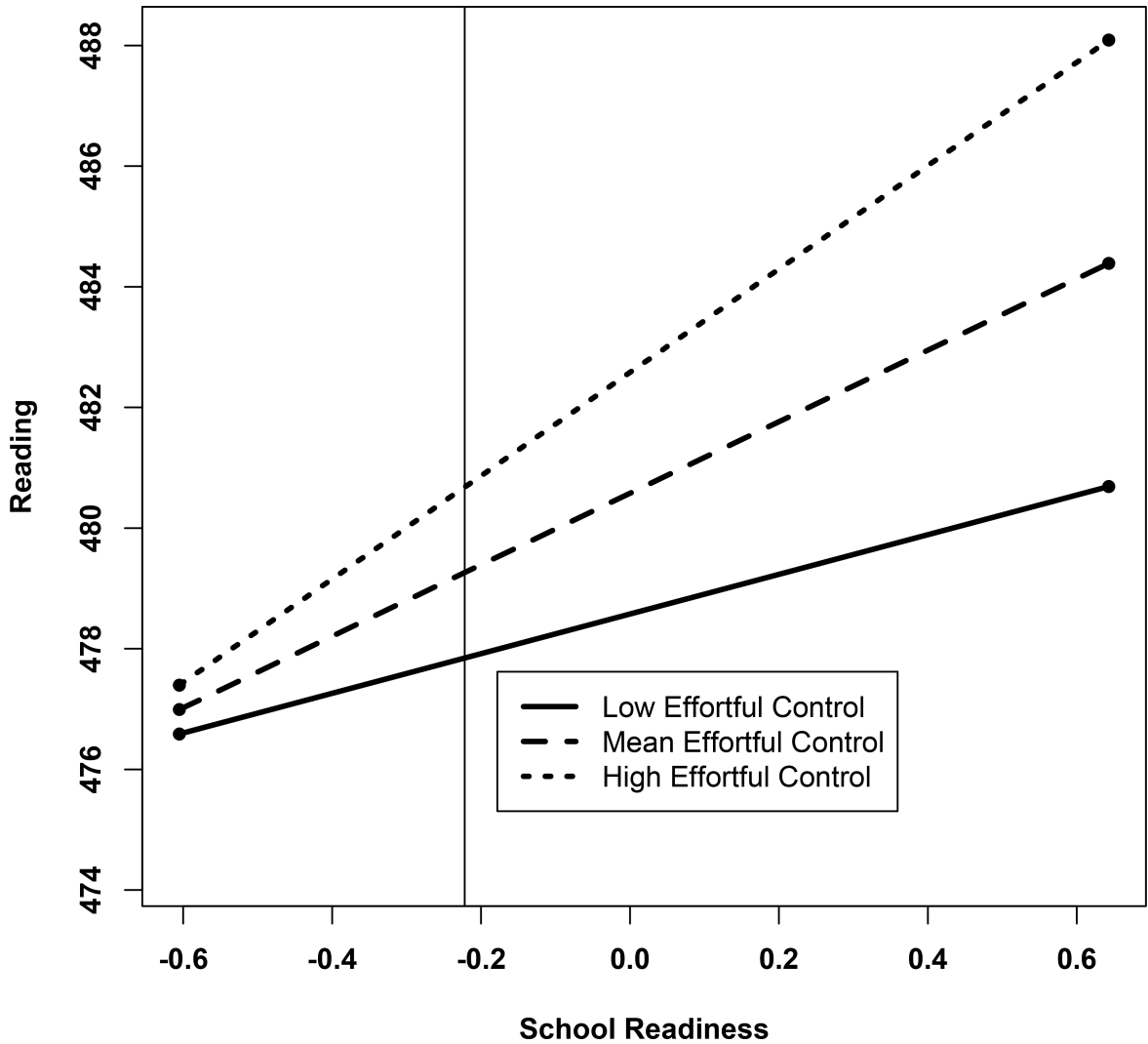
**HIGHLIGHTS**

We tested if temperament moderated the link between school readiness and achievement.

School readiness was positively related to reading when effortful control was high.

School readiness was positively related to reading when shyness was low.

School readiness, effortful control, and shyness uniquely predicted math.

