

## Executive function and the promotion of social–emotional competence

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### Abstract

Executive function is understood as an umbrella term encompassing a number of interrelated sub-skills necessary for purposeful, goal-directed activity. Research suggests a vital role for executive function in children's social–emotional development. However, executive function is rarely considered in models of intervention programs that attempt to promote social–emotional competence. This article reviews the literature linking executive function to children's social–emotional development, and proposes three testable models by which executive function may affect interventions: As a mediator, moderator, and outcome of intervention effects. Finally, the paper discusses important implications and future directions for this research.

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### 1. Introduction

In the past decade there has been an increase in the number of intervention programs targeting the promotion of social–emotional competence in young people. Many of these programs strive to promote competencies in a number of developmentally appropriate skills including inhibition of impulsive behavioral responses, awareness and regulation of feelings, accurate perception of the perspectives of others, correct identification of problems, and development of positive and informed problem solutions and goals (Zins, Elias, Greenberg, & Weissberg, 2000). These skills are thought to allow children to modify and integrate behaviors, actions, and emotions in order to handle developmentally-relevant social tasks (Weissberg, Caplan, & Sivo, 1989). Children who demonstrate mastery of these developmentally appropriate social tasks are generally considered socially and emotionally competent.

The frontal lobes of the brain have received some attention in the development of social–emotional competence as they are considered to be the seat of the brain's self-control processes, often referred to as executive function (EF)

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(Pennington & Ozonoff, 1996; Welsh, Pennington, & Groisser, 1991). Executive function is understood as an umbrella term encompassing a number of interrelated sub-skills necessary for purposeful, goal-directed activity (Anderson, 1989). The ability to inhibit impulses, shift attention from one task to another, plan, initiate tasks, and utilize working memory are among the sub-skills considered to be components of EF (Luria, 1966; Pennington & Ozonoff, 1996).

Many of the cognitive skills that fall under the rubric of EF appear to have equivalents at the social–emotional level such as inhibiting behavioral impulses and problem solving. However, researchers interested in the promotion of social–emotional competence have not traditionally considered EF as an important variable in models of intervention. The general aim of this review is to illustrate the value of EF in models that target the promotion of social–emotional competence. We will first summarize the basic research literature that directly and indirectly links EF to children’s social–emotional development. Then our main focus will be to illustrate the utility of models that include EF when thinking about interventions for the promotion of social–emotional competence. We will discuss three ways in which EF may be applied to intervention models. We anticipate that intervention researchers can implement these models into their own endeavors and attempt to formulate a more detailed understanding of intervention processes and outcomes. Finally, we will propose implications and future directions for intervention programs.

The focus of this paper is on executive function at the individual level in intervention trials. It is important to note, of course, that social–emotional development is a multidimensional process with influences at individual, family, peer, school and community levels. Children’s executive abilities interact with other ecologies, and the nature of these interactions changes across development. Therefore, EF models must also be sensitive to developmental changes that occur as children mature.

## **2. Research linking executive function and social–emotional functioning**

### *2.1. Cross-sectional relations between executive function and social–emotional functioning*

The ontological development of EF in typically developing children has been extensively studied (Diamond, 2002; Stuss & Benson, 1984; Zelazo, Carter, Reznick, & Frye, 1997). Children’s executive capacities begin to progress quickly through the first year of life, followed by another growth spurt in executive development from about 3–7 years of age. Among the executive abilities that develop at this time are inhibitory control (Diamond & Taylor, 1996; Gerstadt, Hong, & Diamond, 1994; Jones, Rothbart, & Posner, 2003; Kirkham, Cruess, & Diamond, 2003), selective attention (Humphrey, 1982), set shifting (Towse, Redbond, Houston-Price, & Cook, 2000), planning (Hudson, Shapiro, & Sosa, 1995), and working memory (Espy, Kaufmann, McDiarmid, & Glisky, 1999). Less dramatic growth in the frontal lobes follows this spurt in neural development. However it appears that the frontal lobes, and therefore most likely the associated executive skills, continue to develop into young adulthood through a process called pruning (Gogtay, Giedd, & Rapoport, 2002).

