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The Implications of Early Attentional Regulation for School Success among Low-Income Children

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Abstract

This study examined the longitudinal associations between attentional regulation in preschool and children's school success in later elementary school within an at-risk sample (N = 2,595). Specifically, two facets of attention (focused attention and lack of impulsivity) at age 5 were explored as independent predictors of children's achievement and behavioral competence at age 9. Overall, the pattern of results indicates specificity between the facets of attention and school success, such that focused attention was predictive of achievement outcomes while impulsivity was predictive of behavioral outcomes. Both facets of attention predicted teacher ratings of children's approaches to learning, which suggests that they jointly influence skills that span both domains of school success. Poverty status, maternal warmth, and infant temperament did not moderate these associations. Implications of these findings for interventions targeting school readiness and success among at-risk children are discussed.

Keywords

focused attention; impulsivity; academic achievement; behavioral competence; low-income children

The Implications of Early Attentional Regulation for School Success among Low-Income Children

The extant literature suggests that attention-related self-regulatory skills have significant implications for children's school readiness, as difficulties in attention regulation are linked with poor academic performance (Alexander, Entwisle, & Dauber, 1993; Horn & Packard, 1985; Raver, Smith-Donald, Hayes, & Jones, 2005) and increased problem behaviors (Campbell, Pierce, March, Ewing, & Szumowski, 1994; Eisenberg et al., 2000; Rothbart & Bates, 2006) across the preschool and early elementary years. Not surprisingly, there is also growing evidence that early attention skills are predictive of children's school success in the

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longer term. For example, longitudinal research supports associations between children's attention in early elementary school and externalizing behavior in the later elementary grades (Belsky, Pasco Fearon, & Bell, 2007). Moreover, the results of a meta-analysis across six studies identified attention skills at school entry as a unique predictor of later math and reading achievement (Duncan et al., 2007). Collectively, these studies highlight attention as a potential target for early intervention efforts aimed at promoting children's school readiness and later school success in both the academic and behavioral domains.

Two attentional processes that have received increased interest in recent years are focused attention and lack of impulsivity, which reflect the ability to intentionally focus on a particular stimulus and to avert prepotent response tendencies, respectively (Derryberry & Rothbart, 1997). Although both facets are likely to contribute to school success, it is possible that they are differentially implicated in achievement and behavior. For example, among predominantly socioeconomically advantaged families, children's focused attention at 54 months accounted for more variance in academic achievement than in behavior, while impulsivity accounted for more variance in behavior than academic achievement (National Institute of Child Health and Human Development [NICHD] Early Child Care Research Network [ECCRN], 2003). Moreover, some evidence suggests that associations between focused attention and impulsivity and later child outcomes may vary by socioeconomic status. Within a low-income sample, focused attention at age 5 was associated with receptive vocabulary among all children, while impulsivity predicted vocabulary and behavior problems for poor but not near-poor children (Razza, Martin, & Brooks-Gunn, 2010). These findings suggest the need for further research on attention processes among low-income children, who demonstrate lower school readiness than their more advantaged peers (Klebanov, Brooks-Gunn, McCarton, & McCormick, 1998; Lengua, 2002; McLoyd, 1998).

In the present study, we address three limitations of the extant literature linking attention with school success. First, with the exception of the two above-mentioned studies (i.e., NICHD ECCRN, 2003; Razza et al., 2010), there has been little research examining the independent contributions made by the individual facets of attention to children's achievement and social behavior. In fact, most of the studies in this area focus exclusively on the link between impulsivity and externalizing behavior (e.g., Belsky et al., 2007). Second, the limited research that does exist is cross-sectional, and thus the long-term associations between attention and academic and behavioral competence remain unknown. Third, most of the research linking attention and school readiness has been generated from a single data set representing a predominantly white, advantaged sample – the NICHD Study of Early Child Care and Youth Development (SECCYD; Belsky et al., 2007; Dilworth-Bart, Khurshid, & Vandell, 2007; NICHD ECCRN, 2003). Given recent evidence suggesting that the implications of attention may vary by poverty status (Razza et al., 2010), it is imperative that we continue to investigate how attentional processes behave within at-risk samples. Thus, the current study examines the independent contributions of focused attention and lack of impulsivity at 5 years to children's academic and behavioral competence at age 9 within a low-income sample.

The Association Between Attentional Processes and School Success

The importance of attention for children's school success is not surprising, given that attentional processes underlie controlled cognitive activities and social behavior (Calkins & Fox, 2002; Lawson & Ruff, 2004), and thus directly influence both children's engagement in learning activities and their interpersonal relationships (Ladd, Birch, & Buhs, 1999; Pianta & Stuhlman, 2004). Notably, attention skills at school entry are uniquely predictive of later school success independent of other indices of readiness, including prior cognitive ability (McClelland, Morrison, & Holmes, 2000; Yen, Konold, & McDermott, 2004) and social-emotional competence (Duncan et al., 2007; Hinshaw, 1992; Konold & Pianta, 2005).

