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Executive functions and approaches to learning in predicting school readiness

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This study examined relations between two components of self regulation, executive functions and approaches to learning, in Head Start preschoolers, and to test whether the effects of executive functions on child outcome gains were mediated by approaches to learning. Data were collected on 179 four-year-old Head Start preschoolers assessed on executive functions (inhibition, cognitive flexibility, and working memory), approaches to learning (including persistence, self-reliance, and motivation, using both a teacher rating scale and a direct observation), school readiness, and verbal ability. Executive functions significantly predicted approaches to learning and change in school readiness from fall to spring controlling for verbal ability. Approaches to learning also significantly predicted change in school readiness, but did not significantly mediate the relation between executive functions and school readiness. Results are discussed in terms of the roles that executive functions and approaches to learning play in preparing at-risk preschool children for success in school.

1. Introduction

Self-regulation is a widely used umbrella term that encompasses many aspects of cognitive, emotional, and behavioral functioning. A child with strong self-regulation is able to control impulses, temper strong emotional reactions, maintain attention to tasks, and hold and manipulate multiple pieces of information in memory (Diamond, 2013). A growing body of research indicates that self-regulation in early childhood is critical to the development of important adaptive capabilities, including forming social relationships, pursuing long-term goals, engaging in positive rather than disruptive behavior, and succeeding academically (Diamond, 2013; Duncan et al., 2007; McWayne, Fantuzzo, & McDermott, 2004). Problems with self-regulation are widely viewed as underpinning common learning and behavioral disorders of childhood, including dyslexia and ADHD (Pennington & Ozonoff, 1996). With a growing research base underscoring its importance to development across multiple domains, self-regulation is now widely viewed as a key emergent skill set in young children with broad applications to positive early development (Blair & Razza, 2007; Hughes, 2011; Liew, 2012).

Although much is known about the different components of self-regulation individually, there has been less research examining how these components work together to produce positive developmental outcomes for children. Specifically, two components of self-regulation have received substantial attention in recent years in relation to academic school readiness: executive functions and approaches to learning. Executive functions, including inhibition, cognitive flexibility, and working memory, are cognitive skills involved in regulating goal-directed cognition and activity and are typically assessed using performance-based tasks (Hughes, 2011). Approaches to learning are "learning-to-learn" skills and dispositions, including motivation, persistence, attention to tasks, and frustration tolerance, that affect how children engage with learning tasks and are typically assessed using rating scales grounded in daily classroom behavior (Razza, Martin, & Brooks-Gunn, 2015). Both are associated with learning gains among preschool children and may be particularly salient to children at risk for poor developmental outcomes due to poverty and other family risk factors (Clark, Pritchard, & Woodward, 2010; Razza et al., 2015; Shaul & Schwartz, 2014).

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There remains a significant gap in our understanding of how these two constructs are related to each other and how they intersect to produce learning. The current study examined associations between executive functions, approaches to learning, and change in school readiness among low-income preschool children. This study had two primary purposes. The first was to examine whether executive functions significantly predicted approaches to learning in preschool children served by Head Start. The second was to test whether approaches to learning mediated the association between executive functions and change in these children's school readiness from fall to spring across one school year.

1.1. Executive functions

Executive functions include multiple cognitive processes, with three broadly-recognized core processes: inhibition, cognitive flexibility, and working memory. Inhibition involves the ability to refrain from giving a prepotent, or dominant, response in favor of a sub-dominant response (Korkman, 2000). Cognitive flexibility refers to the ability to shift between two or more competing response alternatives (Davidson, Amso, Anderson, & Diamond, 2006). Working memory refers to the amount of information an individual can hold and manipulate in conscious thought (Hughes & Graham, 2002). Evidence suggests that executive functions contribute to achievement across age groups. Multiple studies have shown that working memory, inhibition, and cognitive flexibility are related to math and literacy achievement in elementary-aged children (Bull & Scerif, 2001; Hooper, Swartz, Wakely, de Kruif, & Montgomery, 2002; Lee, Ng, Ng, & Lim, 2004; Mazzocco & Kover, 2007; St. Clair-Thompson & Gathercole, 2006). In a study of Head Start children, inhibition and cognitive flexibility predicted kindergarten math and phonemic awareness when children were followed longitudinally from preschool into kindergarten, indicating that executive functions were important during the transition into formal schooling (Blair & Razza, 2007). Similarly, studies have found that preschool children with higher executive functions scores performed better on preschool science, math, vocabulary, and pre-literacy assessments than peers with lower executive functions (Bierman, Torres, Domitrovich, Welsh, & Gest, 2009; Espy et al., 2004; Nayfeld, Fuccillo, & Greenfield, 2013). These studies suggest that executive functions play an important role in achievement as early as preschool.

