Published in final edited form as:
Dev Psychopathol. 2008 ; 20(3): 899–911. doi:10.1017/S0954579408000436.

Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure

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Abstract

This paper examines interrelations between biological and social influences on the development of self-regulation in young children and considers implications of these interrelations for the promotion of self-regulation and positive adaptation to school. Emotional development and processes of emotion regulation are seen as influencing and being influenced by the development of executive cognitive functions, including working memory, inhibitory control, and mental flexibility important for the effortful regulation of attention and behavior. Developing self-regulation is further understood to reflect an emerging balance between processes of emotional arousal and cognitive regulation. Early childhood educational programs that effectively link emotional and motivational arousal with activities designed to exercise and promote executive functions can be effective in enhancing self-regulation, school readiness, and school success.

At the turn of the 21st century, approximately half of the kindergarten teachers surveyed in a nationally representative United States sample indicated that 50% or more of the children in their classrooms were experiencing problems that substantially limited the ability to benefit from early schooling (Rimm-Kaufmann, Pianta, & Cox, 2001). Although some teachers identified poor academic skills at school entry (knowing letters, numbers, etc.) as the primary source of children's difficulties, most noted problems with self-regulation, particularly problems with following directions and controlling attention, as the main cause of children's lack of school readiness. Similarly, a National Center for Education Statistics survey of kindergarten teachers' perceptions of child characteristics considered essential or very important for being ready to start kindergarten indicated clear concern about children's ability to regulate their behavior (Lewit & Baker, 1995). In addition to noting the importance of children being able to follow directions, teachers overwhelmingly endorsed factors such as being able to communicate wants, needs, and thoughts verbally, to be enthusiastic and curious in learning, and sensitive to other children's feelings as essential or very important for being ready to start kindergarten. In contrast, relatively few teachers endorsed academic skills and abilities such as knowing letters of the alphabet or being able to count to 20 as being key characteristics of readiness.

Consistent with this, findings from a recent survey of prekindergarten childcare providers indicates that children in preschool programs in the United States are being expelled for unmanageable behavior at a rate over three times that found in elementary and secondary grades (Gilliam, 2005). Specifically, in a nationally representative sample of all state-funded

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prekindergarten programs in the United States, 10.4% of prekindergarten teachers reported expelling at least 1 child over a 12-month period and 19.9% reported expelling more than 1. This results in a national expulsion rate of 6.7 per 1,000 prekindergarten children per year (Gilliam, 2005). As alarming as these numbers are, however, expulsion rates in some states range as high as roughly 25 per 1,000 or a staggering 1 out of every 40 children enrolled (Gilliam & Shahar, 2006).

Of further and perhaps more than coincidental interest to the phenomena of preschool expulsion and poor school readiness is the finding of a rapid and sizable increase in prescriptions of psychotropic medications to children under the age of 5 years (Zito et al., 2000). As an aspect of a larger trend in which rates of prescriptions for psychotropic medications to children under 18 years approximately doubled between 1987 and 1996 (Olfson, Marcus, Weissman, & Jensen, 2002), rates of prescriptions for children under age 5 increased approximately threefold both for stimulants and antidepressants (Zito et al., 2000). This increase likely reflects an increase in parents' and teachers' needs for assistance in managing the challenging behaviors of young children and a desire for the short-term benefits in regulating behavior associated with medication usage. However, the potential for longer term adverse developmental consequences resulting from psychotropic medication use in young children are real (Panksepp, 1998; Stanwood & Levitt, 2004). The potential for harm suggests that alternative strategies are needed to address what would appear to be a growing problem of poorly regulated behavior in children and the need among caregivers for assistance in managing children's problem behavior.

Although rates of poor school readiness, preschool expulsion, and use of psychotropic medications with young children have not been definitively linked to a common cause, it is clear that each is indicative of problems with the developing ability of children to regulate attention and behavior early in life and that these problems are interfering with positive adaptation and adjustment. Consequently, the promotion of self-regulation, and prevention of the development of problems with adjustment that increase risk for later psychopathology are important foci for developmental research.

