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Executive functioning and school adjustment: The mediational role of pre-kindergarten learning-related behaviors☆

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ABSTRACT

This longitudinal study tested the roles of pre-kindergarten executive function (EF) and learning-related behaviors as predictors of the level and rate of growth in children's academic performance and social adjustment from kindergarten through third grade. Growth curve models were used to estimate direct pathways between EF and trajectories of academic skill development (math, reading, overall academic functioning) and social-emotional adjustment (social competence, aggression), controlling for child gender, race, verbal IQ, and pre-kindergarten baseline scores. In addition, indirect pathways were explored, in which the association between pre-kindergarten EF and elementary school adjustment was mediated by learning-related behaviors. Pre-kindergarten EF directly predicted the level and rate of growth of later math skills and the level of teacher-rated academic functioning. Pre-kindergarten learning-related behaviors directly predicted the level and rate of growth of later reading skills, and the level of teacher-rated social competence and aggression. In addition, pre-kindergarten EF indirectly promoted later reading skills, social competence, and reduced aggression, via its association with learning-related behaviors. Findings from the present study suggest that a parallel focus on EF and learning-related behaviors is warranted in efforts to promote school readiness and adjustment.

Introduction

Children growing up in poverty are particularly likely to show delays in academic and social-emotional school readiness in pre-kindergarten, forecasting long-term disparities in educational outcomes (Blair, 2002; Ryan, Fauth, & Brooks-Gunn, 2006). Accumulating research suggests that exposure to poverty is associated with delays in executive function (EF) development in early and middle childhood (Raver, Blair, & Willoughby, 2013; Raver, McCoy, Lowenstein, & Pess, 2013). Furthermore, poor EF skills appear to mediate the association between poverty and early academic delays (Nesbitt, Baker-Ward, & Willoughby, 2013). In recent years, developmental research on preschool EF skills has proliferated, spurred especially by the hope that understanding and facilitating these skills might enhance school readiness among children growing up in poverty (Hughes, 2011; Raver, Blair, et al., 2013; Raver, McCoy, et al., 2013).

EF skills involve cognitive regulatory processes, including working memory, inhibitory control, and attention set-shifting skills, that enhance children's capacities for sustained goal-oriented exploration and problem-solving (Carlson, 2005). Conceptually, these domain-general cognitive skills help children succeed academically by facilitating concept learning, complex reasoning, and abstract problem-solving (Blair & Diamond, 2008; Zelazo, Carlson, & Kesek, 2008). They may also help children succeed socially by supporting emotion regulation, interpersonal cooperation, and aggression control (Hughes & Ensor, 2011; Zelazo et al., 2008). Yet, unresolved questions remain regarding the links between early EF skills and children's school adjustment.

First, the degree to which EF skills measured during the pre-kindergarten year predict the level and growth of academic and social-emotional adjustment in elementary school is understudied. Second, EF skills may have their effect on some aspects of school success, at least in part, by fostering greater engagement, motivation, and attention in the classroom (learning-related behaviors), and thereby increasing opportunities to benefit from domain-specific classroom instruction. Additional research is needed to determine the degree to which links between pre-kindergarten EF skills and different aspects of later elementary

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school adjustment are direct or indirect, mediated by children's learning-related behaviors (Brock, Rimm-Kaufman, Nathanson, & Grim, 2009; Neuenschwander, Röthlisberger, Cimelli, & Roebers, 2012). Understanding direct and indirect paths linking preschool EF with elementary school adjustment is important to inform early educational interventions designed to promote the school readiness of children growing up in poverty (Blair & Diamond, 2008; Stipek, Newton, & Chudgar, 2010). The present study examined links between pre-kindergarten EF and the level and growth of skills in the dual domains of academic (math, reading, academic functioning) and social-emotional adjustment (social competence, aggression) from kindergarten through third grade. In addition, it assessed the degree to which links between pre-kindergarten EF and later academic and social-emotional outcomes were mediated by learning-related behaviors.

EF skills

EF skills involve an interrelated set of cognitive regulatory capabilities, including the ability to hold and manipulate information in mind (working memory), inhibit prepotent responding (inhibitory control), and flexibly shift from one operation to another (attention set shifting; Hughes, 2011). EF skills are typically measured using standardized tasks designed to challenge children's cognitive regulation under conditions of novel problem-solving (Carlson, 2005). Distinctions have been drawn between "hot EF" tasks that involve an emotional component (e.g., delay of gratification tasks, tasks involving rewards and punishments), and "cool EF" tasks that do not (Zelazo et al., 2008). The current study employed a set of "cool EF" tasks, examining cognitive regulatory processing under affectively neutral conditions, thereby concentrating on cognitive processing skills. For example, on the Backward Word Span task (Davis & Pratt, 1996), children must listen to and repeat a list of words in backward order. On the Peg Tapping task (Diamond & Taylor, 1996), children must inhibit the impulse to imitate the examiner and instead tap twice when the interviewer taps once, or tap once when the interviewer taps twice. On the Dimensional Change Card Sort (Frye, Zelazo, & Palfai, 1995) children sort cards by shape (or color) and then switch and sort by the other dimension, inhibiting the pre-potent response to sort by the first dimension.

