Associations between early family risk, children's behavioral regulation, and

academic achievement in Portugal

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Abstract

This study examined concurrent associations between family sociodemographic risk, self-regulation and early literacy and mathematics in young children from Azores, Portugal ($N = 186$). Family sociodemographic risk was indexed by low maternal education, low family income, and low occupational status. Behavioral aspects of self-regulation were assessed using a direct measure called the Head-Toes-Knees-Shoulders. Results of structural equation modeling revealed that family sociodemographic risk had significant negative effects on behavioral regulation and academic achievement. Behavioral regulation was positively associated with academic achievement when adjusting for the influence of family sociodemographic risk and child verbal IQ. Furthermore, behavioral regulation mediated the association between family sociodemographic risk and mathematics achievement. The results suggest the detrimental effect of family socioeconomic risk in Portugal and the potential importance of behavioral regulation for school success for Portuguese children.

Associations between early family sociodemographic risk, children's behavioral regulation, and academic achievement in Portugal

In many western societies, large numbers of young children move from early childcare settings into increasingly structured schooling environments. As they make this transition, they are expected to demonstrate the ability to regulate their thoughts, feelings and behavior in order to adjust to classroom demands and benefit from learning activities (Morrison, Cameron Ponitz, & McClelland, 2010). Self-regulation skills such as maintaining focus on a task in face of distractions, remembering instructions, inhibiting a dominant response or regulating strong emotions help children to respond to complex classroom settings in a deliberate, adaptive manner that help predict positive outcomes (Blair, 2002; Cameron Ponitz, McClelland, Matthews, & Morrison, 2009; Morrison et al., 2010; Wanless, McClelland, Acock, et al., 2011). The potential role of these skills for early school success is supported by international research showing that self-regulation uniquely predicts academic competence in early childhood (Blair & Razza, 2007; McClelland et al., 2007; Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011). Given this research, it seems critical to understand early contextual influences on self-regulation and academic achievement, particularly in cultural contexts where research is still scarce. In this study, we examine concurrent associations between behavioral aspects of self-regulation, family sociodemographic risk and early literacy and mathematics in a sample of young children in Azores, Portugal.

Self-regulation and Its Importance for School Success

Self-regulation has been defined as a broad, multidimensional construct that refers to children's deliberate attempts to modulate attention, thoughts, emotions, and

behavior in response to a given situation (Liew, 2012; McClelland, Cameron Ponitz, Messersmith, & Tominey, 2010; McClelland & Cameron Ponitz, 2012; Olson & Sameroff, 2009). A growing literature indicates that aspects of self-regulation and related constructs, including effortful control, inhibition, executive functions, behavioral regulation, and emotion-related regulation, are associated with academic competence (Blair & Razza, 2007; McClelland et al., 2007; Valiente, Lemery-Chalfant, & Swanson, 2010). The current study focuses only on behavioral regulation and is assessed with a widely utilized measure, the HTKS (McClelland et al., 2014). In this study, behavioral regulation is understood as the ability to integrate attention, working memory, and inhibitory control in the regulation of overt behavior (McClelland et al., 2007; Cameron Ponitz et al., 2009; Sektnan, McClelland, Acock, & Morrison, 2010; Wanless, McClelland, Acock, et al., 2011). This subset of skills is particularly important in the classroom setting where children are often asked to shift attention and ignore irrelevant, distracting information (attention), remember instructions while responding (working memory) and stop inappropriate responses that could otherwise disrupt classroom activities (inhibitory control; McClelland et al., 2007; Wanless, McClelland, Acock, et al., 2011).

A large body of research now suggests that over and above the effects of important academic skills and demographic factors, behavioral regulation is associated with higher scores on language, mathematics and literacy skills (Blair & Razza, 2007; Graziano, Reavis, Keane, & Calkins, 2007; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003; Liew, Chen, & Hughes, 2010; McClelland et al., 2007; Valiente, Lemery-Chalfant, & Swanson, 2010). Findings of numerous studies show that behavioral regulation and related constructs significantly correlate with academic achievement in preschool and elementary school (Blair & Razza, 2007;

McClelland et al., 2007; Cameron Ponitz et al., 2009). For example, Blair and Razza (2007) found that effortful control contributed to early mathematics and literacy skills in the United States. Similarly, Valiente et al. (2010) found that effortful control was positively related to achievement in kindergarten. In one study examining children's behavioral regulation skills using a direct measure (the Head-Toes-Knees- Shoulders; HTKS) in Taiwan, South Korea, China, and the United States, results indicated that children with higher behavioral regulation scores were more likely to show higher early mathematics, vocabulary, and literacy skills, after important demographic variables were controlled (Wanless McClelland, Acock et al., 2011). In another study conducted in the United States, using the same direct measure, gains in behavioral regulation predicted gains in mathematics skills over the kindergarten year (Cameron Ponitz et al., 2009). Suchodoletz and colleagues (2013) also found positive associations among behavioral regulation and academic skills in Germany and Iceland. Together, these studies show the critical role of behavioral regulation on children's achievement.

In addition, these studies supported the validity of the HTKS in several countries (Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011). The HTKS was designed to assess the integrative nature of behavioral regulation in an ecologically valid manner (Cameron Ponitz et al., 2009). This measure taps aspects of behavioral regulation similar to the behaviors required from children in the classroom context and it was designed to be used in school settings (McClelland & Cameron Ponitz, 2012). The usefulness of a direct measure such as the HTKS can be even greater when assessing behavioral regulation in different sociocultural contexts. For instance, although teacher- and parent- reports can provide valid information on behavioral regulation, they can also be biased because they rely on their expectations

for children's behavior (Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011). Teacher and parent expectations can be particularly susceptible to cultural values and thus reflect culture-specific definitions for child behavior. For this reason, in this study, we use a direct measure, the HTKS, to examine relations between behavioral regulation and academic achievement in Portugal, taking into account important socioeconomic characteristics of children's families.