Much is known about various aspects of developing self-regulation in young children, and much of the information gained from research in this area can likely be applied in straightforward ways in innovative programs designed to promote school success. Understanding of the genetic and neural bases of self-regulation has increased, as has the understanding of the roles played by family, school, and community contexts in which children are situated. The purpose of this paper is to describe certain aspects of the development of self-regulation directly relevant to the transition of young children to formal schooling, and ways in which it is affected by biology and social context.

Regulation, defined as “the process through which one system modulates or governs the reactivity of another system,” is a central integrative concept in psychology and neuroscience (Derryberry & Reed, 1996). Self-regulation refers to the primarily volitional cognitive and behavioral processes through which an individual maintains levels of emotional, motivational, and cognitive arousal that are conducive to positive adjustment and adaptation, as reflected in positive social relationships, productivity, achievement, and a positive sense of self. Consideration of the depth and breadth of influences on developing self-regulation in young children can help to establish a framework for interventions to promote self-regulation as a means of preventing school failure.

An Organizational Approach to Self-Regulation

As a construct determined by multiple levels of influence ranging from the biological to the social, self-regulation development in young children is best understood from an organizational perspective. Such a perspective emphasizes the idea that the psychological and behavioral development of the individual is determined by the combined influence of functions and processes of various systems operating at distinct levels of analysis (Cicchetti & Tucker, 1994; Derryberry & Reed, 1996). These systems range from those associated with gene expression and regulation at the molecular level to those associated with norms, rules, and standards governing social interaction and social behavior at the cultural–institutional level. In the organizational approach the functioning of a system at a given level is understood to be determined by the influence of the components of the system at that level at a given time point and also by the functioning of components of systems at other levels concurrently and at antecedent time points. That is, systems are both horizontally and vertically integrated, and it is the organization of horizontal and vertical processes that determines behavioral and psychological development. Here we are concerned with processes that affect aspects of psychological development that pertain to developing self-regulation and the child's sense of self as one who is effective at regulating his or her own attention and behavior. Processes occurring at a given level provide the foundation for further differentiation and change not only at that level but also at other levels. As a result, development is considered to be dynamic, nonlinear, and probabilistic, meaning that perturbation of the system at a given level at a given time can result in reorganization of processes at other levels and the emergence of novel behaviors and psychological functions.

A hypothetical example of an organizational process in the development of self-regulation can be seen in the scenario in which an individual possesses a variant of a gene (say, the catechol-*O*-methyltransferase [*COMT*] gene) associated with neurotransmitter function (in this case, the function of the neurotransmitter, dopamine). The *COMT* gene codes for the COMT enzyme, which plays an important role in clearing away dopamine released in the prefrontal cortex (PFC; Garris & Wrightman, 1994; Napolitano, Cesura, & Da Prada, 1995). In about 25% of Americans and Europeans both copies of the *COMT* gene have the amino acid, valine (Val), at codon 158; in another 25% both copies of the *COMT* gene have the amino acid, methionine (Met), at codon 158; the other roughly 50% of Americans and Europeans are heterozygous. The valine version of the *COMT* gene results in a faster acting COMT enzyme, which clears dopamine away faster, resulting in less dopamine in the PFC. Thus, people homozygous for the met version of the *COMT* gene tend to have more dopamine in the PFC. This genetic characteristic of individuals influences functioning at the neural level, specifically the functioning of the PFC, a brain region critical for executive function and cognitive control of attention and behavior. There is much overlap between executive functions, especially the inhibitory control component, and self-regulation, although there are also nuanced differences. Executive function researchers have generally focused primarily on cognition and on intentional control, such as the control of emotions, and have not addressed beneficial uses of emotions. Self-regulation, in contrast, addresses both suppressing disruptive emotions and encouraging the flourishing of positive emotions. Besides inhibitory control (resisting habits, temptations, or distractions), the other two core executive functions are working memory (holding information in mind and working with it) and mental flexibility (adjusting to change; Diamond, Barnett, Thomas, & Munro, 2007; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000).