Several studies have documented predictive links between kindergarten EF skills and reading achievement assessed one to two years later (McClelland et al., 2007; Nesbitt et al., 2013; Neuenschwander et al., 2012). A larger set of studies has documented predictive links between kindergarten EF skills and later elementary math achievement (Brock et al., 2009; Mazzocco & Kover, 2007; McClelland et al., 2007; Morrison, Ponitz, & McClelland, 2010; Nesbitt et al., 2013; Neuenschwander et al., 2012). However, relatively few studies have focused on the predictive value of EF skills when they are measured in pre-kindergarten before the transition into formal schooling, which is the focus of the current study. The three existing studies suggest that preschool EF skills predict the level of child math and reading achievement at the end of kindergarten (Blair & Razza, 2007; Clark, Pritchard, & Woodward, 2010) and predict growth in math and reading skills through second grade (Bull, Espy, & Wiebe, 2008).

Although less frequently studied, EF skills have also been linked with social-emotional adjustment. Conceptually, EF skills may function as "top down" regulatory processes that moderate "bottom up" reactive impulses and emotions, facilitating the child's capacity to manage emotional arousal and delay behavioral responding (Miller & Cohen, 2001). This "top down" control enables children to initiate and coordinate their social behavior in response to social expectations and norms, and fosters the inhibition of aggressive impulses (Miller & Cohen, 2001; Raver, Blair, et al., 2013; Raver, McCoy, et al., 2013). Concurrent links between pre-kindergarten EF skills and social-emotional adjustment (social competence and aggression) have been documented (Bierman, Torres, Domitrovich, Welsh, & Gest, 2009). In addition, predictive links exist between EF skills in early elementary school and social competence one year later (Ciariano, Visu-Petra, & Settanni, 2007), as well as social competence and reduced aggression two years later, controlling for baseline behaviors (Riggs, Blair, & Greenberg, 2004). Also, in a study examining growth in EF skills across the transition to school (from ages four to six), growth in EF predicted lower peer and conduct problems at age six (Hughes & Ensor, 2011). However, further evaluation of the link of pre-kindergarten EF with elementary school social-emotional adjustment is still needed in order to extend observed associations, and to examine the direct and indirect nature of these associations.

One contribution of the present study was to examine the predictive links between pre-kindergarten EF skills and elementary school adjustment in both academic and social-emotional domains, extended through third grade. A direct pathway was hypothesized, in which pre-kindergarten EF skills promote the accelerated acquisition of academic and social-emotional skills, resulting in trajectories characterized by faster growth (slopes) and higher end levels (intercepts) from kindergarten through third grade. In addition, an indirect pathway was explored, based on the hypothesis that EF skills may benefit elementary adjustment, at least in part, by promoting learning-related behaviors.

Learning-related behaviors

Parallel to EF skills, learning-related behaviors are often impaired among children growing up in poverty (McClelland, Acock, & Morrison, 2006; Morgan, Farkas, Hillemeier, & Maczuga, 2009). Learning-related behaviors reflect an adaptive response to classroom demands and school learning tasks (Morgan et al., 2009). Children with well-developed learning-related behaviors are able to follow teacher directions, abide by classroom rules and routines, attend to instructions, and engage with interest in learning tasks. They can concentrate, avoid distractions, and persist in problem-solving even when frustrated or bored (Fantuzzo, Perry, & McDermott, 2004; McClelland et al., 2006). Learning-related behaviors are generally considered to be a more proximal gateway to classroom learning than EF skills, because they support effortful and active participation in learning opportunities and maximize the child's exposure to classroom instruction (Stipek et al., 2010).

Research has linked early learning-related behaviors to enhanced academic progress and social adjustment (Bodovski & Farkas, 2007; Fantuzzo et al., 2004; Hirvonen, Tolvanen, Aunola, & Nurmi, 2012; Ladd & Dinella, 2009; Li-Grining, Votruba-Drzal, Maldonado-Carreño, & Haas, 2010). For example, analyses of the Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K) demonstrated significant links between learning-related behaviors in kindergarten, and reading and math achievement in the later elementary years (Bodovski & Farkas, 2007; Li-Grining et al., 2010). Similarly, in another sample, McClelland et al. (2006) found that teacher ratings of children's kindergarten learning-related behaviors predicted growth in reading and math skills from kindergarten to second grade and academic achievement in sixth grade. Examining bi-directional influences from first through fifth grade, Stipek et al. (2010) confirmed that learning behaviors in one grade predicted reading achievement in the following grade, but reading skills did not predict subsequent learning-related behaviors, suggesting a causal influence of learning-related behaviors on reading skill acquisition. Conversely, low levels of learning-related behaviors reflected in elevated distractibility and inattention are linked with academic underachievement (Breslau et al., 2009; Spira & Fischel, 2005).