We focus on two aspects of attentional regulation, focused attention and impulsivity, which have been significantly and differentially associated with achievement and behavioral competence. While both facets of attention predicted outcomes in both domains within a sample of predominantly socioeconomically advantaged children, focused attention accounted for more unique variance than impulsivity did in reading and math achievement, while impulsivity accounted for more variance in problem behaviors and social skills (Belsky et al., 2007; NICHD ECCRN, 2003). Thus, although focused attention may promote successful interpersonal interactions by allowing children to observe and process social cues (Andrade, Brodeur, Waschbusch, Stewart, & McGee, 2009; Davies, Woitach, Winter, & Cummings, 2008), its primary domain of influence appears to be achievement. Specifically, focused attention may be particularly critical for the acquisition of reading and language skills, as it facilitates learning (Ruff & Lawson, 1990) by allowing children to concentrate on relevant material and avoid distraction (Tamis-LeMonda & Bornstein, 1989; Velting & Whitehurst, 1997). Inversely, although children's impulsivity may influence achievement by disrupting the learning process, it appears to be particularly critical for behavioral outcomes. Specifically, the ability to control behavioral impulses underlies successful peer interactions and reduces the likelihood of externalizing problems (Eisenberg et al., 2009; NICHD ECCRN, 2003). For example, children who are able to abide by rules or social conventions are more likely to be perceived as acting fairly and competently by others (Andrade et al., 2009).

A limitation of previous research examining the links between individual facets of attention and school success is that the few studies that do exist are restricted in their longitudinal scope. Specifically, the only two studies (NICHD ECCRN, 2003; Razza et al., 2010) to examine these facets of attention simultaneously assessed the dependent variables contemporaneously (at 54 months and 5 years, respectively). Thus, while these studies suggest that attention at school entry is associated with children's early academic achievement and behavioral competence, they do not address the long-term implications of these attentional processes for children's later school success. However, broad measures of attention skills have been found to predict long-term reading and math achievement (Duncan et al., 2007), as well as increased prosocial skills and reduced problem behavior (Davies et al., 2008). Moreover, there is evidence that children who are unable to pay attention or control their impulses by first grade, when the learning environment becomes more structured, demonstrate difficulties with teachers and peers (Liew, Eisenberg, & Reiser, 2004; Olson et al., 2005; Pianta, Steinberg, & Rollins, 1995). Thus, while early attention skills appear to set the stage for later functioning, it is unclear whether focused attention and lack of impulsivity are both necessary for later achievement and behavioral outcomes.

Additionally, neither Razza et al. (2010) nor NICHD ECCRN (2003) examined the association between attention and children's internalizing behavior. Both focused attention and impulsivity have been implicated in children's internalizing behavior, although in different directions. Specifically, focused attention is thought to protect children from depression and other internalizing problems by preventing rumination and facilitating effective coping strategies, while a lack of impulsivity may contribute to internalizing problems by limiting interactions with peers and opportunities to develop coping mechanisms (Calkins, 2007). To date, however, research has not tested whether focused attention and lack of impulsivity, captured in a laboratory task, predict internalizing problems in the early school years.

Potential Moderators of Associations between Attention and School Success

The negative implications of poverty for children's attention are well established, as the adverse conditions associated with poverty are thought to reduce the brain's ability to engage in attentive behavior (for review, see Mirsky, 1995). Indeed, studies find that low-

income children score lower than their peers on attentional regulation in early childhood (Dilworth-Bart et al., 2007; Entwisle, Alexander, & Olson, 2005; Miech, Essex, & Goldsmith, 2001). What is unclear, however, is whether associations between specific facets of early attention and domains of later school success vary by poverty status. Interestingly, the only study to date examining poverty as a moderator suggests that the specificity in these pathways may diverge for children at the lowest levels of family income. Specifically, Razza et al. (2010) found that among all low-income 5-year-olds, focused attention was associated with receptive vocabulary; however, lack of impulsivity was also associated with receptive vocabulary only among children who fell below the poverty threshold. The greater vulnerability of the children living in poverty was striking because the sample was exclusively low-income. Past research suggests that the association between income and negative outcomes is strongest among the poorest children, such that children from the most impoverished backgrounds demonstrate higher levels of problem behaviors than their more advantaged peers who are also living below the poverty line (Dearing, Taylor, & McCartney, 2006; McLeod & Shanahan, 1996). These findings are consistent with evidence that exposure to multiple stressors within the context of poverty is associated with increased mental health and self-regulation problems among children (Evans, 2003). Thus, it may also be the case that internal resources, such as the ability to control impulsive behavior, exert a stronger or wider scope of influence on developing capacities among children in poverty. Therefore, we test whether poverty status remains a moderator of attention skills at age 9 within a low-income sample, as it was in this data set at age 5.

Developmental theory also suggests that proximal processes, particularly the mother-child interaction, have the greatest effect on child outcomes within the most disadvantaged environments (Bronfenbrenner & Ceci, 1994). Thus, we test whether two other potential sources of vulnerability interact with attention in predicting school success within a low-income sample, starting with the quality of parenting children receive. Higher maternal warmth predicts both academic and behavioral competence in early childhood (Hubbs-Tait, McDonald Culp, Culp, & Miller, 2002; Landry, Smith, Swank, Assel, & Vellet, 2001; Leventhal, Martin, & Brooks-Gunn, 2004). We therefore test whether children who are vulnerable because their mothers score low in warmth demonstrate a stronger association between sustained attention in preschool and later school success. An additional source of vulnerability is difficult (i.e., fussy, irritable) temperament, as research suggests that negative affectivity and attention regulation enhance one another's associations with distress (Muris, 2006). These findings are consistent with Lonigan and Phillips' (2001) theory that strong emotional reactivity associated with a neurotic temperament may predispose children to anxiety, but high attentional control may act as a buffer by providing children with coping strategies. Consequently, the present study asks whether children with difficult temperament have stronger associations between attentional skills at preschool age and subsequent achievement and behavior. Earlier findings in which the effects of lack of impulsivity on achievement and behavior were stronger among the poorest children (Razza et al., 2010) suggest that at least this facet of sustained attention may be more predictive of later success among young children with other sources of vulnerability. However, this proposition has not been tested to date, nor has Lonigan and Phillips' theory been tested with achievement outcomes.