In general, children and adults with the Met/Met *COMT* genotype display better executive function performance than do those homozygous for the val version of the gene (Diamond, Briand, Fossella, & Gehlbach, 2004; Egan et al., 2001). In the organizational perspective, this relation of gene to neural function influences the probability that effective self-regulation will

occur. It does so differentially, depending on social context, however, because having a little more dopamine in the PFC is not only better for executive function, but it also makes one more sensitive to stress (Zubieta et al., 2003). Hence, persons homozygous for the valine version of the *COMT* gene should show better academic performance and cognitive control under conditions of mild stress than do persons homozygous for the met version because levels of stress too mild to disrupt the cognitive functioning of valine homozygotes are disruptive to persons with the met phenotype of the *COMT* gene. Thus, the probability that the Val/Val or Met/Met genotype will be associated with poor self-regulation is dependent in part on the extent to which problems adversely impact relationships with others (parents, peers, teachers), creating stress.

When a child's behavior elicits reactions from individuals that exacerbate that child's difficulties with regulation, those interactions help to maintain a developmental course of poor regulation. In turn, repeated difficulty in regulating behavior in interactions with others also leads a child to develop representations of him- or her-self as one who is ineffective in regulating behavior in ways demanded in a particular context. In contrast, when a child with the same relation of gene to neural function to behavior is situated within a context that provides support, encouragement, and appropriate structure for attempts at self-regulation, the probability of developmental difficulties with regulation is lessened, and that child is more likely to develop a self-perception that reflects, and in turn promotes, effective regulation and effective negotiation of contexts and situations that present regulatory challenges. It is in this interplay of the biological and the social that developing self-regulation and efforts to promote it are best understood.

The organizational approach to developing self-regulation assumes, importantly, that as a consequence of vertical and horizontal integration across levels of biological and social influences that behavior and psychological functioning, particularly self-perceptions, act not only as endpoints of an organizational process of development but also are active and dynamic contributors to that process. This assumption has been expressed in a variety of ways, but perhaps nowhere quite as succinctly as in the phrase “behavior is the leading edge of development” (Cairns, Elder, & Costello, 1996). The phrase nicely captures two ideas: one, that behavioral and psychological development are determined by, but also determining of, functions and processes occurring at other levels of analysis; and two, that behavior change and the active self-striving of the individual to regulate behavior can have enduring effects on development (Cicchetti & Tucker, 1994). There is considerable plasticity in development, but this plasticity can be limited by constraints; by correlated factors at multiple levels that conspire, for good or ill, to maintain behavioral development on a particular trajectory.

Neurobiology of Temperament and Approach–Withdrawal

Following from the ideas of multilevel influences and the active role of the individual in his or her own development is the idea that much of self-regulation development can be characterized as a balance or interaction between processes of emotional–motivational arousal and cognitive control processes (Gray, 2004). Such an approach has been taken to varying degrees in the study of temperament in which several programs of research have focused on processes underlying the development of emotion and cognition in infancy and early childhood (Derryberry & Rothbart, 1997; Fox, Henderson, Marshall, Nichols, & Ghera, 2005; Kagan, 1998; Posner & Rothbart, 2000; Wolfe & Bell, 2004). As an aspect of individual development, temperament is defined in part by early biologically based tendencies that are thought to predispose the individual to certain levels of emotional reactivity. This level of reactivity is understood to reflect thresholds for arousal in brain systems that control autonomic, endocrine, and motoric responses to stimulation. These reactive systems are essentially those associated with approach and withdrawal behavioral tendencies in comparative psychology (Schneirla,

1957) and identified as motivational systems in personality research (Eysenck, 1967), namely, as a behavioral activation or approach system (BAS) associated with sensitivity to pleasurable or appetitive contingencies and as a behavioral inhibition system (BIS) associated with sensitivity to aversive contingencies. The BAS system is thought to be related to dopaminergic pathways in the cortical–striatal–thalamic–cortical loop system associated with the orbitofrontal cortex (Depue & Collins, 1999). The BIS system, in contrast, is thought to reflect serotonergic functioning in the amygdala and septohippocampal system (Gray, 1987). In research on temperament in infants, sensitivity to arousal in these two systems is presumed to underlie behaviors indicative of constructs referred to as distress to limitations and distress to novelty. Distress to limitations is indicated by anger reactivity and frustration in response to blocked appetitive goals. Distress to novelty is indicated by fear reactivity, withdrawal, and avoidance in response to unfamiliar objects and persons that are experienced as aversive (Rothbart & Bates, 2006).