Socioeconomic Risk, Academic Achievement and Behavioral regulation

Research has consistently pointed out the negative associations between socioeconomic risk and child development. Multiple family and social risk factors, including low income, low maternal education and low occupational skills, have been shown to adversely predict children's achievement (Ackerman, Brown, & Izard, 2004; Burchinal, Roberts, Zeisel, Hennon, & Hooper, 2006; Lipina, Martelli, Vuelta, & Colombo, 2005; McLoyd, 1998). Although less extensively examined, a number of studies also suggest the adverse effects of socioeconomic disadvantage on children's behavioral regulation skills (Evans & Rosenbaum, 2008; Lengua, Honorado, & Bush, 2007; Mezzacappa, 2004; Noble, Norman, & Farah, 2005; Wanless, McClelland, Tominey, & Acock, 2011). In one study examining the effects of socioeconomic status (using a composite of income, occupational and educational status), results suggested that socially disadvantaged children performed less proficiently in behavioral regulation than their more advantaged peers (Mezzacappa, 2004). Findings from another study showed that children from low-income families began prekindergarten with significantly lower behavioral regulation than their peers (Wanless, McClelland, Tominey, et al., 2011). Other research suggested that family socioeconomic risk, indexed by ethnic minority status, low maternal education, low family income, and high maternal depressive symptoms had significant negative

effects on both parent- and teacher-rated behavioral regulation in preschool and kindergarten (Sektnan et al., 2010).

To document family risk, researchers have used either a categorical approach or continuous scores of risk indicators (Burchinal, Roberts, Hooper, & Zeisel, 2000; NICHD Early Child Care Research, 2002; Sektnan et al., 2010). In the categorical approach, each risk indicator is dichotomized into two groups representing the presence or absence of risk (Gutman, Sameroff, & Cole, 2003). Although this approach is useful, cutoffs may be arbitrary and important variability is often discarded (NICHD Early Child Care Research, 2002; Sektnan et al., 2010). Thus, to avoid arbitrary cutoff points, we use continuous scores of three risk factors, maternal education level, family income, and low occupational status.

Several pathways have been investigated to explain links between socio-demographic risk and behavioral regulation, including how risk is related to adverse parenting and to children's stress levels (Evans & Kim, 2013; Sarsour et al., 2011). For example, parents with low education, income, and occupational status are more likely to have fewer resources and higher levels of distress (Blair & Raver, 2012; Evans & Kim, 2013). This can lead to lower parent warmth/responsiveness, and less cognitive stimulating experiences for children (e.g., fewer educational materials and learning opportunities, Evans & Rosenbaum, 2008; Mistry, Benner, Biesanz, Clark, & Howes, 2010; Sarsour et al., 2011). Sociodemographic risk can also lead to higher stress levels in children, as indicated by higher levels of physiological dysregulation (Evans & Schamberg, 2009). Chronic stress in the form of chronic activation of the HPA axis can result in "down stream" effects on cortical structures important for the development of behavioral regulation (Blair, 2010; Evans & Kim, 2013; Kiss, Fechete, Pop, & Susa, 2014).

In addition to pathways between sociodemographic risk and behavioral regulation in children, longitudinal research also suggests that behavioral regulation mediates relations between the family environment and children's achievement (Evans & Rosenbaum, 2008; NICHD ECCRN, 2003; Sektnan et al., 2010). Evans and Rosenbaum (2008) found, for example, that family income during early childhood (age 2 to Grade 3) positively predicted behavioral regulation, which, in turn, was related to cognitive development in 5th graders. Sektnan et al. (2010) also found that kindergarten behavioral regulation significantly mediated relations between family risk (e.g., low maternal education, and chronic poverty between birth and 54-months) and first-grade achievement. These longitudinal studies suggest that establishing the mediating role of behavioral regulation can be especially important for prevention efforts (Raver et al., 2011).

Research is relatively scarce outside the United States however. In particular, in order to contribute to a culturally sensitive understanding of the factors influencing child outcomes in different cultures, it is important to consider the broader social and cultural contexts that frame behavioral regulation and family characteristics. Most studies have been conducted in the United States, where ethnic and language status are often intertwined with low levels of maternal education and family income. For example, it has been shown in the United States that African American children are disproportionately more likely to live in poverty than Caucasian children (Duncan, Brooks-Gunn, & Klebanov, 1994; DeNavas-Walt, Proctor, & Smith, 2011). In Portugal, however, the population is relatively homogeneous regarding ethnicity, language, and religion. Conducting studies in different sociocultural contexts can thus provide a clearer understanding of the respective roles of income, maternal education, race or ethnicity on behavioral regulation.

Considering Sociocultural Contexts: The Portuguese Context

Over the last few years, many countries have experienced high levels of income inequality (e.g., OECD, 2013a). In addition, as a result of the recent economic crisis which started in 2008 in Europe, poverty has increased considerably among children and youth (Council of Europe, 2014; Forster, & Richardson, 2011; OECD, 2013a). This is especially relevant in Portugal, which has one of the highest percentages of children living in poverty in Europe (21%). For example, in 2009, nearly one in five Portuguese households with a child under the age of 6 lived under the threshold for poverty, while the mean percentage in Europe was one in seven (Eurydice, 2009). Several reports on household income inequality also show that Portugal is one of the most unequal countries in Europe, showing large disparities on incomes between the richest and the poorest (Carmo, Cantante & Carvalho, 2012; OECD, 2013a).

Given the present economic situation in Portugal, there is no indication of an improvement in the living conditions for young children. In fact, the economic crisis has severely affected the employment and welfare systems (Council of Europe, 2014). Austerity measures in Portugal included cuts to public funding for social transfers, family benefits, heath care and education (Eurochild, 2014). In addition, the Portuguese social transfer system is relatively ineffective compared to other European countries, with state policies having little impact in reducing the risk of poverty among children (Save The Children, 2014). This is particularly worrisome because poverty is associated with other risk factors for child development (Eurydice, 2009).

In the case of Portugal, low income and unemployment are concentrated among low educated parents (Carneiro, 2007; OECD, 2013a). Low parental education has been shown to be a strong predictor of poverty and low work status. In addition of

the large disparities in rates for educational attainment among the population, Portugal has one of the largest proportions of adults without a high-school degree among the developed countries (65% in contrast with the average of 25% for OECD countries; OECD, 2013a). Furthermore, analyses of intergenerational persistence in Europe have indicated that the transmission of low levels of education from parents to children in Portugal is nearly 70%, which clearly contrasts with the mean of 35% for the European countries (Grundiza & Vilaplana, 2013). This suggests that in Portugal low parent education not only affects parents' current economic and occupational status, but also the likelihood of their children to have low levels of education. It has been shown that the experiences children have in early childhood lay the foundation for lifelong learning and development (Shonkoff & Phillips, 2000). It is thus very important, within the application of a prevention framework, to understand whether family socioeconomic risk predicts child behavior and achievement starting early in life. To date, however, the examination of the effects of low education and other socioeconomic risks in early childhood is still limited in Portugal.