Executive function has been directly implicated in children’s social–emotional development by a growing number of studies in which commensurate deficiencies in EF and difficulties in domains of social–emotional function such as distractibility, impulsivity, delay of gratification, lack of concentration, action selection, understanding of mental states, and recognition of the consequences of actions are found (Hughes, 2002; Kusché, Cook, & Greenberg, 1993; Morgan & Lilienfeld, 2000; Pennington, 2002; Stuss & Benson, 1984). A good deal of research on this topic targets adolescents, and investigates the concurrent negative association between executive abilities and domains related to social–emotional dysfunction such as attention deficit hyperactivity disorder (Barkley, 1997; Fisher, Barkley, Smallish, & Fletcher, 2005; Gorenstein, Mammato, & Sandy, 1989; Passler, Isaac & Hynd, 1985; Pennington & Ozonoff, 1996; Pennington & Welsh, 1995), bullying (Coolidge, DenBoer, & Segal, 2004) conduct disorder (Lueger & Lugill, 1990; Seguin, Boulerice, Harden, Tremblay, & Pihl, 1999), delinquency (Brickman, McManus, Grapentine, & Alessi, 1984; Lynam, Moffitt, & Stouthamer-Loeber, 1993; Moffitt & Henry, 1989; White et al., 1994), and autism (Klinger & Dawson, 1996; Lopez, Lincoln, Ozonoff, & Lai, 2005).

Some work has shifted downward to assess relations between EF and social–emotional development in childhood (Cole, Usher, & Cargo, 1993; Hughes, White, Sharpen, & Dunn, 2000; Jahromi & Stifter, submitted for publication; Speltz, DeKlyen, Calderon, Greenberg, & Fisher, 1999). One example is the cross-sectional assessment by Cole et al. (1993) of 82 preschoolers that demonstrated that difficulties in EF (i.e., rapid-alternating stimulus-naming, block sort, and visual search tests) were positively related to young children’s inability to control disruptive behavior. A second example is the investigation by Speltz et al. (1999) of 160 preschool boys, half of whom were clinically referred to a

behavior problem clinic, which suggests that clinic-referred boys performed more poorly on tasks tapping motor planning and verbal fluency. Finally, in a study by Jahromi and Stifter (submitted for publication), preschool children with lower EF (i.e., on a continuous performance test, a day/night stroop-like task, and a stick-tapping task involving inhibition of a prepotent response) showed poorer emotion regulation (i.e., increased negative expressions and use of aggressive coping strategies), and were less able to control their impulsive behaviors.

### 2.2. Executive function, delay of gratification, and social–emotional functioning

An important construct in the study of children's social–emotional development is delay of gratification. Delay of gratification refers to children's ability to resist immediate gratification for a later, more valued, outcome (Mischel, Shoda, & Rodriguez, 1989). This distinct form of self-control is linked to children's social–emotional development, particularly the ability to resist temptation and to regulate frustration and stress (Mischel et al., 1989; Sethi, Mischel, Aber, Shoda, & Rodriguez, 2000). Recent research suggests a link between executive function and children's ability to delay gratification. Here, children's executive ability to plan and inhibit responses, and to control attention deployment, may directly influence their ability to control their behaviors in accordance with social demands, such as when they are expected to delay gratification (Peake, Hebl, & Mischel, 2002). Carlson and Moses (2001) found associations between traditional executive function measures and those requiring children to delay gratification, including a gift delay, tower building, and pinball task. Jahromi and Stifter (submitted for publication) also found that children who performed better on EF tasks were better able to delay gratification in a snack delay paradigm.