The Present Study

The purpose of this study was to increase our understanding of the association between attention in preschool and school success in later childhood among low-income children. We address the limited scope of past studies by examining the link between attention at age 5 and school success at age 9 using a battery of six measures, three of which tapped achievement outcomes (reading, math, and approaches to learning) and three of which

tapped behavioral competence (externalizing problems, internalizing problems, and relations with peers). This should provide a more robust test of the associations among attention and school readiness than previous research with this sample permitted.

The first aim was to examine the longitudinal associations between focused attention and lack of impulsivity in preschool and school success in later childhood. In particular, we were interested in the possibility that the two facets of attention may relate differentially to achievement and behavioral competence. Specifically, we expected focused attention at age 5 to be a more robust predictor of achievement than of social behavior at age 9. Even if focused attention no longer exerted a direct influence on achievement at age 9, there should be residual effects of focused attention at age 5, as it likely supported the acquisition of early math and reading skills, which in turn facilitated the development of more advanced skills as children aged (Tamis-LeMonda & Bornstein, 1989; Velting & Whitehurst, 1997). Given that attentional control appears equally important for both reading and math achievement (Duncan et al., 2007), we expected focused attention to uniquely predict both outcomes. We also hypothesized that focused attention at age 5 would be negatively associated with problem behaviors and positively associated with positive peer relations at age 9 based on previous studies (Eisenberg et al., 2009; Andrade et al., 2009), although these links were expected to be weaker than the links from focused attention to achievement.

In this sample at age 5, lack of impulsivity was associated with both academic and behavioral competence, although only for children living in family contexts below the poverty line. We predicted that a lack of impulsivity would remain predictive of externalizing behaviors at age 9, as it was at age 5, in light of past research and theory linking impulse control to externalizing problems (Belsky et al., 2007; Eisenberg et al., 2000) and expected a similar negative association with internalizing behavior. We also expected lack of impulsivity to be positively associated with peer relations. Given that impulsivity can also impact children's learning and engagement in school (Fergusson & Horwood, 1995; Merrell, & Tymms, 2001), we hypothesized that lack of impulsivity would be positively associated with achievement, albeit to a smaller degree than with behavioral outcomes.

This second aim of this study was to examine poverty status, maternal warmth, and infant temperament, as moderators of the links between attention and school success. As stated above, one study of the current sample at age 5 (Razza et al., 2010) found that impulsivity had farther-reaching effects among poor children, as it impacted both receptive vocabulary and externalizing behaviors. If, as the authors speculated, the test of academic competence required impulse control for only the poorest children because of their relative inexperience with test-like activities at home, then by age 9 such an explanation would no longer be relevant given repeated exposure to those activities at school. The present study examines this possibility. In addition, given that low maternal warmth and difficult infant temperament are risk factors for compromised attention and school success, we examined these as moderators of the attention-school success link. Although these analyses were largely exploratory, we hypothesized that the associations between attention and school success would be strongest for the most vulnerable children, namely those exposed to low maternal warmth or those with a difficult temperament.

Methods

Participants

The participants for this study were drawn from the Fragile Families and Child Wellbeing Study, which follows a birth cohort of (mostly) unwed parents and their children. At baseline, the predominantly low-income, minority sample included nearly 4,900 children

born between 1998 and 2000 in 20 U.S. cities. By design, children born to unmarried parents were oversampled (n = 3,712 vs. n = 1,186 children born to married parents), and cities were selected to be representative of all U.S. cities with populations of 200,000 or more (for additional information on sample selection, see Reichman, Teitler, Garfinkle, & McLanahan, 2001). Mothers were interviewed in the hospital within 48 hours of the child's birth and fathers were interviewed soon after. The core study consisted of mother and father phone interviews when the child was 1, 3, 5, and 9 years of age.

The present study draws on data from a subsample of the core called the In-Home Longitudinal Study of Preschool Aged Children. At the time of the core phone interview, mothers were invited to participate in this substudy, which required a visit to their homes by a data collector who interviewed the mother, observed the environment, and directly assessed the child. Specifically, 2,863 families across 18 cities were eligible for inclusion in our analytic sample because they participated in the in-home substudy at age 5, when attention data were collected. An additional requirement for inclusion in our analytic sample was that children have data on at least one of the five measures of school success at age 9. This criterion resulted in the exclusion of 456 families, which brought our final analytic sample to 2,595 families. As shown in Table 1, the analytic sample was predominantly socioeconomically disadvantaged and racially diverse. It should be noted that the final analytic sample was no longer representative of mid-sized U.S. cities and was slightly more advantaged than those lost to attrition at age 9. For example, families in the analytic sample were more likely to be white (22% vs. 19%) or black (52% vs. 47%), less likely to be Hispanic (23% vs. 31%), more likely to have some college education (43% vs. 34%), and less likely to be below the poverty line (42% vs. 47%).