Generally speaking, BAS and BIS are rooted in brain circuitry associated with the distributed limbic system, which includes the network of connections among the ventromedial (orbital) PFC, anterior cingulate cortex (ACC), amygdala, hippocampus, and related structures (Heimer & Van Hoesen, 2006; Morgane, Galler, & Mokler, 2005). As such, approach and avoidance motivation can be thought of as operating in a ventromedial or phylogenetically older information processing stream (Luu, Tucker, & Derryberry, 1998). Physiological and motor responses to appetitive and aversive stimulation in this ventromedial stream are relatively automatic and rapid, and can precede conscious awareness and cognitive control (Critchley, 2005; Dolan, 2002; Ohman & Soares, 1993). An important complement to the automaticity of emotional and behavioral reactivity (Bargh & Ferguson, 2000) is found in the development of cognitive control abilities, particularly the control of attention, that emerges in the toddler period and allows for the modulation of arousal and for controlled engagement with, or withdrawal from, stimulation (Posner & Rothbart, 2000). The development of attentional control, referred to as executive attention, relies on the development of cortical networks that are phylogenetically newer and primarily lateral (especially the dorsolateral and ventrolateral PFC), which provide the neural substrate for executive functions. As shown in both functional and anatomical brain mapping research with human and nonhuman primates, the hierarchically integrated older and newer prefrontal networks are distinct, and can be considered as supporting related but distinct domains of functioning (Ghashghaei & Barbas, 2001; Heidbreder & Groenewegen, 2003; Petrides, 2005).

A central brain structure in the hierarchical integration of the ventromedial (emotional reactive) network and the lateral (cognitive control) network is the ACC (Koski & Paus, 2000; Luu & Tucker, 2004; Yamasaki, LaBar, & McCarthy, 2002). As several neuroimaging studies have shown, the ACC is active in response to tasks that require the resolution of cognitive conflict, as in the Stroop color–word task. It is composed of a ventral segment that is more active in conflict tasks with emotional content and a dorsal segment that is more active in response to arousal attendant to increased difficulty or awareness of making an error on cognitively demanding but emotionally neutral tasks. Activity in the ventral and dorsal segments of the ACC tends to be reciprocal, meaning that when activity in one is increased, activity in the other is decreased (Bush, Luu, & Posner, 2000). There is a growing consensus that the primary function of the ACC is to signal the need for cognitive control on the part of the lateral PFC in response to motivational contingencies (Botvinick, Cohen, & Carter, 2004; Luu & Tucker, 2004; Sohn, Albert, Jung, Carter, & Anderson, 2007).

As such, the role of the ACC in detecting error and in signaling the need for cognitive control is further highlighted by its connectivity with limbic effector systems of autonomic and motoric arousal (Critchley, 2005; Paus, 2001). That is, it bridges or connects limbic processes of

physiological and motor arousal and reactivity with cortical goal-directed planning and problem solving.

Emotionality and Cognitive Control: An Optimal Balance

Central to self-regulation development, and the best ways to promote it, are (a) the integrating or bridging functions of the ACC and (b) relations between processes of arousal that are primarily associated with the ventromedial PFC and those of control that are primarily associated with the lateral PFC. How is emotionality related to emerging cognitive control abilities? Is a high level of negative emotionality in infancy a risk factor for problems with the development of cognitive control? Or does a high level of negativity promote the development of cognitive control? Furthermore, when considering control, is it important to differentiate negative emotionality associated with fear reactivity from negative emotionality associated with anger reactivity? Or is high negative emotionality, whether anger or fear, only a risk factor when processes of cognitive control are not developing appropriately or when a child is developing within contexts that preclude the development of effective control? These are key questions for programs designed to promote self-regulation. They can help to identify not only risk factors but also ways to disrupt risk processes and prevent problems with adjustment and adaptation resulting from poor self-regulation.

Functional neuroimaging studies would seem to suggest a reciprocal relation between emotional arousal and cognitive control, meaning that when one is active the other is less so. From a reciprocal activation point of view, one might be tempted to conclude that a high level of cognitive control promotes positive adjustment and that a high level of emotionality, whether positive or negative (but primarily negative) disrupts adjustment. This would seem to be one of the more or less implicit themes of research on developing self-regulation; that emotionality usually acts as the nemesis of cognitive control. Accordingly, a developmental goal for young children would be to maximize control and minimize emotional reactivity. However, it does not necessarily follow that extremely high levels of cognitive control and low levels of emotionality are indicative of positive adjustment in children.