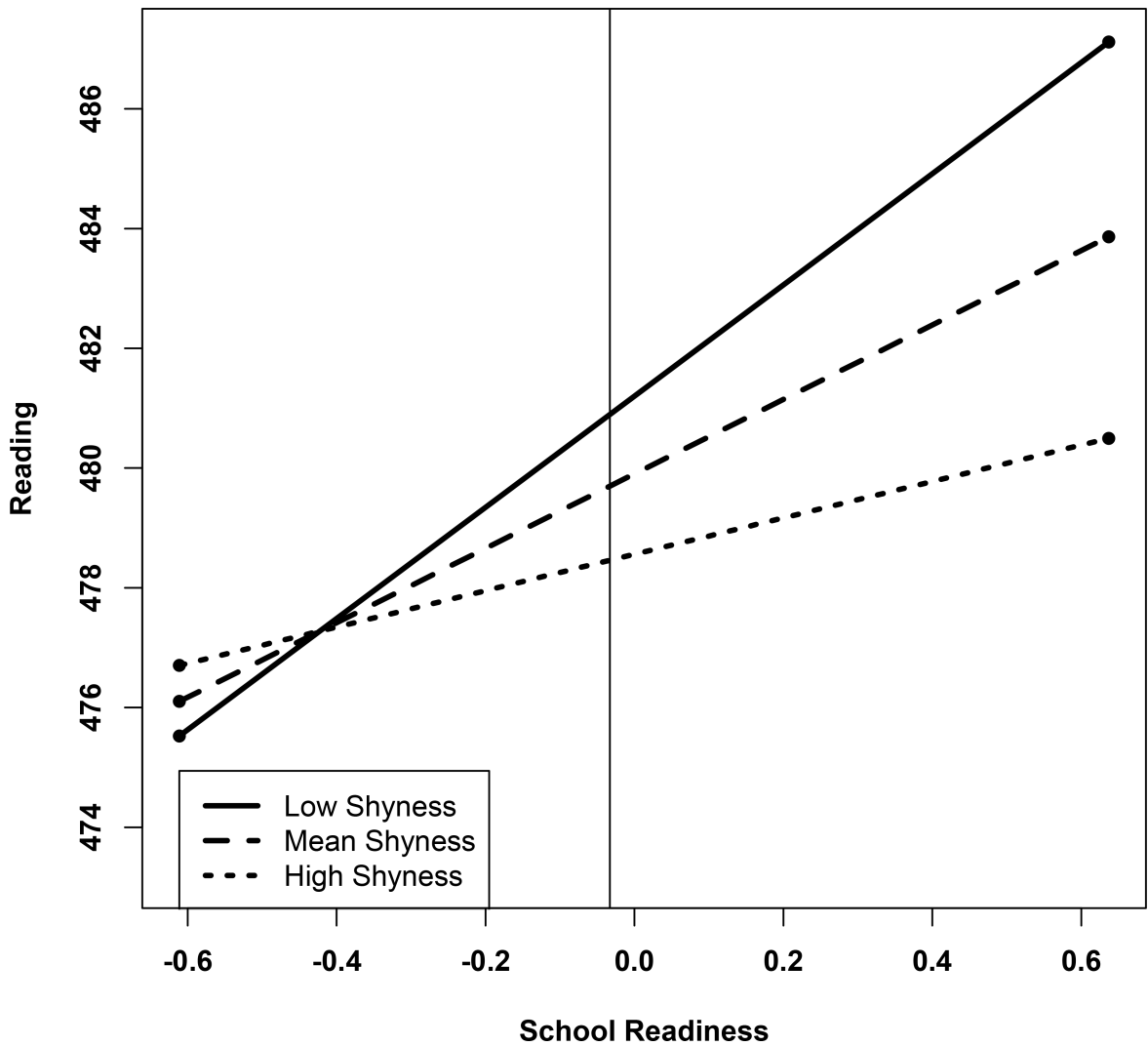


**Figure 1:**

The Interaction Between T1 School Readiness and T2 Effortful Control Predicts T2 Reading

*Note.* Differences between the slopes are significant to the right of the vertical line. The slopes for high ( $b = 8.52, p < .01$ ) and mean level ( $b = 5.85, p < .01$ ) effortful control were significant, whereas the slope for low ( $b = 3.19, ns$ ) effortful control was not significant.





**Figure 2:**

The Interaction Between T1 School Readiness and T2 Shyness Predicts T2 Reading

*Note.* Differences between the slopes are significant to the right of the vertical line. The slopes for low ( $b = 9.25$ ,  $p < .01$ ) and mean ( $b = 6.17$ ,  $p = .01$ ) shyness were significant, whereas the slope for high ( $b = 3.10$ ,  $ns$ ) shyness was not significant.