### 2.3. Executive function, theory of mind, and social–emotional functioning

Theory of mind, another developmental achievement important for social–emotional competence theory of mind, has also been linked to executive function. Theory of mind refers to children's awareness and understanding of the mental states of others, and the effect of others' mental states on their beliefs and behaviors (Wellman, 1990). Executive function skills such as mental flexibility, inhibitory control, working memory, and strategic planning are associated with successful performance on tasks used to test theory of mind, such as intentional deception, and understanding another's false belief (Carlson & Moses, 2001; Frye, Zelazo, & Palfai, 1995; Hughes, 1998a,b). Some of the skills common to both are very general (e.g., working memory, mental flexibility) and others are more specific to EF (e.g., inhibitory control, strategic planning). This suggests that executive function skills may be an important component of theory of mind development.

In addition to research linking EF to theory of mind, some research has demonstrated relationships between theory of mind and social and behavioral development. Studies of young children have found theory of mind to be negatively related to teacher ratings of aggression and positively related to interpersonal problem-solving, positive social skills, and socially-competent peer play (Capage & Watson, 2001; Jenkins & Astington, 2000; Lalonde & Chandler, 1995; Watson, Nixon, Wilson, & Capage, 1999). Such work points to a possible indirect relation between EF and social–emotional competence through theory of mind. Preliminary support for this potential mediational model can be found in the literature (e.g., Watson et al., 1999).

### 2.4. Longitudinal relations between executive function to social–emotional development

In contrast to the growing number of studies demonstrating concurrent relations between EF and social–emotional competence, longitudinal research in this area is still uncommon. Longitudinal research is crucial in that it aids in the determination of relations between EF and social–emotional functioning that develop over time. A two-year longitudinal study of 235 1st and 2nd grade children demonstrated that after controlling for other important variables, inhibitory control predicted behavior outcomes and social competency two years later (Nigg, Quamma, Greenberg, & Kusché, 1998). A second study found that inhibitory control and sequencing ability were significantly related to decreases in both externalizing and internalizing behavior problems over a two-year period (Riggs, Blair, & Greenberg, 2003).

Hughes and colleagues' research (Brophy, Taylor, & Hughes, 2002; Hughes, Cutting, & Dunn, 2001; Hughes et al., 2000) also supports a longitudinal link between EF and social–emotional development. Results from their studies of "hard-to-manage" preschoolers demonstrated that poor executive control was related to negative behavior in both

“hard-to-manage” as well as matched typically-developing preschool children (Hughes et al., 2000), that executive deficits at age 4 predicted negative behavior at age 5 (Hughes et al., 2001), and that children classified as “hard to manage” at age 4 continued to be more likely than controls to commit both rule violations as well as perseverative errors at age 7 (Brophy et al., 2002). Taken together this research suggests a link between children’s executive abilities and social–emotional development over time.

Finally, longitudinal research also supports EF as a predictor of false-belief understanding. Hughes’s (1998b) examination of the associations between EF and theory of mind found that, after controlling for age-related effects, inhibitory control was related to both later deceit and false-belief explanation. Additionally, improvements in inhibitory control mediated age-related improvements in children’s deception, suggesting that executive function played an important role in children’s development of deception. A recent study by Carlson, Mandell, and Williams (2004) found longitudinal relations consistent with those of Hughes (1998b) in a sample of younger children. This study found a stronger relation between 2 year olds’ performance on executive function tasks and their theory of mind performance at 3 years than the opposite directional relation. Finally, the results of a microgenetic study by Flynn, O’Malley, and Wood (2004) indicated that children were able to perform well on tests of inhibitory control before they had developed an understanding of false beliefs. These studies support the contention that executive function is a precursor to theory of mind.

In sum, there appears to be a growing literature demonstrating direct and indirect (i.e., through delay of gratification and theory of mind) associations between children’s EF and their social–emotional development. Although some of this research is longitudinal in nature, few are considering EF as an important variable in preventive interventions.

