

# Effortful Control, Executive Functions, and Education: Bringing Self-Regulatory and Social-Emotional Competencies to the Table

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**ABSTRACT**—*Self-regulatory skills are essential for school readiness and future achievement, but self-regulation is a broad and multidimensional construct consisting of both behavioral and cognitive processes. Thus, researchers often study these processes from either a behavioral and temperament-based approach or a cognitive/neural systems approach. The temperament-based framework often focuses on effortful control, whereas the cognitive or neuroscience framework often focuses on executive functions. Although literatures on effortful control and executive functions come from different research traditions, the field needs to view them as complementary rather than incompatible to advance the understanding of the role of self-regulation in learning and achievement across development. This article calls for bringing both bodies of research to the table when making decisions about educational policies and practices.*

**KEYWORDS**—*self-regulation; effortful control; executive functioning; school readiness; achievement*

Developmental science is as much about understanding distinct domains of development as it is about “reassembling the ‘whole child’ from the network of allied developmental changes that tend to be otherwise studied distinctly” (Thompson, 1993, p. 397), and educational and developmental sciences are key

pieces in the puzzle of how best to educate the whole child (Diamond, 2010). Although evidence shows that self-regulatory and academic competencies go hand in hand (e.g., Blair & Razza, 2007; Duncan et al., 2007; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003; Payton et al., 2008; Raver, Garner, & Smith-Donald, 2007), such a dual-focus perspective is not yet common in curriculum development or teaching practices (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Diamond, 2010; Liew & McTigue, 2010). Developmental scientists have both the opportunity and the responsibility to inform curriculum development processes through research and dialogue with stakeholders on what it takes to nurture complete learners.

## SELF-REGULATION AND SCHOOL READINESS

Before entering formal schooling, many children participate in early childhood education or preschool programs that prepare them to start kindergarten ready to learn. School readiness, or “the state of child competencies at the time of school entry that are important for later success” (Snow, 2006, p. 9), includes pre-academic and social-emotional competencies (Bierman et al., 2008; Blair, 2002; Denham, 2006; Ladd, Herald, & Kochel, 2006; Raver et al., 2007). School readiness may be especially important for children from disadvantaged backgrounds, as they often lag behind in school readiness skills (Winsler et al., 2008). In the United States, the School Readiness Act (H.R. 2123, 2005) mandates federal programs such as Head Start to prepare children for formal schooling by facilitating child gains in the areas of language and comprehension skills, prereading and pre-mathematics skills, cognitive abilities, and social and emotional development. The competencies that fall under the area of social and emotional development include self-regulation, which facilitates learning and social relations at school (Raver & Knitzer, 2002).

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Child Development Perspectives © 2011 The Society for Research in Child Development  
DOI: 10.1111/j.1750-8606.2011.00196.x

There is consensus that self-regulation skills underlie school readiness (Blair, 2002). Self-regulation is a broad construct consisting of cognitive and behavioral processes that allow individuals to maintain optimal levels of emotional, motivational, and cognitive arousal for adaptation (Blair & Diamond, 2008; Molfese et al., 2010; Raffaelli, Crockett, & Shen, 2005). As a result of its multidimensional nature, researchers have traditionally studied self-regulation from a behavioral/temperament-based or a cognitive/neural systems approach. Those using temperament-based or behavioral measures of self-regulation often focus on *effortful control*, whereas those using cognitive or neurological measures often focus on *executive functions*. Effortful control is temperament-based and refers to voluntary control over approach (activation) or withdrawal (inhibition) behavioral tendencies via attentional (shifting and focusing) and inhibitory control mechanisms (Eisenberg, Spinrad, & Eggum, 2010; Lengua, Bush, Long, Kovacs, & Trancik, 2008; Rothbart & Bates, 2006). Executive functions (sometimes called “cognitive control”), on the other hand, are the ability to engage in deliberate, goal-directed thought and action via inhibitory control, attention shifting or cognitive flexibility, and working memory processes (Diamond, Barnett, Thomas, & Munro, 2007; Garon, Bryson, & Smith, 2008; Zelazo, Craik, & Booth, 2004).