Procedure

Data on children's attention were collected via direct assessment by trained interviewers at age 5 as part of the in-home substudy. Age 9 school success data included direct assessments of children's reading and math achievement, obtained by trained interviewers during the in-home visit. At the time of the age 9 interview, parents were asked for consent for the study staff to contact teachers regarding their child's academic skills and classroom behavior. Teachers were sent questionnaires via mail. In our analytic sample, we have teacher reports for 1,612 children (67%). Thus, the sample for analyses including teacher-reported outcomes (i.e., behavioral outcomes and approaches to learning) was notably smaller than that for the direct child assessments (i.e., reading and math achievement). The majority of children were in 3rd (66%) or 4th (20%) grade at the time of the teacher report.

Measures

Attentional regulation—Children's attention at age 5 was assessed using the Attention Sustained task from the Leiter International Performance Scale-Revised (Roid & Miller, 1997). Children were shown a picture of a variety of objects scattered throughout the page. There was a target object at the top of the page and children were asked to put a line through as many of the objects matching the target as possible without accidentally crossing out any distractor objects. Children's performance across four timed trials was averaged to yield two attention scores. The number of correct responses (cross-outs of objects matching the target) reflected the child's *focused attention*, while the number of incorrect responses (cross-outs of objects not matching the target) was reverse coded to represent the child's *lack of impulsivity*. These two facets of attention have been distinguished using similar criteria on a continuous performance task (Halperin, Sharma, Greenblatt, & Swartz, 1991; NICHD ECCRN, 2003). Scores were standardized against a national norming sample with a mean of 10 (SD = 3). The task has high internal reliability (α = .83) for children ages 4 to 5 years and good test-retest reliability (r = .85) (Roid & Miller, 1997).

Academic competence—Children's academic competence at age 9 was measured by the Passage Comprehension and Applied Problems subtests of the Woodcock Johnson III Tests of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001). The WJ-III is nationally normed by age (standard score of $M = 100$, $SD = 15$) and has high test-rest reliability for this age group ($\alpha = .81–.94$). Passage Comprehension taps a child's ability to understand what he/she reads. Children are asked to identify a missing key word that makes sense in the context of the sentence or passage, first pictorially and then orally. Applied Problems measures the child's ability to analyze and solve math problems. Children are presented with math word problems orally and visually, and are asked to solve the problems with paper and pencil. Standardized scores on both tasks were used in analyses.

Teachers also rated children's approaches to learning using a scale derived from the Early Childhood Longitudinal Program - Kindergarten Class of 1998-99 (ECLS-K; see http://nces.ed.gov/ecls/kindergarten.asp). The Approaches to Learning scale consisted of 7 items ($\alpha = .93$) capturing children's behaviors during learning activities; sample items include "persists in completing tasks" and "follows classroom rules." For each item, teachers rated the frequency of the child's behavior using a 4-point scale ranging from 1 (*never*) to 4 (*very often*). Scores were averaged across items.

Behavioral competence—Children's behavioral competence at age 9 was assessed via teacher report. Teachers rated children's problems behaviors using the Social Skills Rating System (SSRS; Gresham & Elliott, 2007). The Externalizing subscale consisted of 6 items ($\alpha = .93$) tapping aggressive behaviors; sample items include "argues with others" and "threatens or bullies others." The Internalizing subscale consisted of 6 items ($\alpha = .85$) tapping anxiety and withdrawn/depressed behaviors; sample items include "has low self-esteem" and "shows anxiety about being in a group of children." Teachers also rated children's peer interaction skills using a subscale adapted from the ECLS-K study, which included select items from the SSRS. The Relations with Peers subscale consisted of 10 items ($\alpha = .95$) capturing children's ability to interact with peers; sample items include "makes friends easily" and "joins an ongoing activity or group without being told to do so." For each item, teachers rated the frequency of the child's behavior on a 4-point scale ranging from (1) *never* to (4) *very often*. Items were averaged to create the three behavioral competence subscales.

Control variables—Key characteristics of the child and his or her family were included as controls in all multivariate models. Indicators were created to reflect child's sex and mother's race/ethnicity (white, black, Hispanic, and other). Difficult temperament in infancy was assessed at 1 year and represents the average of three items ($\alpha = .60$; "often cries and fusses," "gets upset easily," and "reacts intensely when upset") drawn from the Emotionality scale of the Emotionality, Adaptability, Sociability (EAS) Temperament Survey for Children (Buss & Plomin, 1984). The remaining control variables were collected at age 5. Specifically, maternal education was coded as less than high school, high school graduation or general equivalency diploma, or some college or more. Maternal marital status was coded as married, cohabiting, or single. The family's poverty status reflected the ratio of total household income to that year's official poverty threshold. Maternal depression was a count of depressive symptoms (0–7) during the past year collected via the Composite International Diagnostic Interview – Short Form (CIDI-SF) Section A (Kessler, Andrews, Mroczek, Ustun, & Wittchen, 1998). Maternal warmth was measured using items from the HOME Inventory (Caldwell & Bradley, 1984); it was the average of 8 dichotomous items ($\alpha = .80$) observed by the data collector that denoted the mother's responsiveness and affection towards the child during the home visit. Two variables reflecting cognitive ability and behavior problems at age 5 were included as controls. Specifically, children's performance on a receptive vocabulary task (PPVT-III; Dunn & Dunn, 1997) represented cognitive

ability. Total behavior problems (reported by mothers) was assessed by summing the Externalizing and Internalizing subscales of the Child Behavior Checklist (Achenbach, 1991).