In one study that has been conducted in Portugal, results examining links between family socioeconomic risk (e.g., low maternal education, large households, low income) and children's literacy skills at school entry indicated large disparities among five-years-olds and provided evidence of the negative impact of family risks on child literacy development in Portugal (Cadima, McWilliam, & Leal, 2010). Specifically, findings suggested that at the end of preschool, at-risk children had significantly lower literacy skills than their non-risk peers and that the differences between at-risk and non-risk children tended to increase throughout first grade. These early disparities highlight the need to better understand specific aspects that can contribute to or inhibit the development of children's academic skills in Portugal.

Given that behavioral regulation can be a key component of school success, this study examined patterns among behavioral regulation and children's achievement in the context of family risk for young Portuguese children.

The Present Study

The present study examines concurrent associations between family sociodemographic risk, behavioral regulation and early literacy and mathematics in young children in Portugal. Three objectives are addressed. First, we investigate relations between family sociodemographic risk (low maternal education, low income, and low occupational skills) and children's behavioral regulation and achievement in preschool. We were particularly interested in examining this influence in the Portuguese context in order to contribute to a culturally informed understanding of the factors influencing child outcomes. Second, we investigate the extent to which child behavioral regulation is associated with early literacy and mathematics after taking into account important variables, namely child verbal IQ and family sociodemographic risk (low maternal education, low income, and low occupational skills). Finally, we test the extent to which the influence of family sociodemographic risk on early literacy and mathematics is mediated through children's behavioral regulation.

Considering the particular context of Portugal, we expect that maternal education will influence the capacity of families to foster their children's skills by showing high associations with the other socioeconomic risk factors. Because of the intergenerational persistence of social disadvantage in Portugal, we expect that family risk will have a strong negative impact on child outcomes. Based on previous research findings in other countries (Mezzacappa, 2004; Wanless, McClelland, Tominey, et al., 2011), we expect that family sociodemographic risk will be negatively associated with

children's behavioral regulation and academic achievement. We also expect that behavioral regulation will be significantly related to literacy and mathematics skills (Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011). In addition, we anticipate a negative indirect effect of family sociodemographic risk on child achievement through children's behavioral regulation (Sektnan et al., 2010). This study extends prior research in two important ways: First, it examines family sociodemographic risk factors in a population relatively homogeneous with respect to language, racial and ethnical status, contributing to a better understanding of the respective roles of maternal education, income, and occupation on behavioral regulation and academic achievement; Second, it examines the utility of a direct measure of behavioral regulation, which has not previously been used in Portuguese children. Thus, the study aims to place behavioral regulation and family characteristics in their social and cultural contexts (Raver, 2004).

Method

Participants

Participants were 186 Portuguese children (86 girls and 100 boys), their families and their preschool teachers participating in the study *Risk factors in child development in Azores*. This research project was designed to describe the family environment of preschool children and to investigate its associations with children's skills from a small urban area of the Terceira island in the Azores archipelago, Portugal. In Portugal, preschool is not compulsory and is attended by children aged 3 to 5. Compulsory school starts at age 6 (first grade) in elementary school, but the preschool attendance rate is relatively high, 74% (Instituto Nacional de Estatística [INE], 2012). In this study, all the preschool classrooms from two school groups were recruited, for a total of 17 classrooms. In each participating classroom, teachers sent

consent forms describing the study to all parents of children who met the following criteria for participation: 1) were 4 or 5-years old and 2) did not have an individualized education plan. The average rate of parent consent was 65%.

Children's mean age was 5 years and 1 month ($SD = 6.7$ months). All children were Caucasian and all parents had the Portuguese nationality. Mothers' average level of education was 8 years ($SD = 3.5$; See Table 1 for descriptive statistics). The percentages of mothers attending basic education (9 years), secondary school (12 years) and university were, respectively, 73.9%, 15.9%, and 10.2%. The percentages of fathers were, respectively, 79.6%, 13.6% and 6.8%. These percentages are similar to Azores educational levels of completing high school (24%) and somewhat lower than national educational levels, with 32% of adults having at least the equivalent of a high-school degree (INE, 2012; OECD, 2013b). It is worth noting that in the United States, the percentage of adults with a high-school degree is 89% (OECD, 2013b). Mothers' and fathers' levels of education were strongly related, $r = .59$. The average household monthly income for participants in the study was 1000€–1499€(which is equivalent to about $1,364 USD–$2,044 USD a month, and $16,369 USD–$24,537 USD a year), with monthly incomes ranging from less than 499€(7.9%) to over 2000€(4.5%). This sample income average is comparable to the national average of $19,366 USD a year, which is less than the OECD average of $23,047 USD and half of the average in the United States of $38,001 USD a year (OECD, 2013a).

With respect to the mother's current job and occupation status, based on the European Union variant of the International Standard Classification of Occupations (ISCO-88, Elias & Birch, 1994; Eurostat, 1988), 45% of the mothers were unemployed or non-active (See Table 1).

Measures

Behavioral regulation. Head-Toes-Knees-Shoulders (HTKS) directly

assesses children's behavioral regulation and requires 5–7 minutes to administer. It

measures the executive function processes of attentional or cognitive flexibility,

working memory, and inhibitory control (McClelland & Cameron Ponitz, 2012). In

the task, children are asked to first touch their head and then touch their toes and then

asked to do the opposite and touch their head instead of their toes. There are three

parts to the task involving paired rules: a head-toes section (4 practice items and 10

test items), a knees-shoulders section (4 practice items), and a section with four types

of paired commands (10 test items). There are a total of 20 test items given in a

consistent order and with scores of 0 (incorrect), 1 (self-correct), or 2 (correct) for

each item. A self-correct is defined as any motion to the incorrect response, but self-

correcting and ending with the correct action. Self-corrections must occur without

verbal cues. Scores range from 0 to 40 where higher scores indicate higher levels of

behavioral regulation. The task is available in English and Spanish and has been

found to be reliable and significantly predict academic outcomes in diverse samples