It should be apparent that effortful control and executive functions partially overlap conceptually, because attentional and inhibitory control mechanisms are central self-regulatory processes to both constructs. Empirical evidence also indicates positive associations between parent-reported temperamental effortful control and performance on executive function tasks in early childhood (see Simonds, Kieras, Rueda, & Rothbart, 2007, for a review). However, effortful control and executive functions are not the same: There are unshared elements between them. For example, working memory has been recognized as central to self-regulation in the literature on executive functions but less so in the literature on effortful control. Furthermore, measures of effortful control and executive functions provide independent contributions to early literacy or mathematics skills (Blair & Razza, 2007). Although the literature on effortful control and executive functions comes from different research traditions, we need to view them as complementary rather than incompatible if we are to understand the role of self-regulation in learning and achievement across development. Temperamental effortful control appears early in life, shows modest continuity across the lifespan, and is shaped by hereditary and environmental factors (Goldsmith et al., 1987; Kagan & Snidman, 2004; Lemery, Goldsmith, Klinnert, & Mrazek, 1999; Nigg, 2006), whereas executive functions are higher order and later developing cognitive abilities that are relatively responsive to intervention or training (Brocki & Bohlin, 2004; Diamond et al., 2007; Garon et al., 2008; Zelazo et al., 2004). Thus, the following sections will first focus on effortful control for a discussion of school readiness and early achievement and

then focus on executive functions for a discussion on school-based intervention.

### EFFORTFUL CONTROL AND SOCIAL SKILLS

Before children enter grade school, social-emotional and behavioral competencies have already set the stage for preacademic learning through social or play activities (Coolahan, Fantuzzo, Mendez, & McDermott, 2000). To successfully participate in and learn from everyday preschool and kindergarten activities such as call and response or shared reading, young children need to demonstrate effortful control (i.e., attentional and inhibitory control). By first grade, when the learning environment becomes increasingly structured, children who are unable to pay attention or control their behavior are likely to experience difficulties with peers and teachers (Denham et al., 2003; Pianta, Steinberg, & Rollins, 1995; Rimm-Kaufman, LaParo, Downer, & Pianta, 2005), whereas those who exhibit good effortful control skills tend to exhibit social competence and low problem behaviors and are likely to be viewed as “good citizens” by teachers or peers (e.g., Blair, Denham, Kochanoff, & Whipple, 2004; Eisenberg et al., 1993; Fabes et al., 1999; Liew, Eisenberg, & Reiser, 2004; Olson, Sameroff, Kerr, Lopez, & Wellman, 2005).

Although evidence shows that temperamental effortful control and social or behavioral competencies are linked, this is not simply because these constructs overlap conceptually and empirically (Lengua, West, & Sandler, 1998). To demonstrate this, Lengua et al. (1998) used confirmatory factor analyses and expert ratings to eliminate overlapping items on questionnaire measures of temperament and symptoms. They found that temperament and symptomatology were distinct constructs, with effortful control measures being related to conduct problems. In a different study on preschool children’s self-regulation using physiological measures (suppression of respiratory sinus arrhythmia) and behavioral measures (observed attentional and inhibitory control), results indicated that behavioral regulation might have been one mediating mechanism by which physiological (temperament-based) regulation contributed to parents’ ratings of preschoolers’ adaptive skills or social competencies (Liew, Johnson, Smith, & Thoemmes, in press).

### EFFORTFUL CONTROL AND ACADEMIC ACHIEVEMENT

Building on an impressive body of research documenting the role of temperamental effortful control in children’s short- and long-term social and behavioral competencies (Eisenberg et al., 2005; see Eisenberg, Hofer, & Vaughan, 2007, for a review), researchers have become increasingly interested in its role in academic adjustment. Recent and growing empirical evidence points to a linkage between effortful control and academic achievement in young school-aged children, including those from low-income and ethnic minority backgrounds. For example, in a study of

preschoolers enrolled in Head Start programs, Blair and Razza (2007) found that both teacher-reported effortful control (tapping attentional and inhibitory control but also low approach reactivity and low anger) and observed inhibitory control (assessed with a peg-tapping/executive functions task) made independent contributions to math skills in kindergarten, whereas observed inhibitory control also contributed to emergent literacy skills. In another study on preschoolers from diverse socioeconomic backgrounds, McClelland et al. (2007) found that behavioral measures of self-regulation (primarily tapping inhibitory control but also attention and working memory) were significantly associated with early mathematics and literacy skills.