An alternative perspective on the relation between emotionality and cognitive control is that both work most effectively when operating in concert, as an integrated whole (Diamond, 2007). This view suggests that an optimal balance rather than a reciprocal antagonism is the appropriate metaphor for developing self-regulation (Blair & Dennis, in press; Gray, 2004). For example, functional magnetic resonance brain imaging indicates that induced fearful emotionality is associated with better performance on a test of visual–spatial working memory and better right dorsolateral PFC function, whereas induced positive emotion is associated with better performance on a test of verbal working memory and increased left dorsolateral PFC activity (Gray, Braver, & Raichle, 2004). The balance view recognizes that high levels of negative emotionality can interfere with control and adjustment, but also recognizes that high levels of control in the presence of low levels of emotionality can also result in problems with adaptation (Luu et al., 1998).

That emotion and cognitive control work most effectively when integrated is consistent with the understanding of cognitive control as goal directed, that the executive functions of the PFC organize information adaptively in response to motivational contingencies (Blair, 2006; Fuster, 1997). Thus, emotions both organize and are organized by cognitive control (Cole, Martin, & Dennis, 2004). This has important consequences for the development of adaptive behavior. Sometimes this organization is consistent with established norms for behavior within a given context, as in exuberant behavior in the playground or on the athletic field, and at other times it is at odds with norms, as when exuberant behavior occurs in the classroom or an institutional setting requiring reflection and interferes with the goals of that context. Furthermore, with

development, individual differences in the functioning of emotional and cognitive control processes lead to representations of the self that work to maintain a particular style of emotion–cognition organization that carries from one context to another. In this developmental process, if the emotion–cognition relation is weighted disproportionately to emotional reactivity or to cognitive control, and acts to disrupt rather than facilitate interpersonal relations, risk for later psychopathology is likely to increase (Derryberry & Reed, 1996).

School Readiness as the Integration of Emotion and Cognitive Control

The organizational perspective suggests that to understand self-regulation development within the context of early schooling, it is necessary to assess emotionality and approach–withdrawal motivation as well as cognitive control. From this perspective, the ideal early school environment should foster an emerging balance between emotion and cognition that supports active engagement in, and motivation for, learning and a sense of agency and capability in the school environment (Blair, 2002). Support for this comes from a study of school readiness and self-regulation involving children in Head Start, the federal preschool program for children from low-income homes (Blair & Razza, 2007). The study's findings indicate that readiness for school is characterized by the development of cognition–emotion integration, and suggest that the optimal relation between processes of emotionality and processes of cognitive control is one of balance and mutual reinforcement. Self-regulation emerges in the *coordination* of systems relating to emotional arousal and cognitive control, rather than the dominance of one over the other. For example, Blair and colleagues (Blair, Granger, & Razza, 2005; Blair, Peters, & Granger, 2004) found that children who exhibit increased arousal to moderate stress (as indicated by change in levels of salivary cortisol) are more sensitive to aversive contingences (as rated by parents) and exhibit higher levels of executive functions (as assessed by age appropriate measures of inhibitory control, working memory, and attention shifting.

Cortisol is the steroid hormone in humans associated with the action of the hypothalamic–pituitary–adrenal axis stress response system, a central component of the physiological response to stress and emotionally arousing stimulation. Consistent with the theory of self-regulation as emotion–cognition integration, moderate physiological and emotional arousal in children in Head Start was associated with a higher level of executive function (Blair et al., 2005).

Furthermore, consistent with the idea that the promotion of self-regulation can foster school readiness and prevent early school failure, the data also indicated that change in cortisol and performance on executive function tasks related positively to teachers' perceptions of children's classroom behavior (Blair et al., 2005) and to objective measures of academic ability in kindergarten (Blair & Razza, 2007). Findings for the influence of executive functions were particularly strong, as mathematics knowledge, letter knowledge, and an aspect of early reading ability known as phonemic awareness, all measured in kindergarten, were positively associated with executive function ability measured in preschool and kindergarten. Further, those relations were present over and above those for measures of general intelligence, for which associations with the academic outcomes were generally reduced or absent when executive function abilities were controlled. Of course, the measures of executive functions were moderately correlated with general intelligence, but it was performance on executive function measures (rather than general intelligence) that was primarily indicative of, indeed predictive of, how children were doing in math and reading at the end of kindergarten.