(McClelland et al., 2014; McClelland & Cameron Ponitz, 2012; McClelland et al.,

2007). The task has also been found to be reliable and predict academic outcomes in

samples in Asia (Taiwan, S. Korea, and China, Wanless, McClelland, Acock et al.,

2011) and Europe (Germany, Iceland and France; von Suchodoletz et al., 2013;

Gestsdottir et al., 2014). In the current study, Cronbach's alpha was .94. Although not

a focus of the current study, preliminary validity for the HTKS was determined

through inspecting correlations with another measure of behavioral regulation, the

teacher-rated Child Behavior Rating Scale (CBRS; Bronson, Tivnan, & Seppannen,

1995). The CBRS assesses behavioral regulation in the classroom and its reliability

has been shown in several studies (cf. McClelland et al., 2007). For this sample,

higher scores on the HTKS were correlated to higher teacher ratings on CBRS behavioral regulation ($r = .25$, $p < .001$). The magnitude of association between HTKS scores and teacher-reported scores was comparable to that found in previous research in the United States and Asia (Wanless, McClelland, Acock et al., 2011).

Letter identification. Children's ability to identify letters was assessed using the subscale of the Portuguese test, the Cross-Linguistic Assessment of Foundation Level (CLAFL, Castro, Cary, & Gomes, 1998). Two lists of 21 randomly sorted letters were presented; the Portuguese alphabet has 23 letters, but *h* and *q* are not part of the list, because of idiosyncrasies of the Portuguese language, in which *h* serves different purposes and *q* is always taught as *qu*. The child is asked to say the name or the sound of each letter. A total score with the number of correct responses was created and used in the present analyses. In the current study, internal consistency was very good, $\alpha = .96$.

Mathematics skills. Preschool math ability was assessed with the Portuguese translation of the Test of Early Mathematics Ability (TEMA-3; Ginsburg & Baroody, 2003). This test measures both informal and formal concepts and mathematics skills across different domains of number sense, such as numbering skills, calculation skills, and understanding of concepts. Several questions of increasing difficulty are presented to the child (e.g., "I'm going to tell you some numbers, and I'd like you to write them down on the worksheet here. The first number is 24"). The assessment is untimed and the assessor starts at the entry point established for each age group. The floor (five consecutive correct responses) and ceiling rules (five consecutive incorrect items) were the same in the Portuguese version as in the original version. This test has been used in Portugal, demonstrating good validity and reliability (Cadima, Abreu-Lima, Gomes, Coelho, Lobo, & Ramalho, 2008). The validity and reliability studies

of TEMA-3 for Portuguese children involved 281 four- to 7-year-olds. Internal consistency coefficients were reported to be above .90; test-retest reliability was adequate, with a correlation coefficient of .90; and its scores were demonstrated to be highly correlated with scores on the Arithmetic subtest of the WISC-III, $r = .62$ (Cadima et al., 2008). In this study, the sum of correct responses was used, with a possible maximum score of 72. Cronbach's alpha was .95.

Child verbal IQ. Children's verbal IQ was assessed with the Vocabulary subtest of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-R; Wechsler, 2010). The WPPSI is a widely used, well-validated test that assesses the intelligence of children between 3 and 7 years of age. It has been shown to be a highly reliable and valid measure across diverse populations, with its validity being established for the Portuguese children as well (Weschler, 2003). The test reports good reliability estimates for all subtests and composite scores for the Portuguese children, which range from .79 to .94 (Wechsler, 2010). The vocabulary subtest was used for analysis in the current study, consisting of 21 items asking children to give definitions of a particular word. The item's score can vary from 0 to 2. The subtest total was obtained by summing across the items. In the current study, Cronbach's alpha was .87.

Family sociodemographic risk. A background measure was used to gather family sociodemographic risk data. Items included the mother's education level, mother's current job and employment status, and family income. For maternal education, the total years of education was reverse-coded so that higher scores indicated lower education and more family risk. Regarding maternal occupation status, mothers' current jobs were classified using the European Union variant of the International Standard Classification of Occupations (ISCO-88; Elias & Birch, 1994)

by two research assistants. Double coding for agreement was conducted on all cases. Mother's jobs were coded so that higher scores represented more socioeconomic risk. Categories included a) unemployed or elementary occupations (simple and routine tasks which mainly require the use of hand-held tools and require skills at the first primary school skill level); b) plant and machine operators; c) skilled agricultural and fishery workers or craft workers (e.g., farmers, carpenters, plumbers); d) service workers or clerks (e.g., restaurant service workers; personal care workers; secretaries; typists); e) technicians and associate professionals; and f) managers and professionals. Categories for family monthly income were a) less than 499 € of income; b) between 500 € and 999 €; c) between 1000 € and 1499 €; d) between 1500 € and 1999 €; e) between 2000 € and 2499 €; and f) more than 2500 € (see Table 1).

Procedure

Children's skills were measured in the spring of the preschool year. Research assistants administered the battery of tests individually at the child's preschool center, in a quiet room. Information regarding family characteristics was collected in preschool. Mothers completed the background questionnaire in the spring with the help of research assistants.

Analytic Strategy

To answer our research questions, data were analyzed using structural equation modeling with Mplus software (Muthén & Muthén, 1998-2010). A latent factor representing family sociodemographic risk was created with three indicators, maternal education, income, and occupation. A series of models were then estimated to examine the concurrent relationships among family sociodemographic risk factors, behavioral regulation, and children's school readiness outcomes. To test for mediation, a final model was tested in which the direct and indirect effect coefficients

were modeled simultaneously. In this model, all proposed direct and indirect paths were computed at the same time and significance tests for each separate path were obtained. To account for the influence of child characteristics, in the models, direct effects on behavioral regulation from child age and gender were estimated as well as the covariation between behavioral regulation and child IQ. Direct effects on letter identification and mathematics from child age, gender and verbal IQ were also estimated. Sobel's (1982) test was used to test the significance of the indirect effects. The following fit indices were used to evaluate fit between the data and the models: comparative fit index (CFI), and the root mean square error of approximation (RMSEA). The fit of the models is considered adequate if CFI exceeds .95 and RMSEA is less than .06 (Hu & Bentler, 1999; Kline, 2005). To address nesting of children in classrooms, the models were estimated using the special feature for complex survey data available in Mplus software (Muthén & Muthén, 1998-2010). This feature uses the maximum likelihood with robust standard errors (MLR) to take into account the nonindependence of observations, and corrects the standard errors that otherwise would be underestimated.