Missing Data

Among the 2,595 families in the analytic sample, approximately 25% were missing data on at least one of the control variables. Each of these variables was missing for less than 10% of cases, with the exception of child receptive vocabulary at age 5 (24%), and maternal warmth at age 5 (32%). In addition, attention data were missing for 28% of the children, largely due to data collection by phone instead of in-person. Based on the assumption that data were missing at random (that is, their missingness could be modeled by observed characteristics; Allison, 2009), we used multiple imputation in Stata 11 (StataCorp, College Station, TX) to create 5 complete data sets with control and predictor variables. The ICE command in Stata (Royston, 2007) conducts multiple imputation based on a regression switching protocol using chained equations. Although the outcome variables were used in imputation models for other missing variables, they themselves were not imputed, as recommended by von Hipple (2007). The 5 data sets were analyzed using the mi beta prefix for regression analyses in Stata, which combines coefficients and standard errors across imputed data sets and estimates standardized regression coefficients.

Results

Table 1 presents the percentages, means, and standard deviations for all study variables. Bivariate correlations among the measures of attention at age 5 and school success at age 9 are displayed in Table 2. The two facets of attention were positively correlated ($r = .17$, $p < .001$), indicating that children who demonstrated higher levels of focused attention were also less impulsive. As expected, significant associations were found between both facets of attention at age 5 years and all measures of children's academic and behavioral competence at age 9.

Data analysis involved a two-step process. In the first step, school success outcomes at age 9 were regressed on both facets of attention at age 5, simultaneously. This set of regression models tested the independent contributions of focused attention and lack of impulsivity on children's academic and behavioral competence, which was the first aim of our study. In the second step, we examined poverty status, maternal warmth, and infant difficult temperament as potential moderators of the above associations, which was the second aim of our study. Models used robust standard errors to account for clustering by city.

The Effects of Attentional Processes on School Success

The results of the regressions predicting achievement outcomes are displayed in Table 3. Focused attention significantly predicted passage comprehension ($\beta = .08$, $p < .05$), applied problem solutions ($\beta = .13$, $p < .001$), and approaches to learning ($\beta = .08$, $p < .01$). Specifically, the children who displayed higher levels of focused attention at age 5 scored higher on reading and math achievement tests and were rated higher on approaches to learning by teachers at age 9 than their less attentive peers. Lack of impulsivity predicted only one measure of academic competence -- approaches to learning ($\beta = .08$, $p < .01$), although it was marginally associated with applied problem solutions ($\beta = .04$, $p < .10$). A post-estimation comparison of the coefficients for focused attention and lack of impulsivity in the model for approaches to learning showed that they did not significantly differ from each other (results not shown); that is, they were similarly predictive of approaches to learning at age 9.

A similar series of regressions were conducted to examine the longitudinal associations between children's attention at age 5 and their behavioral competence at age 9. The results of these regressions are displayed in Table 4. Lack of impulsivity was significantly negatively associated with internalizing behaviors ($\beta = -.07$, $p < .05$). Specifically, the children who displayed less impulsivity at age 5 were rated as demonstrating fewer internalizing behaviors by teachers at age 9 relative to their more impulsive peers. Lack of impulsivity was not associated with teacher-reported externalizing behaviors and was only marginally associated with relations with peers ($\beta = .07$, $p < .10$) at age 9. In addition, focused attention failed to significantly predict any of the three behavioral outcomes.

Tests of Moderation

Additional regression analyses were conducted to test whether poverty status, maternal warmth, or difficult infant temperament moderated the associations obtained between attention and school success. Interactions between the potential moderators and the facets of attention were tested in those models in which either facet of attention significantly predicted school success. Specifically, interactions with focused attention were tested in models predicting all three academic outcomes, and interactions with lack of impulsivity were tested in models predicting approaches to learning and internalizing behaviors. Interactions with each of the three potential moderators were tested individually. None of the interaction terms reached significance in any of the models (results not shown), suggesting that the influence of both facets of attention on later school success is similar within this low-income sample across levels of poverty, maternal warmth, and infant temperament.

Discussion

The present study highlights the importance of early attentional regulation for later school success among low-income children. In particular, this study advances our knowledge regarding the specificity of the links between these two constructs by elucidating the associations between individual facets of attention and children's achievement and behavioral competence. Overall, results suggest that focused attention is predictive of achievement outcomes while lack of impulsivity is primarily predictive of behavioral outcomes. This pattern of findings was supported for all children in the sample, indicating that the associations between attention and school success were not moderated by poverty, low maternal warmth, or difficult temperament.

This study makes three significant contributions to the attention literature. First, it increases our understanding of the independent contributions made by individual facets of attention to children's competence across both the achievement and behavioral domains of school success. Specifically, results indicate that when focused attention and lack of impulsivity were considered simultaneously, the former was associated with children's achievement outcomes, while the latter was more relevant for children's behavioral outcomes. Second, the present study extends the time-frame over which the specificity among these constructs was considered. Although previous studies have documented differential concurrent associations between these facets of attention and indicators of school readiness, our study confirms that these differences extend longitudinally into the elementary-school years. Third, this study furthers the examination of the attention-school success link within low-income children. Findings indicated that three sources of developmental vulnerability did not moderate the associations between attention and school success, as the interactions involving poverty status, maternal warmth, and infant temperament failed to reach significance.