Further, children who did not evidence reactivity in cortisol and did less well on the measures of executive functions were more likely to arrive at the assessment session and perhaps at school itself in an aroused state. The optimal level of arousal for exercising cognitive control or engaging in taxing cognitive activity, for most people, is a mild level. When too aroused, it

is difficult to think clearly (Arnsten & Li, 2005; Lupien, Maheu, Tu, Fiocco, & Schramak, 2007). Arriving at the assessment session already aroused would mean that even if the stress associated with assessment were minimal, that mild stress added to the individual's initial arousal would likely result in arousal levels too high for feelings of comfort and for optimal performance. This would lead to a disorganized response to that mild stress and withdrawal or reduced persistence, and poor performance on the executive function tasks. Indeed, children performing least well on the executive function measures were reported to be poorly adjusted to the classroom by their teachers and were also characterized by a higher level of baseline cortisol (Blair et al., 2005).

Averting School Failure Through the Promotion of Self-Regulation

The findings outlined above, relating indicators of arousal and cognitive control to children's adjustment to school, suggest that school readiness is a process through which motivation and emotion foster and complement executive function processes that contribute to self-directed learning, resulting in the child having a sense of individual agency, a sense that he or she is an effective, capable learner. Children who have poor executive functions (and/or whose executive function performance is impaired by heightened stress or anxiety) have problems paying attention in class, completing assignments, and inhibiting impulsive behaviors. School is less fun for them because they find compliance with school demands so difficult and because their teachers so often get annoyed and frustrated with them. Teachers come to expect poor self-control and poor work, and the children come to hold more negative self-perceptions of themselves as students. People withdraw from situations where they have negative experiences and that threaten their feelings of self-worth (Crocker, 2002). Hence, children who begin school with poorer executive functions would be expected to become increasingly resistant to school and schoolwork, put less effort and self-investment into school, and drop out at much higher rates as expected (Vitaro, Brendgen, Larose, & Tremblay, 2005). Children who have better emotional, attentional, and behavioral regulation, in contrast, are a pleasure to teach, get praised for their good behavior, find schoolwork easier, enjoy school more, and want to spend more time on schoolwork. Teachers come to expect good self-control and good work from them, and the children come to hold more positive self-perceptions of themselves as students.

The powerful “self-fulfilling prophecy” effects of one's own and others' perceptions of and expectations for oneself are well documented (Rosenthal, 2002; Skinner, Zimmer-Gembeck, & Connell, 1998; Stipek, 2002; Trouilloud, Sarrazin, Bressoux, & Bois, 2006). Thus, the trajectories of children who start with better self-regulation and executive functions, and worse, would be expected to diverge more and more each year as the positive feedback loop for the former, and the negative feedback loop for the latter, progressively enlarge what might be relatively small differences at the outset, producing an achievement gap that widens each year (Alexander, Entwisle, & Kabbani, 2001; O'Shaughnessy et al., 2003). All things being equal, children who get started on a more promising trajectory will end up better. Clearly, it would be all to the good if negative feedback loops could be prevented from starting in the first place.

Given the foregoing characterization of self-regulation as absolutely critical for school readiness and the very real long-term negative consequences of early adjustment problems in school, what are the early learning contexts that can best promote the development of self-regulation? There are a number of programs focusing on the promotion of emotional competence in preschool and early school-age children (Raver, 2002). These programs begin in preschool or in the early elementary grades and are designed to reduce behavior problems and promote social–emotional competence. For example, the Promoting Alternative Thinking Strategies program (Domitrovich & Greenberg, 2000) provides teachers with systematic, developmentally appropriate lessons, materials, and instructions for teaching emotional literacy, self-control, social competence, positive peer relations, and interpersonal problem-

solving skills to children. Another such program is the Incredible Years (Webster-Stratton, 1998), which combines parent, teacher, and child training activities with the goal of reducing the onset of conduct problems in young children. A final example is the Good Behavior Game (Ialongo, Poduska, Werthamer, & Kellam, 2001), which is a behavior modification program designed to prevent impulsive and aggressive behavior in the classroom by improving the teacher's ability to define tasks, set rules, and discipline students within the context of a game in which students work in teams.