There are two mechanisms that may explain these associations. The first is that executive functions are directly involved in learning (Altemeier, Jones, Abbot, & Berninger, 2006; Blair & Razza, 2007). Neuroimaging studies support the idea that executive functions are involved in transferring new information into long-term storage. Executive functions are activated when people are exposed to new information and show decreasing activation over repeated exposures (Chein & Schneider, 2005; Luu, Tucker, & Stripling, 2007). Evidence also indicates that, when faced with a novel learning situation, executive functions are directly involved in maintaining the goals and rules of the task, inhibiting irrelevant information, selecting an appropriate response, and monitoring for errors (Blasi et al., 2006; Chein & Schneider, 2005; Luu & Tucker, 2002; Miller & Cohen, 2001; Pennington & Ozonoff, 1996; Ridderinkhof, van den Wildenberg, Segalowitz, & Carter, 2004).

Beyond this, however, evidence indicates that executive functions are positively related to behaviors that are directly relevant to learning. In a study of school-age children, teacher ratings of impulsivity, hyperactivity, and inattention were correlated with performance on the Wisconsin Card Sorting Task, a measure of inhibition and cognitive flexibility (Riccio et al., 1994). In middle childhood, children who had been identified by their mothers as “hard to manage” at age four had lower inhibition than typical peers and were rated by testers as having higher instances of meaningless repetitive behaviors and inattentiveness during testing (Brophy, Taylor, & Hughes, 2002). In other studies, executive functions have been positively related to teacher ratings and observations of on-task behavior (Blair & Peters, 2003; Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009). Taken together, this research indicates that executive functions are involved in maintaining attention, suppressing extraneous movement, and staying on-task in learning situations – observable behaviors that teachers may recognize as positive approaches to learning.

1.2. Approaches to learning

Approaches to learning, also called task orientation, learning-related social skills, self-regulated learning, or learning behaviors, are skills and dispositions, including curiosity, engagement, flexibility, persistence, frustration tolerance, and self-direction, that are hypothesized to support achievement across multiple content domains by bringing children into greater contact with learning opportunities (Bustamante, White, & Greenfield, 2016; McClelland, Morrison, & Holmes, 2000; Razza et al., 2015). Although less extensively researched than executive functions, a growing body of literature indicates that positive approaches to learning are key to positive outcomes in early childhood (Bustamante et al., 2016; Kagan, Moore, & Bredekamp, 1995; McWayne et al., 2004; Razza et al., 2015; Schaefer & McDermott, 1999). In fact, children with poor approaches to learning may be at risk for difficulty transitioning into formal schooling. Kindergarten teachers consider these children to be at high risk for maladjustment in first grade and are more likely to refer them for special education services than their peers (Cooper & Farran, 1988; Cooper & Speece, 1988). Children exposed to multiple risk factors may be at particular risk for developing poor approaches to learning. In one study, children with low approaches to learning scores were more likely than peers to come from single-adult households and homes with poor literacy environments, as well as having parents with low educational attainment and low occupational status (McClelland et al., 2000).

On the other hand, positive approaches to learning may serve a protective role during the transition to elementary school. In studies of preschool, kindergarten, and first grade children, higher approaches to learning predicted higher achievement test scores and teacher-assigned grades both concurrently and longitudinally (Alexander, Entwisle, & Dauber, 1993; McClelland et al., 2000; McWayne et al., 2004). Perhaps most importantly, approaches to learning consistently predict achievement beyond the effects of cognitive ability (Alexander et al., 1993; McClelland et al., 2000; Yen, Konold, & McDermott, 2004).

In effect, poor approaches to learning function as a risk factor and positive approaches to learning function as a protective factor. Understanding positive approaches to learning may be important in preparing children for school, especially when they come from stressed or low income families, such as those served by Head Start.

1.3. Approaches to learning as a mediator

Although there is little doubt that executive functions are directly involved in information processing, there may be additional indirect pathways that account for the effects of executive functions on achievement. One such indirect path is through the regulation of behavior. Executive functions have been conceptualized as forming a cognitive control system that acts as a gateway between cognition and action (Lord & Levy, 1994). Under this theory, formation of a new goal leads to the activation of cognitive processes that subserve goal-directed actions, and the detection of discrepancies between intended and actual goal-directed actions can lead to adjustments in behavior. For example, a child may want to complete an activity matching letters to pictures while other children play and talk around him or her. Strong executive functions may allow the child to activate the engagement and attention needed to complete the task, resist distractions, suppress frustration if the task is difficult, and maintain the goals of the task in mind long enough to complete it. An adult observer would see a child who is motivated, engaged, and persistent in the face of challenge; observable behaviors with conceptual links to the construct of approaches to learning.