Specificity in the Associations Between Attentional Skills and School Success

As expected, attention in preschool had significant implications for children's achievement and behavioral competence in later elementary school. Focused attention significantly predicted all three of the achievement outcomes, including passage comprehension (d = .03), applied problem solutions (d = .04), and approaches to learning (d = .02). This finding extends previous research identifying concurrent associations between focused attention and achievement at preschool age (NICHD ECCRN, 2003; Razza et al., 2010). Notably, we find that focused attention is predictive of both math and reading, and of teacher-reported readiness to learn. These results are consistent with the notion that focused attention facilitates learning by allowing children to concentrate on lessons and remain actively engaged with tasks. Thus, focused attention may increase the amount of time that children participate in learning activities, thereby promoting their academic skills.

Also as hypothesized, lack of impulsivity significantly predicted fewer internalizing behaviors (d = .03). It may be that children with a greater ability to control their impulses received more praise and less harsh discipline from their parents, which in turn may have averted distress and anxiety. It is also possible, however, that teachers are more apt to identify internalizing symptoms among children who gain their attention because of problems such as poor impulse control. Contrary to expectation, lack of impulsivity failed to predict teacher reports of externalizing behavior, and it only marginally predicted peer relations. These findings are in contrast to others highlighting the fundamental role of impulsivity in behavioral skills (Belsky et al., 2007; Shoda, Mischel, & Peake, 1990). Specifically, it is thought that a lack of impulsivity directly influences children's socioemotional development by facilitating self-control in social situations that evoke feelings of frustration and aggression. A lack of impulsivity can also facilitate positive interactions with others by enabling adherence to social rules, such as the expression of gratitude for a gift even when the gift is disappointing (Liew et al., 2004). It may be that other processes are more predictive of externalizing behaviors within a low-income sample than is a lack of impulsivity. For example, in our sample, maternal warmth was a significant predictor of both externalizing behaviors and relations with peers (see Table 4). If the effect of mother-child interaction on children's behavior is strongest for the most disadvantaged (see Bronfennner & Ceci, 1994), then it is possible that maternal warmth overshadowed attention in our study. Moreover, it is plausible that other factors not measured here, such as exposure to violence or the experience of trauma, may have greater predictive power among poor children, as they are more likely to be exposed to such risk factors (Liaw & Brooks-Gunn, 1994). Further research is needed to explicitly test whether, and why, approaches to learning is less predictive of externalizing behaviors and peer relations in lower- versus higher-income samples.

Another contradiction to the expectation that lack of impulsivity would be more strongly associated with behavioral than academic outcomes was the finding that lack of impulsivity predicted positive approaches to learning (d = .03). However, approaches to learning is a multidimensional construct tapping attentiveness, persistence, flexibility, curiosity, and compliance (Fantuzzo et al., 2007; McWayne, Fantuzzo, & McDermott, 2004). Collectively, these behaviors reflect attentional, cognitive, and behavioral control. One reason such behaviors are adaptive in the classroom is that they allow children to focus their attention on lessons despite distraction or disinterest; another is that they reflect the desire to be challenged (Blair, 2002; Raver, 2002; Stipek, Newton, & Chudgar, 2010). Thus, approaches to learning may be conceived of as a measure of both cognitive and behavioral competence. It follows, then, that it was influenced by lack of impulsivity as well as focused attention. In sum, then, the findings may be interpreted as suggesting a largely consistent pattern: Measures of achievement were predicted by focused attention, some measures of behavior

were predicted by lack of impulsivity, and measures of both achievement and behavior were predicted by both facets of attention.

Finally, the above links were robust across three risk factors including poverty, low maternal warmth, and difficult infant temperament. The lack of significant findings appears inconsistent with a previous study of this sample finding that impulsivity in preschool was cross-sectionally associated with a wider range of outcomes for poor children than non-poor children (Razza et al., 2010). However, the authors' proposed explanation for that finding is consistent with the present results. Specifically, cognitive tasks may have been particularly demanding on poor children's impulse control skills during preschool, because poor children tend to have less exposure at home to assessment-like experiences requiring behavioral control, such as book-reading activities (Bradley, Corwyn, McAdoo, & García Coll, 2001). It is likely that the influence of impulsivity on academic testing diminishes over time for these children, as they are increasingly exposed to test-taking situations across the elementary school years. Our results support this experience-related development, as early impulsivity was largely unrelated to achievement at age 9 for all children. Thus, it appears that the links between attention and school success become increasingly differentiated by domain over time and are increasingly generalizable across all children. Indeed, the overall pattern suggesting that focused attention is more predictive of achievement, and impulsivity more predictive of behavioral competence, is consistent with existing cross-sectional data from a sample that includes more advantaged and white children (i.e., NICHD ECCRN, 2003).

Conclusions and Limitations

Although the present study adds to our understanding of the links between early attention and later school success among low-income children, it is important to note its limitations. First, although our data are longitudinal, we are unable to establish causal links between attention at age 5 and school success at age 9, as we did not have earlier data on our outcome variables or data on attention at age 9. Thus, it is possible that attention mainly influenced children's achievement and behavioral competence concurrently at school entry, and that had we adjusted for children's earlier performance on these outcomes using the same measures, the longitudinal associations would not have been supported. We feel that this possibility is unlikely, however, as our models control for children's earlier cognitive ability and total behavior problems.