Complete data were available for all 186 children for child age and gender. Family income and maternal occupational status had less than 5% missing data, and maternal education had 16% missing data. In addition, 6% of the sample were missing data on HTKS, 8% were missing on letters and 21% on child verbal IQ and mathematics. The reasons for missing data for child verbal IQ and mathematics primarily related to child absence as these measures were administered at the end of the battery and frequently during a second visit to the setting. To examine patterns of missing data, for those variables with greater than 5% missing data, we conducted t-tests using dummy variables indicating whether data were missing or not and

examined differences on the variables for which we had complete information, namely child age and sex. Missingness on these variables did not predict any of the other variables, with the exception that participants missing mathematics data were more likely to be older. Little's MCAR test, $\chi2$ (151) = 179.35, *ns*, suggests that data were missing completely at random. Missing data were handled using full information maximum likelihood estimation (FIML) to prevent sample size reduction and subsequent loss of statistical power (Enders, 2001). FIML estimates model parameters and standard errors directly from all available data, including cases with incomplete data, and without imputing missing values (Buhi, Goodson, & Neilands, 2008). FIML parameter estimates are advantageous to traditional techniques, such as listwise and pairwise deletion and mean substitution, as it provides less biased estimates (Baraldi & Enders, 2010; Enders, 2001). Regarding effect sizes, we present the standardized path coefficients assessing the direct effects that can be used as effect sizes (Durlak, 2009).

Results

Descriptives and Correlations

Descriptive statistics and correlations are provided in Table 2. Children's behavioral regulation scores showed considerable variability, covering the entire range of the task. Relatively few children scored at ceiling level (*n* = 7; 4%), but nearly 20% (*n* = 34) scored at floor level, which supports other studies with children at this age (Cameron Ponitz et al., 2009). Skewness and kurtosis values were nevertheless within an acceptable range, suggesting no severe deviations from an expected normal distribution (Kline, 2005). Pearson correlations indicated that early family sociodemographic risk factors (including maternal education, income, and job status) were statistically significantly and modestly related to behavioral regulation,

early literacy and mathematics, in the expected directions, with higher risk associated with lower skill levels. In addition, family sociodemographic risk factors were moderately intercorrelated with each other and behavioral regulation was positively related to both literacy and mathematics skills. Child's age was also positively correlated with higher skill levels.

Next, we performed analyses testing the direct and indirect pathways among family sociodemographic risk factors, behavioral regulation and academic achievement. Figure 1 presents the standardized coefficients and the factor loadings for the latent construct family sociodemographic risk for the overall model. The overall model provided adequate model fit, $\chi^2 (14) = 20.42$, $p = .117$, RMSEA = .050, CFI = .990. The model explained 19% of the variance in behavioral regulation, 38% of the variance in letter identification, and 57% of the variance in mathematics skills.

1. Is Family Socioeconomic Risk Associated with Behavioral Regulation, Letter Identification and Mathematics?

The first research question addressed the extent to which the latent construct family sociodemographic risk is associated with child behavioral regulation, letter identification, and mathematics (see Figure 1). Consistent with our expectations, family sociodemographic risk was negatively and modestly associated with lower levels of behavioral regulation, $\beta = -.19$, $SE = .06$, $p = .002$, letter knowledge and mathematics skills in the spring of preschool, respectively $\beta = -.18$, $SE = .06$, $p = .002$, and $\beta = -.22$, $SE = .08$, $p = .005$, after taking into account child age, gender and IQ. Children experiencing higher levels of family sociodemographic risk scored lower in behavioral regulation, letters, and mathematics than children exposed to low levels of family sociodemographic risk. Specifically, an increase of one standard deviation in family sociodemographic risk was associated with a decrease of about one fifth of a

standard deviation in behavioral regulation, letters, and mathematics.

2. Is Behavioral Regulation Associated with Letter Identification and Mathematics, After Taking Into Account Family Sociodemographic Risk and Child Verbal IQ?

Also consistent with our expectations, in the spring of the preschool year, behavioral regulation was modestly associated with higher levels of both letter identification, and mathematics, respectively $\beta = .23$, $SE = .09$, $p = .007$, and $\beta = .21$, $SE = .07$, $p = .003$, after controlling for child verbal IQ, age and gender, and family sociodemographic risk (see Figure 1). Children with high scores on behavioral regulation scored higher in letters and mathematics than children low in behavioral regulation. Specifically, a one standard deviation increase in behavioral regulation was associated with one fifth of a standard deviation increase in letters and mathematics scores (.23 and .21, respectively).

3. Does Behavioral regulation Mediate the Relation between Family Sociodemographic Risk and Children's Letter Identification and Mathematics?

To test whether the associations between family sociodemographic risk and children's letter identification and mathematics skills were mediated through behavioral regulation in the spring of the preschool year, indirect paths were simultaneously computed in the overall model. Table 3 presents total effects, direct effects and indirect effects. As shown, the results indicated that the association between family sociodemographic risk and children's mathematical skills in the spring of preschool was significantly mediated by children's behavioral regulation (unstandardized indirect effect = -.42 [.0.12, 0.72]). Children with higher levels of family sociodemographic risk tended to have lower levels of behavioral regulation. In turn, children with lower levels of behavioral regulation tended to have lower levels

of mathematics skills. The effect was somewhat modest in size, with a standardized regression coefficient of -.04. No evidence of mediation was found for literacy skills. Although higher levels of family sociodemographic risk were related to lower levels of letter identification, the indirect effect of family sociodemographic risk through behavioral regulation only reached marginal levels of statistical significance in the overall model.

Discussion

The present study examined the direct and indirect pathways between family sociodemographic risk, behavioral regulation and early literacy and mathematics in young children in Portugal. Findings demonstrated that family sociodemographic risk, indexed by low maternal education, low family income, and low maternal occupational status, was negatively related to behavioral regulation and academic achievement. Consistent with earlier studies (Mezzacappa, 2004; Mistry et al., 2010; Wanless, McClelland, Tominey, et al., 2011), children who experienced higher levels of family sociodemographic risk showed poorer behavioral regulation skills, lower levels of letter identification and mathematics as compared to children who experienced lower levels of risk. In addition, higher levels of behavioral regulation were associated with higher levels of letter identification and mathematics skills, after adjusting for the influence of family sociodemographic risk and child verbal IQ. Finally, family sociodemographic risk was negatively related to mathematics indirectly through child's behavioral regulation.