Findings across the various programs targeting social–emotional competence in children are mixed, reflecting variation in type, timing, and intensity of services provided (Raver, 2002). There are, however, clear indications of the value of a focus on emotional development in children at risk for school failure (Izard, 2002; Trentacosta & Izard, 2007) and the excellent opportunity that this focus offers to support child development within the US federal mandate to assure school readiness and equality in educational opportunity for all children.

The neurobiological underpinnings of the emotion–cognition balance model indicate that by promoting positive social–emotional development, that emotion-focused programs can provide a solid foundation for the development of executive function and school success. Of importance, it is not simply by preventing behavior problems that emotion-focused programs are thought to influence academic achievement. Behavior problems have relatively small associations with academic outcomes (Duncan et al., 2007; Rabiner, Murray, Schmid, & Malone, 2004). Rather, in theory, it is by promoting social–emotional competence and thereby helping to facilitate the development of executive function and self-regulation, and ultimately learning, that these programs are understood to affect school achievement.

The emotion–cognition balance model suggests an integrated understanding of education and children's experiences in the classroom. In research on the types of support for learning that teachers provide to young children, two broad dimensions of everyday student–teacher interactions have been identified: (a) information-based interactions that provide instructional support and (b) relationship-based interactions that promote an overall positive classroom climate and provide emotional support (Hamre & Pianta, 2005). Instructional support refers to the type and quality of information that teachers provide to children. Instructional approaches that do not simply provide students with answers, but allow and enable students to actively participate in discovering the answers for themselves are associated with the largest benefits to child learning (Bruner, 1991; Olson, 1964). Emotional support refers to general warmth and positive emotional climate in the classroom as well as the sensitivity of the teacher in interactions with individual children. It is not as simple, however, as instructional approaches being important only for their cognitive outcomes and relationship-based approaches being important only for their emotional outcomes. For example, instructional approaches that spark children's interest in (emotional excitement about) the subject matter, which are really fun and enjoyable for the children (e.g., which include the incorporation of music, movement, or games), that is, that ignite children's love of the material, school, or learning, will succeed best. In addition, instructional approaches that enable children to feel good about themselves (proud of themselves for having mastered something that was challenging) will also show more success (Clark, 1988; White, 1960).

A central goal for prekindergarten and early elementary education should be to develop curricula to promote self-regulation through instructional and emotional support and to utilize well-developed and appropriate measures to assess the effects to these curricula on the development of social–emotional, cognitive, and early academic abilities. One prekindergarten and kindergarten program that focuses on enhancing self-regulation is known as Tools of the Mind. Developed by Bodrova and Leong (2007), it is based on Luria's (1980) and Vygotsky's (1978) theories and practical insights on higher mental functions and how a comprehensive

system of activities and social interactions promote self-regulation and a positive sense of self. In Tools of the Mind, techniques for supporting ("scaffolding"), training, and challenging executive functions are interwoven in almost all classroom activities throughout the day. Whether children are playing, or learning language or math skills, they are also receiving training in executive function skills at the same time.

Self-regulation and executive-functioning training is approached from a variety of different angles in a variety of different activities in Tools of the Mind, especially intentional dramatic play (Vygotsky, 1967). A "play plan" is something a child creates under a teacher's guidance prior to a play session. The play plan lays out what the child plans to do in the upcoming play session (e.g., "I will be an astronaut headed to the moon"). It requires a child to coordinate motivations and interests with an orientation toward the immediate future, that of the play session that will soon begin. By considering what they would like to do and developing a plan for engaging in and forwarding those interests under the teacher's supervision, it is likely that children begin to develop the facility to coordinate emotional and motivational aspects of their experience with cognitive control aspects. Further, during social pretend play, children must hold their own role and those of others in mind (working memory), inhibit acting out of character (employ inhibitory control), and flexibly adjust to twists and turns in the evolving plot (mental flexibility); all three of the core executive functions thus get exercise. Tools of the Mind emphasizes a child's own contributions to his or her development (consistent with the organizational perspective's emphasis on developing abilities and self-perceptions as both shaped by, and shaping, processes of development at multiple levels).