During grade school, effortful control continues to contribute to school adjustment and achievement. In a longitudinal study of first through third graders who were predominantly from low-income and ethnic minority families and were assessed by their school district as entering first grade with below-average literacy skills, effortful control at first grade, assessed with behavioral tasks that tap primarily inhibitory control, predicted literacy achievement at third grade (Liew, McTigue, Barrois, & Hughes, 2008). In third to fifth grades, effortful control (assessed with adolescent and parent ratings of adolescents' attention shifting, activation control, and inhibitory control from the subscales of the Early Adolescent Temperament Questionnaire; Capaldi & Rothbart, 1992) predicted grade point averages (GPAs) better than did GPAs from the previous semester and teacher-student relationship quality (Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008). Researchers have found similar results in countries other than the United States. For example, in a longitudinal study of children in mainland China, Zhou, Main, and Wang (2010) found that effortful control at first or second grade (assessed with parents' and teachers' ratings of children's inhibitory control and attention focusing subscales from the Child Behavior Questionnaire; Goldsmith & Rothbart, 1991; Rothbart, Ahadi, Hershey, & Fisher, 2001) predicted GPAs at fifth or sixth grade. Importantly, Zhou et al.'s results indicated that the prediction of GPAs from effortful control was mediated by social competence. Consistent with the view that preschoolers' effortful control contributed to school readiness through behavioral regulation and adaptive or social competencies (Liew et al., in press), Zhou et al. speculated that children with high effortful control developed higher social competence, which in turn helped them to secure greater social-emotional and instructional resources for academic achievement. Similarly, Valiente et al. (2011) found that 6-year-olds' effortful control predicted their social functioning (social competence and low externalizing problems) at 8 years old, which then predicted their academic achievement (teacher- and child-reported grades) at 10 years old. Thus, children with good effortful control skills were likely to be good citizens who developed and maintained positive school relationships that could then provide them with a support network for learning and future achievement.

### **EFFORTFUL CONTROL AND TEACHER-STUDENT RELATIONSHIP: PROTECTIVE AND COMPENSATORY FACTORS**

If children's effortful control contributes to their achievement through social competencies, including positive relationships with teachers, it should not be surprising that positive and supportive teacher-student relationships have consistently been associated with positive school outcomes (Goodenow, 1993; Hamre & Pianta, 2005; Ladd, Birch, & Buhs, 1999; Palermo, Hanish, Martin, Fabes, & Reiser, 2007; Reddy, Rhodes, & Mulhall, 2003). Although further research is needed to specify the student and teacher behaviors responsible for establishing and maintaining positive relationships, teachers are likely to play important roles in supporting children, especially those who lack self-regulatory skills, to be self-directed or autonomous learners (Vygotsky, 1978). As Dodge (2004) noted, "The environment and one's biologically based dispositional tendencies may dance with each other across development to lead, in some cases, to compensate for each other's vulnerabilities, and, in other cases, to potentiate each other's effects" (p. 424). In support of this view, evidence suggests that the link between positive teacher-student relationships and academic outcomes may be especially pronounced for students with self-regulatory difficulties (Hughes, Cavell, & Jackson, 1999; Liew, Chen, & Hughes, 2010; Pianta, Nimetz, & Bennett, 1997).

Teacher-student relationships characterized by warmth and support have consistently been found to be linked to increased academic motivation, positive self-concept, and better academic achievement (Birch & Ladd, 1997; Howes, 2000; Hughes, Gleason, & Zhang, 2005; Hughes & Kwok, 2006; Palermo et al., 2007; Pianta et al., 1995; Ryan, Stiller, & Lynch, 1994). For example, kindergarteners who were paired with supportive teachers performed significantly better on standardized measures of reading and mathematics skills than those who were paired with less supportive teachers (Graziano, Reavis, Keane, & Calkins, 2007). There is also preliminary evidence to suggest that positive teacher-student relationships may protect children from negative family relationships (O'Connor & McCartney, 2007). In addition, Rimm-Kaufman et al. (2002) found that 15-month-olds who were classified as socially bold were more academically engaged as kindergarteners when paired with sensitive teachers than with less sensitive teachers. Consistent with the notion that child temperament interacts with the learning environment to affect learning or achievement (Rothbart & Jones, 1998; Rudasill & Rimm-Kaufman, 2009), Liew et al. (2010) found that child effortful control (assessed with a behavioral measure of attentional and inhibitory control) and positive teacher-student relationships interacted with one another to contribute to future academic achievement on standardized tests of reading and mathematics. Liew et al.'s results indicated that children with low effortful control performed just as well academically as children with high effortful control when paired with a positive

and supportive teacher, and that children with high effortful control performed similarly well regardless of the teacher. Such a finding is somewhat consistent with research showing that effortful control protects children from adverse outcomes associated with negative or neglectful parenting (Lengua, 2008; Morris et al., 2002). Thus, whereas effortful control may serve as a protective factor for children without the presence of a positive and supportive teacher, supportive teachers may serve to compensate for children with self-regulatory difficulties by fostering students' autonomy that would subsequently benefit their future academic achievement (Liew et al., 2010).