Relations between Family Sociodemographic Risk, Academic Achievement, and Behavioral regulation

Our findings showed that lower maternal education, family income, and maternal occupational status were related to lower behavioral regulation and academic

achievement for young Portuguese children. Previous research has also shown that the family socioeconomic risk factors examined in this study individually or jointly predicted achievement and behavioral regulation. Family income has been shown to negatively predict numerous academic outcomes (Burchinal et al., 2006; Krishnakumar & Black, 2002; McLoyd, 1998) and more recently, behavioral regulation (Evans & Rosenbaum, 2008; Mistry et al., 2010; Raver, Mccoy, Lowenstein, & Pess, 2013; Sektnan et al., 2010; Wanless, McClelland, Tominey, et al., 2011). It has also been established that children whose mothers have low levels of education are more likely to perform poorly on achievement and behavioral regulation tasks (Ardila, Rosselli, Matute, & Guajardo, 2005).

Comparable evidence has also indicated that socioeconomic status, as assessed from parents' occupations, adversely affects cognitive development (Bradley & Corwyn, 2002) and behavioral regulation (Mezzacappa, 2004; Noble et al., 2005; Sarsour et al., 2011). Our results provide further evidence for the negative effects of family sociodemographic risk on behavioral regulation and achievement outcomes for Portuguese children, until now found primarily for North American children. Of note, the negative effects of family sociodemographic risk on behavioral regulation and academic achievement could be found for children as early as the age of four. These findings highlight that variations among children emerge early in development.

It has been shown that children from families experiencing higher levels of risk may have fewer opportunities to experience supportive and cognitive stimulating family environments and may have less access to the kind of resources and interactions that promote behavioral regulation and achievement (Mistry et al., 2010; Rhoades, Greenberg, Lanza, & Blair, 2011). It has also been suggested that family risk affects children's stress levels, which can interfere with the development of

behavioral regulation (Evans & Kim, 2013). Potential mechanisms linking risk to behavioral regulation should continue to be examined in future work.

In support of our expectations, maternal education, family income, and maternal work status were strongly correlated with each other. Mothers with low educational levels were likely to have low incomes and be in low skilled occupations. These findings are consistent with prior research conducted in other countries showing that family risk factors are likely to be correlated (Burchinal, Roberts, Hooper, et al., 2000; McLoyd, 1998). Research has suggested that the actual effects of each risk factor should be understood in the context of the others (Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001). In the particular case of Portugal, it is possible that the high associations between family factors are a result of the detrimental effects of low maternal education on professional status and wage (Carneiro, 2007). It has been demonstrated that, in Portugal, education is an important source of income inequality and directly affects work status (Carneiro, 2007). Moreover, the odds of school failure due to low parental education for Portuguese children are extremely high compared to other European countries (Grundiza & Vilaplana, 2013). The high variability in educational levels among parents in Portugal, combined with a high percentage of mothers with low education, may place Portuguese children at increased risk for poor outcomes. Findings from this study provide some support to this contention by showing that, even before starting compulsory school, children exposed to low levels of maternal education, income, and occupational status already are at increased risk for poor behavioral regulation and achievement outcomes. Our results are limited by the concurrent nature of the data, and further longitudinal research is needed to investigate family socioeconomic effects in early childhood in countries such as Portugal.

The Role of Behavioral Regulation in Early Academic Achievement

Findings from this study indicated that children with higher behavioral regulation skills performed better on the letter identification and mathematics tasks. These findings support previous research showing that behavioral regulation is positively related to early academic achievement in preschool (Cameron Ponitz et al., 2009; McClelland et al., 2007; Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011). Children with strong behavioral regulation are likely better able to shift attention and ignore irrelevant cues, remember instruction, and stop inappropriate behavior, which can facilitate learning and help children succeed academically (McClelland et al., 2007). In other words, it seems that early behavioral regulation is associated with skills needed to be successful in the classroom providing the basis for academic competence (Blair, 2002). Of note is the finding that behavioral regulation was associated with letter knowledge and mathematics when controlling for the effects of family sociodemographic risk. Regardless of family risk levels, children with high behavioral regulation scored higher in the academic tasks than children with low behavioral regulation. Furthermore, the relations between behavioral regulation and academic skills are robust after controlling for child verbal IQ. Findings from this study contribute to the growing body of research on the importance of behavioral regulation for achievement in the context of family sociodemographic risk, and suggest that success in school depends on cognitive and socioemotional processes that are likely to be intertwined rather than merely on academic skills (Evans & Rosenbaum, 2008).

Findings also support the utility of the HTKS as a measure of behavioral regulation associated with achievement for young children in Portugal. The HTKS showed significant variability among children and scores on the HTKS correlated to

achievement in the expected directions. Moreover, the effect sizes of HTKS for letters and mathematics were similar to the effect sizes of socioeconomic risk and child age. Our findings are consistent with other studies using the HTKS among children from different countries. For example, Wanless, McClelland, Acock, et al. (2011) reported that higher HTKS scores significantly predict higher achievement in the United States, Taiwan, South Korea, and China. The magnitude of the associations between HTKS and achievement found in our study (ranging from .50 to .58) was in line with previous studies in the United States, South Korea and China (ranging from .30 to .59; Ponitz et al., 2009; Wanless, McClelland, Acock, et al., 2011). Moreover, although we could not test the statistical significance of the difference, the mean scores in our sample were comparable to that found in Germany and in the United States for kindergarten children, although somewhat lower. Possible reasons for these differences can be the large disparities among maternal education levels between Portugal and the other countries, although more research on the HTKS task is clearly needed. Taken together with previous research, the present findings suggest that HTKS may be an adequate, ecologically valid measure to assess behavioral regulation among young children in different countries.