Clearly, the Tools of the Mind curriculum is effective in improving young children's executive functions (Diamond et al., 2007) and in enhancing their academic performance (as studies in various states and with diverse comparison conditions have all shown; Barnett, Yarosz, Thomas, & Hornbeck, 2007; Saifer, 2007). Why? What factors mediate Tools of the Mind instructional practices and these beneficial outcomes? It is probably a confluence of positive influences. Tools of the Mind classrooms tend to have a positive climate and are less stressful for teachers and students (Barnett et al., 2007). Because of techniques for managing potentially difficult times (such as transitions between activities), scaffolding children's emerging self-regulation, and continually improving that, situations where children's self-regulation fails are minimized. Stress and anxiety impair executive functions and academic performance. Perhaps children in Tools of the Mind perform better in part because their stress levels are lower. Children's improving executive functions, and the reduced need for teacher-imposed discipline, also enable teachers to spend more time on instruction, thereby aiding children's academic advancement.

Many of the activities in Tools of the Mind aid social development. Better self-regulation and training in social norms such as turn taking (emphasized by Tools of the Mind), makes for better interpersonal interactions with peers and teachers. Such social benefits probably amplify the positive effects of the curriculum. Children interact with one another a lot in Tools of the Mind and often alternate in taking the roles of the giver or recipient of help or instruction. Various techniques are used to ensure that each child plays, and interacts, with every other child in the class. Tools of the Mind teachers are trained in ways to avoid there being loners, outcasts, or cliques. We know that positive socioemotional development aids and supports academic development and contributes importantly to positive classroom climate.

Conclusion

The interrelations between emotion and cognition discussed in this review suggest that a focus on developing emotional, attentional, and behavioral regulation in children at risk for school failure is likely to be a more effective strategy in promoting school success throughout the

school years than a sole focus on acquiring academic content, such as an exclusive focus on teaching the basics of early literacy and math. This is not because it is somehow inappropriate to teach literacy or math facts to young children. Of course, it is necessary to do so but (a) a focus on content on its own is likely to be ineffective in promoting children's ultimate ability to comprehend text and to solve mathematical problems and (b) the teaching of content needs to be done in developmentally appropriate ways. If children are helped to acquire the capacity to persevere in working at a task, the skills to sustain and focus their attention, and the ability to hold information in mind long enough to relate one idea or piece of information to another, they can acquire academic content. If they believe they are capable as learners and if they are motivated learners who find learning to be fun, they will go to the effort to acquire academic content. If, in contrast, they have memorized content but do not have the skills to learn on their own, their continued progress is in danger. Similarly, if they have found learning the content to be aversive, they will less likely to put in the effort needed to succeed in school. Early schooling that teaches children academic content but leaves them hating school, or anxious or fearful in school contexts, has failed the children. It is not age appropriate to expect very young children to sit still for long periods listening to group instruction. Young children need to be actively doing. They can learn cognitive and emotional regulation skills, and academic content, best through actively participating in activities, including structured play. There is no reason why school activities cannot be ones that the children thoroughly enjoy. The improvement of critical skills does not have to be painful; it can be great fun. Children who are happy rather than anxious learn better and seeing themselves master skills feeds back on their emotional state, making them happier and prouder.

In sum, learning occurs through a process of engagement and participation in a relationship with a caring and trusted other who models the process of and provides opportunities for self-directed learning. In acquiring the capacity for self-regulated learning, social–emotional skills that foster the relationship and executive function skills that promote self-regulation are quite literally foundational for learning. One need not look any further than the central importance of the parent–child relationship as a foundation for language learning for an excellent example of this principle (Bruner, 1996). Indeed, it is the potential for disruption of the parent–child relationship by the conditions of poverty, which then has adverse consequences for children's language and social–emotional development that is a primary reason why poverty increases the risk for early school failure (Hart & Risley, 1995; McLoyd, 1998). As such, an emphasis on the acquisition of knowledge without an equal and perhaps superordinate emphasis on the processes through which knowledge is acquired, particularly for young children, is likely to lead to an ineffective and inefficient educational system.

Acknowledgements

The authors' research and scholarly activities are partially supported by National Institute of Child Health and Human Development Grants P01 HD39667 and R01 HD51502 (to C.B.) and National Institute of Drug Abuse Grant R01 DA19685 (to A.D.).

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