Second, there were limitations of our moderator variables that could have affected our ability to find interactions. For example, our test for poverty moderation was limited given that our sample was predominantly low-income. Because the upper range of income for the group above the poverty line was truncated, our models could only test for differences between poor and near-poor (but not affluent) families. Thus, it is possible that poverty does significantly moderate the longitudinal associations between attention and school outcomes, but that we were unable to detect it within our sample. In the future, researchers may wish to examine poverty as a moderator of these associations in samples with heterogeneous socioeconomic backgrounds. Our measure of temperament was also limited in that it was based on three maternal report items tapping negative affect at age 1. Recent studies differentiate anger and fear as distinct facets of negative emotion with divergent etiologies and outcomes (Braungart-Rieker, Hill-Soderlund, & Karrass, 2010; Henderson & Wachs, 2007). Thus, it is possible that a more comprehensive measure of temperament distinguishing anger from fear may have revealed significant interactions with attention in predicting school success. Moreover, given that temperament can change over time, it is possible that toddler- or preschool-age temperament interacted with attention at age 5, but

we were unable to test for such interactions given that temperament data were only collected at age 1.

Finally, a third limitation of the current study is its exclusive focus on attentional regulation as a predictor of school success. Attentional skills are certainly important for children's socio-emotional development and academic achievement, as they are inherent in children's self-regulation. Specifically, attention is an essential component of both effortful control (EC) and executive function (EF), and represents an important commonality between these two self-regulatory processes (Liew, 2011; McClelland & Cameron, 2011; Zhou, Chen, & Main, 2011). However, EC and EF are both multidimensional constructs, of which attention is just one component. This may explain why our effect sizes, while significant, are small in absolute terms. Thus, other notable components of EC, such as inhibitory control, and of EF, such as working memory, may interact with attentional skills in the prediction of school success or make their own unique contributions to these outcomes. Unfortunately, additional measures of children's self-regulation were not collected in the FFCWS, so we were unable to address this possibility with our data. Given the increasing call from the field for an integrated model of self-regulation (Liew, 2011; Zhou et al., 2011), however, it is imperative that future research in this area considers the associations both between and across individual components of EC and EF.

In conclusion, the present study makes an important contribution to the field, as it is the first to examine how individual facets of attentional regulation in preschool uniquely predict children's achievement and behavioral competence in later elementary school within a low-income sample. Moreover, this study extends the literature by demonstrating the predictive power of these facets of attention to outcomes at age 9, identifying the significant link between lack of impulsivity and internalizing behaviors, and acknowledging potential moderators of this association within a low-income sample. Our results emphasize the critical role of early attention for later academic and behavioral success and highlight attentional regulation as a potential target for intervention to enhance school success among low-income children. In particular, it appears that focused attention and impulsivity represent two distinct avenues for intervention, as their effects were domain specific. However, results also suggest the added benefit of targeting both facets of attention, as they each made independent contributions to ATL, which has important implications for children's academic trajectories. Specifically, individual differences in ATL predicted both reading and math achievement across elementary school in a large-scale, nationally representative sample (Li-Grining, Votruba-Drzal, Maldonado-Carreño, & Haas, 2010). Thus, initiatives that promote both aspects of attention may be particularly effective strategies for increasing school success among low-income children in the long run.

Our findings also underscore the importance of intervening early, as there is growing evidence that skills at school entry set the stage for later competence (Duncan et al., 2007; Li-Grining et al., 2010). These results are consistent with the cumulative advantage theory (DiPrete & Eirich, 2006), which posits that advantages accumulate over time. Therefore, in addition to directly influencing their later academic and behavioral skills, early attention may also indirectly impact children's long-term school success by enhancing these competencies at school entry. Fortunately, attention regulation is already being successfully targeted by interventions with preschool-aged children. At present, however, these efforts are restricted to packaged curricula that take a comprehensive approach to promoting self-regulation via teacher-directed exercises (i.e., *Tools of the Mind;* Diamond, Barnett, Thomas, & Munro, 2007) or short-term (i.e., 5-day) computer-based training studies targeting executive function skills among preschoolers (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005). Thus, additional work is needed to design effective strategies specifically targeting attention that teachers can incorporate into their early childhood

classrooms, particularly those serving low-income children. For example, play-based activities may be a fruitful approach, as these are relatively inexpensive to administer and effective at fostering attention-related skills (Berk, 1994).

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Highlights

- Focused attention was predictive of academic competence.
- Lack of impulsivity was predictive of behavioral competence.
- Poverty, maternal warmth, and infant temperament did not moderate the associations between attention and school readiness.

Table 1

Descriptive Statistics for Control, Predictors, and Outcome Variables

Variable	*M*	*SD*	%
Controls			
Child male			51.95
Maternal race/ethnicity			
White			21.90
Black			52.12
Hispanic			23.08
Other			2.90
Maternal education			
Less than high school			29.76
High school graduation/GED			26.94
Some college or more			43.30
Maternal marital status			
Single			39.48
Cohabiting			30.84
Married			29.68
Poverty ratio	1.87	2.11	
Child receptive vocabulary	93.85	15.97	
Infant difficult temperament	2.82	1.06	
Maternal depression	1.04	2.05	
Maternal warmth	0.77	0.25	
Age 5 behavior problems	13.72	8.59	
Predictors			
Focused attention	12.71	3.32	
Lack of impulsivity	10.08	2.93	
Outcomes			
Achievement			
Passage comprehension	92.92	14.45	
Applied problem solutions	97.75	16.54	
Approaches to learning	2.87	0.75	
Behavioral competence			
Externalizing behaviors	1.57	0.68	
Internalizing behaviors	1.60	0.55	
Relations with peers	3.04	0.71	

Note. Calculations for control variables and predictors are based on five multiply imputed data sets. $N = 2,595$.