The Mediating Role of Behavioral Regulation

In this study, we elaborate on previous findings on family and early achievement by examining whether associations between family sociodemographic risk and achievement were mediated by observed behavioral regulation. We examined one possible mechanism, behavioral regulation, given that it has been demonstrated that behavioral regulation is amenable to intervention (Raver et al., 2011; Sanford Derousie & Bierman, 2012). The results indicated that behavioral regulation mediated the relation between family sociodemographic risk and mathematics, but not between

family sociodemographic risk and letter identification. This finding matches previous research, which has found stronger associations between behavioral regulation and mathematics than for literacy (Blair & Razza, 2007; Cameron Ponitz et al., 2009; Sektnan et al., 2010). One possible reason is that the components of behavioral regulation are more directly linked to mathematics learning (Blair & Razza, 2007). When solving mathematics problems, children are required to reason actively, attend to specific cues, process information and shift attention appropriately. Literacy skills and, in particular, letter identification, are likely to make less demands of behavioral regulation. Mathematics seems therefore more effortful compared to letter identification (Blair & Razza, 2007). It is also possible that other mediators, namely language skills, have a more substantial role for the relation between family risk and literacy (Burchinal et al., 2006; Sarsour et al., 2011). Language is an important skill underlying academic achievement that is negatively affected by early exposure to risk (Krishnakumar & Black, 2002). For example, Burchinal et al. (2006) reported that the child's language skills at school entry mediated associations between family sociodemographic risk and achievement outcomes. It is very likely that multiple mediators contribute simultaneously to explain the detrimental effects of risk on early achievement.

The present findings provide preliminary support for the mediation role of behavioral regulation in the influence of family sociodemographic risk on mathematics achievement. One possible explanation is that children experiencing higher levels of family sociodemographic risk are likely to face several stressors and simultaneously have less access to enriching resources that foster behavioral regulation (Blair & Raver, 2012). Mothers' education, in particular, may reflect less awareness on the part of the mothers of the importance of providing enriching

environments, limiting opportunities to practice these skills (Dilworth-Bart, 2012; Sektnan et al., 2010). Furthermore, low levels of education, along with other family sociodemographic risk factors, are likely to reflect less responsive, consistent forms of caregiving and limit setting, which influence children's regulation of attention and behavior (Blair & Raver, 2012). Lower levels of behavioral regulation are, in turn associated with decreased ability to plan, pay attention and complete mathematics' activities (Blair & Razza, 2007; Dilworth-Bart, 2012). It is also possible that children in families with lower maternal education have fewer opportunities to learn mathematics at home and rely heavily on the classroom context. Because of their difficulties in regulating their behavior in ways that contribute to their learning, they may miss opportunities to learn mathematics in the classroom context.

Our findings offer the promise that promoting the development of behavior regulation may be an effective way to help Portuguese children who face socioeconomic risk to succeed early in mathematics, although we are not able to make causal claims. Recent research provided evidence of the benefits of intervention programs for later academic success through supporting children's behavioral regulation skills. For example, Raver and colleagues (2011) have shown that children enrolled in a classroom-based program designed to support behavioral regulation substantially improve their behavioral regulation and academic skills. It seems that helping children in being better able to stay on task, ignore irrelevant cues, and follow through on teachers' instructions can support them in being able to take the most advantage of learning and improve their academic skills. This seems an important line of inquiry and more investigation on the mediating role of behavioral regulation may shed light on the potential targets for interventions efforts aimed at promoting school success.

Taken together, the present findings, in conjunction with previous research, underscore the relevance of behavioral skills for school success in young children. It needs to be emphasized, though, that these findings are preliminary and need to be examined further. Next, we present some suggestions for future research.

Limitations and Future Directions

When interpreting our findings, some limitations should be noted. A key limitation is that the results of this study are based on cross-sectional data and therefore the causal roles of family sociodemographic risk and behavioral regulation cannot be determined. Longitudinal studies are needed to provide further evidence of the potential mediating role of behavioral regulation skills. In spite of this limitation, however, this study was one of the first to investigate these research questions and can be used as a foundation from which to extend further research.

Second, to further understand cultural nuances, research would benefit from multiple group analyses in cross-cultural studies. Future research is needed to compare the equivalence of the measures, namely the HTKS, across countries so that meaningful cross-cultural comparisons can be made. It is important to note that this measure has been used in several European and Asian countries. Findings from this study also support utility for the HTKS in Portugal, and extend its adequacy to a new country.

Third, although we have included in this study the most widely used indicators of socioeconomic risk, consistent with an ecological systems framework (Bronfenbrenner, 1986), other distal and proximal family factors should be included in future research. For instance, in addition to other risk factors that have been shown to negatively predict child development (e.g., being a single parent, and having negative life events), it would be important to further examine the quality of the home

environment, including parenting quality and type of activities and materials. Similarly, future studies would benefit from examining potential mechanisms linking family risk to behavioral regulation, including the potential role of chronic stress on behavioral regulation in children from different countries and cultural backgrounds. Cross-cultural studies could be particularly helpful in understanding whether there are universal patterns linking family conditions to behavioral regulation. Considering that national education policies are increasingly affected by international and European level factors, understanding the extent to which studies conducted in different regions and countries report similar and comparable results seems crucial.

An additional limitation that requires mention is that we were not able to address classroom effects. An important body of research has documented the critical role of high-quality childcare for children's development (Burchinal, Roberts, Riggins, et al., 2000; Mashburn et al., 2008). There is evidence suggesting that high-quality early childhood programs promote children's cognitive, language, and socioemotional development (Bierman et al., 2008; Raver et al., 2011), but there is limited research on the associations between childcare quality and behavioral regulation. An important line of inquiry would be to examine the associations between childcare quality and children's behavioral regulation skills. In addition, in the present study, classrooms in the sample were drawn from a region in Portugal, the Terceira island in Azores. It is important to replicate findings in other regions of Portugal to account for possible variations within the country in respect to the associations between family risk factors, behavioral regulation and academic achievement. A final point that requires mention is that income was collected through ordinal categories.

Despite these limitations, this study contributes to the growing body of literature on the complex relations between early family sociodemographic risk, children's behavioral regulation, and early achievement. It provides important information on an understudied population, Portuguese children, and demonstrates the negative effects of family sociodemographic risk on behavioral regulation and achievement. It also highlights the critical role that behavioral regulation skills may have for early achievement, particularly for mathematics for young Portuguese children.