### 3. The role of executive function in intervention trials

The research reviewed above suggests a potential role for EF in an integrated framework of children’s social–emotional development. Accordingly, a number of neurocognitive abilities, particularly those associated with the frontal lobes, are suggested to be related to children’s competence in social spheres of development (Greenberg, Kusché, & Riggs, 2004; Kochanska, Murray, & Coy, 1997; Kopp, 1982; Schultz, Izard, Ackerman, & Youngstrom, 2001). By extension, some argue that neuropsychological models may have implications for the enhancement of social–emotional competence (e.g., Fishbein, 2001; Greenberg & Kusché, 1993). However, testable models of the relation between EF and social–emotional development have only recently been proposed (Aguilar, Sroufe, Egeland, & Carlson, 2000; Blair, 2002; Moffitt, 1993). Furthermore, there has been little research to date investigating the application of EF to models of social–emotional enhancement. The following sections propose three testable models, each relevant to researchers, in which EF may be applicable to intervention. In these models EF is conceptualized as a moderator of developmental outcomes, a mediator of developmental outcomes, or something that is itself an important outcome in intervention trials.

### 4. Models of the application of EF to intervention

#### 4.1. Executive function as a moderator in intervention trials

Although little research has been conducted to investigate the influence of EF on intervention outcomes, researchers may be able to achieve a greater understanding of this relationship by attending to models of moderation and mediation. Moderators affect the direction and strength of the relation between an independent variable and a dependent variable (Baron & Kenny, 1986). Here, preexisting EF capacities may alter the relationship between intervention (the independent variable) and social–emotional outcomes (the dependent variable). Research linking executive capacities to aspects of behavioral control implies that children with deficient executive abilities may begin intervention less equipped to inhibit impulsive behavioral responses, problem solve, and attend to intervention curricula than children with executive proficiencies (Hughes, 2002; Kusché et al., 1993; Morgan & Lilienfeld 2000; Stuss & Benson, 1984). However, little research has focused on potential moderating effects that baseline EF may have on children’s intervention outcomes. One might speculate that such effects may occur through a number of pathways. First, preexisting executive proficiencies may act in concert with intervention to further enhance the social–emotional development of children. Some children might possess higher preexisting levels of executive skills that, when accompanied by intervention, facilitate the enhancement of social–emotional development to a greater extent than for

children with executive deficits. If this were the case, high baseline EF proficiency would be related to greater social–emotional gains. Conversely, participation in intervention programs may compensate children with relative EF deficiencies by providing them a healthy and stimulating environment. Intervention programs could alter the social–emotional trajectories of such children at greater rates than for those with executive proficiencies because, theoretically, children with EF deficits would have greater room for social–emotional growth. Here, low baseline EF proficiencies would be related to greater social–emotional gains.

#### 4.2. Executive function as mediator in intervention outcomes

A second way that EF may influence intervention outcomes would be by mediating the relationship between intervention and social–emotional development. A mediator is a “generative mechanism” through which an independent variable influences a dependent variable (Barron & Kenny, 1986; MacKinnon, Krull, & Lockwood, 2000). Although very few preventive interventions intend to explicitly promote the development of children’s executive abilities, some (Botvin, Baker, Dusenbury, Botvin, & Diaz, 1995; Frey, Hirschstein, & Guzzo, 2000; Shure & Spivack, 1982) do promote skills that may ultimately aid in the development of children’s EF by focusing the emphasis of interventions on the enhancement of competencies and skills considered to be in the domain of EF (see Paschall & Fishbein, 2002 for a comprehensive review of programs). For example, the I Can Problem Solve intervention (ICPS; Shure, 2001; Shure & Spivack, 1982) teaches children cognitive (executive) aspects of problem solving to reduce and prevent the development of high-risk behaviors. Long-term evaluations have demonstrated that fifth and sixth grade children who participated in ICPS were less impulsive, more prosocial, and better problem-solvers than children not in ICPS (Shure, 1993). Another intervention, Second Step, is a violence-prevention program that targets social, emotional, and behavioral problems, and aims to promote social competence through a school-based curriculum focusing on executive function skills (Committee for Children, 1992a,b, 1995; Frey et al., 2000). Results have demonstrated that compared to matched controls, children who participated in Second Step showed significant decreases in physical aggression (Grossman et al., 1997). The results of these interventions suggest that implementing lessons throughout the school year may allow children to practice and enhance their executive skills such as problem solving, attention, concentration, and conscious strategies for self-control. This practice may serve the often unanticipated function of strengthening the connections between the prefrontal lobes, and between the prefrontal lobes and other neural substrates (i.e., limbic system) linked to social–emotional competence.