### **FROM SCIENCE TO PRACTICE: EXECUTIVE FUNCTIONS AND SELF-REGULATION IN SCHOOL CURRICULUM**

This brief review highlighted the importance of self-regulatory capacities such as attentional and inhibitory control in school readiness and subsequent school-related outcomes including positive social and behavioral adjustment, learning or achievement, and improved standardized test scores (e.g., Blair, 2002; Blair & Razza, 2007; Liew et al., 2008; Liew et al., 2010; McClelland et al., 2007; Payton et al., 2008; Valiente et al., 2008). Acknowledging that attention focusing and inhibitory control are shared elements between effortful control and executive functions, our review on children's school readiness and early achievement focused on effortful control. For discussion of intervention programs, we will shift our attention to executive functions. Recall that executive functions involve working memory and higher order processes such as hierarchical representation or planning (Zelazo, 2004; Zelazo & Frye, 1998), which are not shared with effortful control. Executive function is relatively plastic and responsive to training beginning as early as 4 or 5 years of age (Diamond et al., 2007). Before 3 years of age, children fail to follow abstract rules calling for inhibition of competing response tendencies (Zelazo, Reznick, & Pinon, 1995).

In a systematic review of six studies that included measures of children's attention and social-emotional behaviors during the period of school entry (5 or 6 years of age), Duncan et al. (2007) found that attention-related skills predicted academic achievement more so than social-emotional behaviors such as internalizing, externalizing, or social skills. A growing number of studies support the view that direct training in cognitive tasks involving working memory, inhibitory control, and attention set shifting may improve children's more generalized self-regulatory skills over their emotion, behavior, and attentional focus (Barnett et al., 2008; Bierman et al., 2008; Diamond et al., 2007; Dowsett & Livesey, 2000; Thorell, Lindqvist, Nutley, Bohlin, & Klingberg, 2009). For example, the Tools of the Mind curriculum (Bodrova & Leong, 2007) was designed to target children's self-regulation and emergent literacy skills on the basis of Vygotsky's (1978) principles of interactive and constructivist learning including the use of self-regulatory private speech, dramatic play, and aids to

help memory and attention. A randomized trial study (Barnett et al., 2008) assigned 3- and 4-year-old children to classrooms using either the Tools of the Mind curriculum (106 children from 7 classes) or the district curriculum (168 children from 11 classes). Results indicated that children in the Tools of the Mind classrooms had fewer behavior problems and moderately more advanced language development than those in the control classrooms, suggesting that the Tools of the Mind curriculum was effective in improving children's classroom experiences, social development, and, to a modest degree, cognitive development (Barnett et al., 2008; see also Diamond et al., 2007).

At a time when educational practices increasingly emphasize high-stakes, standardized testing to assess accountability and achievement, some may question whether we could afford to spend the money, time, and effort on self-regulation and social-emotional competencies, without realizing that these are core skills needed for learning and achievement (Diamond, 2010). To translate research into practice, a dual focus integrated intervention model has proved to be effective (Bierman et al., 2008), and resources are available to help schools identify, select, and implement evidence-based programs aimed at fostering self-regulatory and social-emotional skills (e.g., Collaborative for Academic, Social, and Emotional Learning, 2003). Examples of such evidence-based programs are the Head Start REDI program (Bierman et al., 2008), the PATHS (Promoting Alternative Thinking Strategies) curriculum (Greenberg, Kusche, Cook, & Quamma, 1995; Kam, Greenberg, & Kusche, 2004), and the Tools of the Mind curriculum (Bodrova & Leong, 2007; Diamond et al., 2007).

### **CONCLUSION**

Developmental needs of the whole child, including academic achievement and social-emotional learning, must be considered and aligned throughout the educational process, ranging from curriculum development to teacher professional development and teaching practices. Back in 2007, the Association for Supervision and Curriculum Development launched its Whole Child Initiative to ensure that all children are healthy, safe, engaged in learning, supported by caring adults, and academically challenged. Although some schools offer curriculum or interventions aimed at social-emotional and self-regulatory skills, programs are ineffective unless they are delivered with fidelity (Bierman et al., 2008). To achieve intervention integrity, teachers must receive the necessary training and institutional support to synchronize and integrate such interventions into their existing academic curriculum to seamlessly interweave social-emotional and academic learning. Reflecting Aristotle's long-ago observation that "educating the mind without educating the heart is no education at all," self-regulatory and social-emotional competencies must be brought to the table so as to nurture children to become educated and personally responsible citizens—hallmarks of true success in education.

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