Table 2

Correlations among Measures of Sustained Attention and School Success

	1.	2.	3.	4.	5.	6.	7.
1. Focused attention	--						
2. Lack of impulsivity	.17	--					
3. Passage comprehension	.27	.14	--				
4. Applied problem solutions	.29	.14	.66	--			
5. Approaches to learning	.18	.14	.30	.31	--		
6. Externalizing behaviors	−.07	−.08	−.18	−.14	−.51	--	
7. Internalizing behaviors	−.09	−.09	−.18	−.19	−.41	.36	--
8. Relations with peers	.12	.13	.26	.24	.75	−.77	−.43

Note. Table presents bivariate correlations. All correlations are significant at $p < .01$.

Table 3

Results of Models Predicting Achievement at Age 9

	Passage comprehension (*n* = 2,547)			Applied problem solutions (*n* = 2,558)			Approaches to learning (*n* = 1,739)		
Variable	***B***	***SE***	**B**	***B***	***SE***	**B**	***B***	***SE***	**B**
Focused attention	.37	.11	.08*	.66	.13	.13***	.02	.01	.08**
Lack of impulsivity	.19	.11	.04	.25	.12	.04	.02	.01	.08**
Child male	−1.48	.56	−.05*	.93	.60	.03	−0.33	.03	−.21***
Black	−.55	1.17	−.02	−2.71	1.32	−.08	−.04	.04	−.03
Hispanic	−.60	1.15	−.02	−.89	1.26	−.02	.06	.03	.03
Other race	1.52	2.00	.02	3.29	1.49	.03*	.20	.08	.04*
High school grad/GED	.08	.53	.00	.62	.69	.02	−0.02	.05	−.01
Some college or more	1.61	.71	.06*	1.94	.05	.06	.00	.04	.00
Cohabiting	.03	.64	.00	.07	.60	.00	.02	.05	.01
Married	.95	.56	.03	1.64	.86	.05	.24	.04	.15***
Poverty ratio	.25	.14	.04	.38	.16	.05*	.03	.01	.09**
Difficult temperament	−.05	.23	.00	.01	.26	.00	.01	.01	.01
Maternal depression	−.10	.13	−.04	−.07	.18	−.01	−.01	.01	−.03
Receptive vocab (age 5)	.37	.04	.41***	.36	.04	.35***	.00	.00	.04
Maternal warmth	−1.70	1.08	−.03	−2.03	1.60	−.03	.07	.08	.02
Behavior problems (age 5)	−.09	.03	−.05*	−.11	.04	−.06*	−.01	.00	−.11***
R^2			.27			.25			.16

Note. Reference group is female, white child with single mother who has less than high school education. Robust standard errors account for clustering by city.

* $p < .05$;

** $p < .01$;

*** $p < .001$.

Table 4

Results of Models Predicting Behavioral Competence at Age 9

	Externalizing behaviors (*n* = 1,736)			Internalizing behaviors (*n* = 1,737)			Relations with peers (*n* = 1,735)		
Variable	***B***	***SE***	**B**	***B***	***SE***	**B**	***B***	***SE***	**B**
Focused attention	.00	.01	.00	−.01	.01	−.06	.00	.01	.02
Lack of impulsivity	−.01	.01	−.04	−.01	.01	−.07*	.02	.01	.07
Child male	.20	.04	.15***	.04	.03	.04	−.25	.03	−.17***
Black	.23	.04	.17***	−.01	.03	−.01	−.15	.04	−.10**
Hispanic	−.05	.05	−.03	.01	.03	.01	.03	.04	.02
Other race	.09	.08	.02	.06	.09	.02	−.02	.10	−.01
High school grad/GED	.02	.06	.01	.04	.04	.03	.00	.06	.00
Some college or more	−.01	.05	−.01	.03	.04	.03	.03	.05	.02
Cohabiting	.00	.04	.00	.01	.04	.01	.01	.05	.00
Married	−.20	.04	−.14***	−.08	.04	−.07	.23	.04	.15***
Poverty ratio	−.03	.01	−.08**	−.02	.01	−.06*	.03	.01	.09**
Difficult temperament	.02	.01	.03	−.01	.01	−.02	.00	.01	.00
Maternal depression	.00	.01	−.01	.00	.01	.02	.00	.01	−.01
Receptive vocab (age 5)	.00	.00	.05	.00	.00	−.02	.00	.00	−.01
Maternal warmth	−.18	.07	−.06*	−.04	.06	−.02	.17	.06	.06*
Behavior problems (age 5)	.01	.00	.11***	−.01	.00	.12***	−0.01	.00	−.13***
R^2			.14			.05			.15

Note. Reference group is female, white child with single mother who has less than high school education. Robust standard errors account for clustering by city.

* $p < .05$;

** $p < .01$;

*** $p < .001$.