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Table 1

Decriptives for family risk variables

	N	%	M	SD	Range
Mother's education	176		8.45	3.57	0-16
Elementary school (≤ 6 years)		46%			
Compulsory school (≤ 9 years)		28%			
High school (≤ 12 years)		16%			
College/University		10%			
Mother occupation status	181				
Unemployed/non-active		45%			
Elementary occupations		29%			
Skilled agricultural craft workers		11%			
Service workers or clerks		8%			
Technicians or ass. professionals		4%			
Managers and professionals		3%			
Family income	177				
< 499 €		8%			
500 €- 999 €		38%			
1000 €- 1499 €		45%			
1500 €- 1999 €		4%			
2000 €- 2499 €		3%			
> 2500 €		1%			

Table 2

Descriptives and correlations of the observed variables

	1	2	3	4	5	6	7	8	*M*	*SD*
1. Maternal education (reversed)										
2. Family income (reversed)	.57**									
3. Mother's job status	.68**	.66**								
4. Child age	-.01	-.17*	-.19*						4.21	.65
5. Child gender[a] (% female)	-.02	-.05	-.04	.01					.46	
6. Behavioral regulation	-.19*	-.23*	-.20*	.43**	.11				19.51	14.14
7. Child IQ (vocabulary)	-.26**	-.31**	-.25**	.39**	.06	.55**			17.63	7.38
8. Letter identification	-.28**	-.33**	-.33**	.37**	.06	.50**	.53**		7.34	7.03
9. Mathematics	-.37**	-.35**	-.35**	.47**	.13	.58**	.64**	.70**	13.86	8.18

[a]1 = girl

* $p < .05$. **$p < .01$.

Table 3

Summary of tests of mediation for path analysis

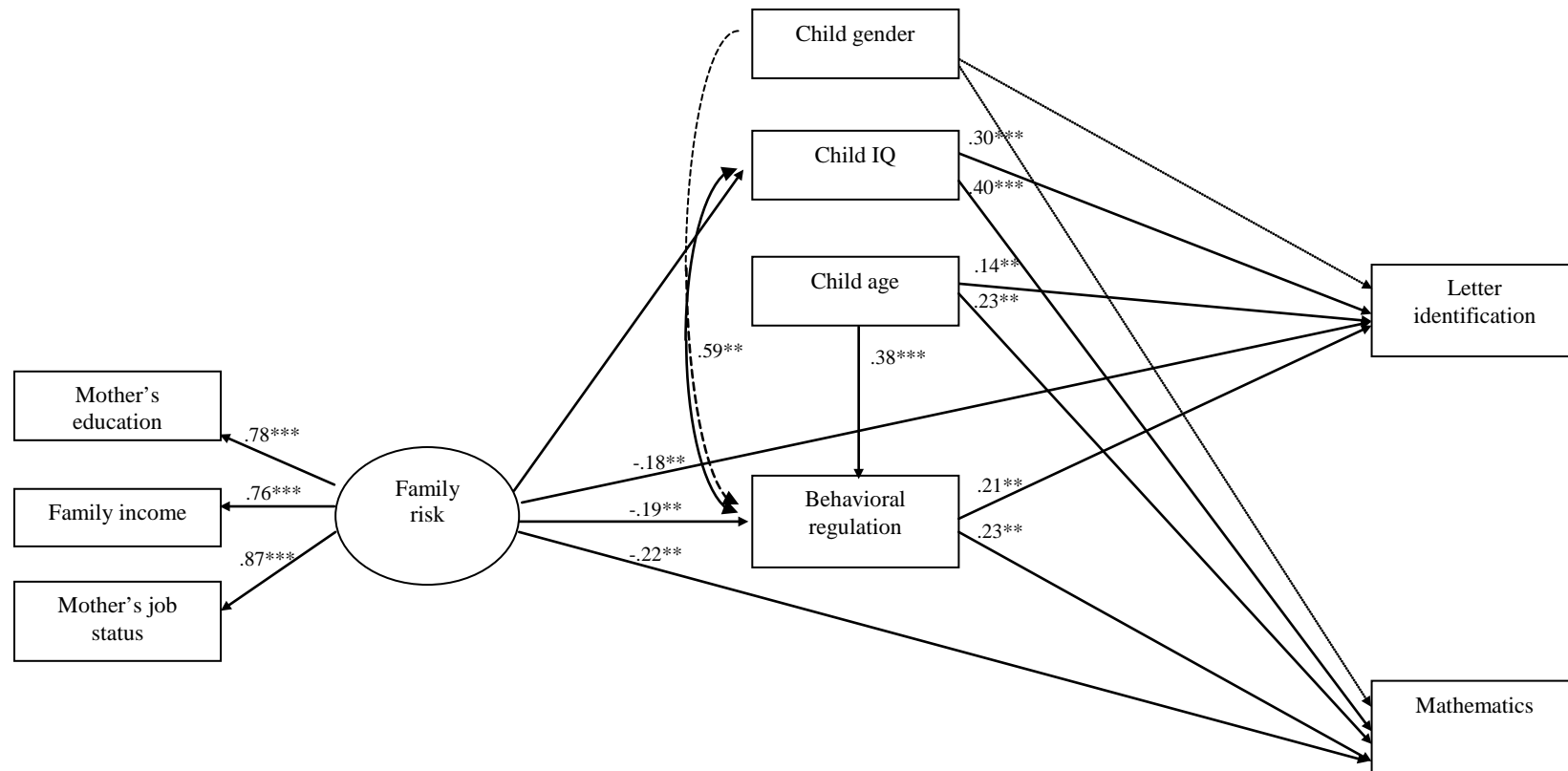|	Total effect		Direct effect		Indirect effect	
	Unst B	*SE*	*Unst B*	*SE*	*Unst B*	*SE*
Family risk → Mathematics	-4.03**	0.87	-2.29**	0.77	-0.42*	0.16
Family risk → Letter identification	-2.91**	0.69	-1.65**	0.54	-0.41	0.21

* *p* < .05. ***p* < .01.

Figure 1

Standardized coefficients for model of influence of family risk on children's behavioral regulation and achievement, with behavioral regulation as mediating pathway.

Note: Model fit statistics, χ^2 (14) = 20.42, p = .117, RMSEA = .050, CFI = .990. *p < .05, **p < .01, ***p < .001.