To our knowledge, only one study to date has addressed the mediational effect of EF in a social–emotional intervention. This study evaluated the effects of the Promoting Alternative THinking Strategies curriculum (PATHS; Greenberg & Kusché, 1993). PATHS is a program that explicitly attends to developmental models of frontal lobe organization. It is a universal, comprehensive, developmentally-based curriculum targeting the promotion of social and emotional competence in elementary school-aged children. PATHS attempts to achieve the integration of affect, cognition, and behavior by implementing curriculum, based in part on the premise that during the early school-aged years the frontal lobes are extremely malleable and are proceeding through a stage of rapid structural organization. In a recent study of the effects of PATHS, the effects of the curriculum on decreasing externalizing and internalizing behaviors were mediated by executive function, specifically inhibitory control (Riggs, Greenberg, Kusché, & Pentz, *in press*).

In sum, there are at least two ways that EF may influence future intervention outcomes. The first is that baseline executive abilities may interact with, or moderate, the effect of intervention programs. The second is that EF may mediate the relationship between intervention and social–emotional outcomes. Models of moderation and mediation can be relatively easy to test (Barron & Kenny, 1986; MacKinnon et al., 2000) and may greatly enhance the understanding of intervention outcomes.

#### 4.3. Executive function as an outcome in intervention trials

A third area of interest to some prevention researchers is the extent to which intervention may itself have an effect on children’s executive development. Such attention has arisen, in part, from studies demonstrating the effect of the environment on the brain at each stage of neural development, from neural birth or neurogenesis (Altman & Bayer, 1997; Miller, 1996), to neuronal migration and differentiation (Crumpton, Atkins, Zawia, & Barone, 2001; Lauder & Schambra, 1999), synapse formation and remodeling (Crnic, 1984; Kleim, Vij, Ballard, & Greenough, 1997; Patrick &

Anderson, 2000), and degeneration (Ikonomidou et al., 2000; Ishimaru et al., 1999). Although much of the research illustrating environmental impacts on brain development has been based on non-human research, there is also growing evidence that human social experience is linked to both temporary and permanent alterations in the structure and function of the brain (Beers & De Bellis, 2002; Cicchetti & Tucker, 1994; Dawson et al., 2001; De Bellis, Keshavan, Spencer, & Hall, 2000; Fishbein, 2001; Ito, Teicher, Glod, & Ackerman, 1998; McEwen, 1997; Sapolsky, 1996; Stein, Koverola, Hanna, Torchia, & McCarty, 1997).

With support from the external environment, children's brains can develop dense connections between neurons as well as sufficient neurotransmitter activity (Greenough, Black, & Wallace, 1987). While many children are supported by rich environments with ample physical and sensory stimulation, others grow up in families, schools, and communities that do not promote opportunities for social stimulation. It is children who are stimulus-deprived that are less responsive to their environments. If this deprivation is chronic, it may result in learning impairments, cortical underdevelopment, inadequate neurotransmitter activity, and/or less dense connections between neurons (Greenough et al., 1987; Grossman et al., 2003).

There are a number of studies that address the effect of the environment on the development of executive function. For example, Landry, Miller-Loncar, Smith, and Swank's (2002) study followed 253 children from 3 to 6 years of age, and found that maternal scaffolding ability at 3 years of age positively influenced children's language and nonverbal problem-solving skills at 4 years of age, which, in turn, positively influenced executive processing skills at 6 years of age. Similarly, Sethi et al. (2000) demonstrated that 5 year-old children with less controlling mothers were more likely to employ effective self-regulation strategies than children with more controlling mothers.