Table 1

## Descriptive Statistics for Major Variables

	1	2	3	4	5	6	7	8	9	10
1. Female <sup>1</sup>										
2. Non-Hispanic White <sup>1</sup>	.01									
3. T2 Age <sup>1</sup>	.02	-.06								
4. T1 SES <sup>1</sup>	.00	.24 <sup>**</sup>	-.13							
5. T1 School Readiness <sup>1</sup>	.03	.22 <sup>**</sup>	-.04	.37 <sup>**</sup>						
6. T2 Effortful control <sup>2</sup>	.31 <sup>**</sup>	.05	-.08	.06	.30 <sup>**</sup>					
7. T2 Anger <sup>2</sup>	-.18 <sup>**</sup>	-.01	.11 <sup>+</sup>	.00	-.15	-.52 <sup>**</sup>				
8. T2 Shy <sup>2</sup>	.03	-.10	-.04	-.21 <sup>**</sup>	-.22 <sup>*</sup>	-.09	.10			
9. T2 Reading <sup>3</sup>	.02	.25 <sup>**</sup>	.10	.31 <sup>**</sup>	.47 <sup>**</sup>	.29 <sup>**</sup>	-.10	-.23 <sup>**</sup>		
10. T2 Math <sup>3</sup>	-.14 <sup>*</sup>	.12	.09	.23 <sup>**</sup>	.47 <sup>**</sup>	.27 <sup>**</sup>	-.11 <sup>+</sup>	-.27 <sup>**</sup>	.60 <sup>**</sup>	
Minimum	0.00	0.00	7.26	-1.86	-3.24	1.44	1.00	1.00	442.00	436.00
Maximum	1.00	1.00	9.91	1.61	.65	5.00	5.00	5.00	508.50	531.00
M	.51	.54	8.61	-.05	-.03	3.54	1.82	2.56	481.44	487.14
SD	.50	.50	.52	.79	.63	.84	.86	.77	10.37	18.48

Note. T1 = Time 1; T2 = Time 2

<sup>1</sup> = Parent reported

<sup>2</sup> = Teacher reported

<sup>3</sup> = Woodcock Johnson (reading represents the average of picture vocabulary and passage comprehension whereas math was assessed with the applied problems subtest)

SES = socioeconomic status (i.e., mean of parent-reported household income and mothers' and fathers' education after standardization); The data presented for T1 SES and T1 School Readiness were calculated after the standardized composite was created.

<sup>+</sup>  $p < .10$

<sup>\*</sup>  $p < .05$

$10^{-d}$   
\*\*

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

**Table 2**

## School Readiness and Temperament as Predictors of Achievement

	T2 Reading			T2 Math		
	B	SE b	$\beta$	B	SE b	$\beta$
Effortful Control						
Female	-1.62	1.12	-.08	-8.55**	2.15	-.23**
Non-Hispanic White	2.81*	1.33	.13*	.57	2.41	.02
T2 Age	2.61*	1.26	.13*	5.10*	2.46	.14*
T1 SES	2.11*	1.00	.16*	2.24	1.88	.10
T1 SR	5.85**	1.68	.35**	11.43**	2.78	.39**
T2 EC	2.38**	.76	.19**	5.01**	1.71	.23**
T1 SR X T2 EC	3.17*	1.40	.14*	-.72	3.77	-.02
	R <sup>2</sup> = .33			R <sup>2</sup> = .32		
Anger						
Female	-.58	1.10	-.03	-6.71**	2.01	-.18**
Non-Hispanic White	2.90*	1.40	.14*	.60	2.49	.02
T2 Age	2.64*	1.34	.13*	4.32 <sup>+</sup>	2.53	.12 <sup>+</sup>
T1 SES	2.23*	1.09	.17*	1.93	2.04	.08
T1 SR	6.06**	1.74	.37**	12.91**	2.87	.44*
T2 Anger	-.63	.74	-.05	-1.90	1.43	-.09
T1 SR X T2 Anger	-.90	1.42	-.04	-2.78	3.11	-.06
	R <sup>2</sup> = .28			R <sup>2</sup> = .28		
Shyness						
Female	-.38	1.10	-.02	-5.47**	2.00	-.15**
Non-Hispanic White	2.83*	1.40	.14*	.15	2.39	.00
T2 Age	2.37 <sup>+</sup>	1.30	.12 <sup>+</sup>	3.55	2.44	.10
T1 SES	1.76 <sup>+</sup>	1.03	.13 <sup>+</sup>	1.49	1.99	.06
T1 SR	6.17**	1.59	.37**	12.38**	2.90	.42**
T2 Shy	-1.69*	.81	-.12*	-3.55**	1.61	-.15*
T1 SR X T2 Shy	-3.99**	1.36	-.18**	.21	3.02	.01
	R <sup>2</sup> = .31			R <sup>2</sup> = .28		

Note. T1 = Time 1; T2 = Time 2; SR = School readiness; EC = effortful control. SES = socioeconomic status (i.e., mean of parent-reported household income and mothers' and fathers' education after standardization); The *N* for each regression is 551.

<sup>+</sup>  $p < .10$

\*  $p < .05$

\*\*  $p < .01$