With respect to the effect of children's school experience on EF, McCrea, Mueller, and Parrila's (1999) cross-sectional investigation of 115, 7 to 9 year-old children suggested moderate associations between children's formal schooling in the 1st through 4th grade and executive development as measured by verbal fluency, planning, and set-shifting. Finally, some interesting research by Bialystok (Bialystok, 1999; Bialystok & Majumder, 1998) has demonstrated the positive effects of children's language environment (i.e., bilingualism) on the mastery of EF. Specifically, these studies have revealed that Chinese–English bilingual preschool children possessed greater attention control than monolingual English-speaking children (Bialystok, 1999), and that French–English, bilingual 3rd graders performed better than monolingual English-speaking children on problem-solving tasks requiring attention control (Bialystok & Majumder, 1998).

There is also evidence of a relation between negative social experience and executive deficits. For example, in their study of the deleterious effects of stress on executive development, De Bellis et al. (2000) found that children with posttraumatic stress disorder (PTSD) had lower anterior cingulate levels of total *N*-acetylaspartate/creatine ratio (an indicator of neural integrity), than matched controls. Beers and De Bellis' (2002) further investigated children with PTSD related to maltreatment and found that these children performed at lower levels on measures of EF than matched controls.

Together, these studies suggest that reduced levels of chronic stress and some types of social–environmental stimulation are two aspects of children's experience that can affect the development and maintenance of EF. This research provides a perspective on how intervention programs that are aimed at reducing stress — such as programs to promote family management and parenting skills, or programs to provide safe after school activities may also increase the conditions to promote EF development.

## 5. Implications and future directions

Future intervention research that includes measures of EF using innovative methodological designs can help advance the current state of knowledge regarding the role of EF in social–emotional development. As basic researchers continue to further define EF, some agree that future applied research should incorporate a diverse set of age-appropriate EF measures (Blair, Zelazo, & Greenberg, 2005). There exist a number of EF measures appropriate for individuals as young as 2 years of age through adulthood that may be incorporated into the task battery of intervention studies with relative ease.

The incorporation of EF into intervention models may have particularly important implications for school-based intervention programs. Given that frontal lobe development begins to rapidly advance at around the same time children are entering school, it is likely that EF plays a critical role in children's successful transition to school. Because typical classroom environments require behaviors associated with EF, such as following directions, controlling motor activity,

and attending to lessons, it is clear that EF has implications for children's school readiness and may be an important target for intervention. This view is supported by neurobiological models of children's school readiness, which suggest relations between EF and both social–emotional and academic functioning (Blair, 2002).

Another important area of intervention research that may benefit from the future consideration of EF is the field of atypical development, particularly autism research. There has been considerable growing interest in interventions targeting social, emotional, and communicative skills in young children with autism. For example, the recently developed SCERTS Model (Prizant, Wetherby, Rubin, & Laurent, 2003) emphasizes social–communicational and emotion regulation skills in children with autism. Additionally, Kasari and colleagues have conducted an intervention study targeting social–communication skills in children with autism, and have found significant treatment effects on social–communicational, symbolic play, and language variables (Kasari, Freeman, & Paparella, in press). Kasari (2005) also targets social skills, including positive peer interactions, socially-appropriate behaviors, and self-regulation in an ongoing intervention of children with autism included in typical elementary school classrooms. These interventions do not currently include measures of EF. One might speculate, however, that given the deficits in EF that appear to underlie many characteristic behaviors of children with autism (e.g., rigidity, perseveration, and repetitive behaviors; Hill, 2004), a consideration of EF in these programs will enable interventionists to better understand the effects of each targeted treatment.

In conclusion, there is growing research linking EF with children's social–emotional development. This research demonstrates concurrent associations between executive deficits and problematic functioning in a number of social–emotional domains and longitudinal relations between aspects of children's early EF and subsequent social–emotional competence. Drawing upon findings from developmental studies, some researchers have considered EF as an important element to be incorporated into social–emotional intervention models. The present paper proposes three models by which EF may play a role in interventions: As a moderator, mediator, or as an outcome. Research that explicitly tests these models can provide important guidance to the design and implementation of effective intervention for social emotional competence.

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