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# Self-Regulation

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## 1 Self-Regulation

Self-regulation has received enormous attention in recent years as a key predictor of a variety of outcomes, including obesity (Evans et al. 2012), school readiness (Blair and Razza 2007; McClelland et al. 2007; Morrison et al. 2010), academic achievement in adolescence (Duckworth et al. 2010b), and long-term health and educational outcomes (McClelland et al. 2013; Moffitt et al. 2011). Although researchers have focused on self-regulation from a diverse set of perspectives (Geldhof et al. 2010;

McClelland et al. 2010), there is consensus that self-regulation has important implications for individual trajectories of health and well-being across the life course. Indeed, over a decade ago, it was suggested that “understanding self-regulation is the single most crucial goal for advancing the understanding of development” (Posner and Rothbart, 2000, p. 427).

Self-regulation is fundamental to successful accomplishment of adaptive developmental tasks at all stages of life. In the field of maternal and child health, a recent emphasis utilizing a life course health development (LCHD) perspective has shed new light on how these trajectories are shaped by dynamic mechanisms such as self-regulation. This perspective is captured by the seven LCHD principles—as described by Halfon and Forrest (2017)—which are also consistent with the relational developmental

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systems (RDS) perspective in the field of human development.

The development of self-regulation is a prime example of many of the LCHD principles in action. For example, the notion that health develops continuously over the life span would imply that individual pathways in self-regulation skills are formed partly through life course transitions and turning points or the points in a person's life which can influence developmental pathways in either positive (protective) or negative (maladaptive) ways, and in fact this is the case. Similarly, the notion that the timing and structure of environmental exposures are important for health development applies very well to self-regulation, the development of which is significantly and adversely affected by persistent and chronic stress, especially prenatally and in the first few years of life. (Conversely, protective factors such as sensitive and engaged caregiving can be a buffer for a child's development of these skills during this time.) Additionally, the LCHD notion that the rhythm of human development is a result of synchronized timing of molecular, physiological, behavioral, and evolutionary processes and that the synchronization of these processes contributes to the enormous individual variability in health development over time is also relevant to self-regulation.

Another illustration of the degree to which the development of self-regulation serves as a powerful example of the LCHD framework and its underlying principles in action is the fact that, at a time in history when the importance of children's self-regulation is perhaps greater than in previous decades due to an increasing academic focus in school settings, children and youth are using media to a much greater extent than ever before, a trend which could be detrimental to the development of these essential skills. This mismatch between the demands of the environment and the capacities of the developing individual is well described by the LCHD principles, which emphasize how evolution enables and constrains health development pathways and plasticity, how different aspects of development are intertwined over time (e.g., biobehavioral development is connected to sociocultural development), and

how efforts to promote more optimal health development can promote survival and enhance thriving by countering the negative impact of these kinds of mismatches.

Finally, the LCHD principles capture the dynamic and complex nature of health development and emphasize that development emerges as a result of person interactions at multiple levels. This speaks to the importance of integrating interventions both vertically—meaning along primary, secondary, and tertiary care continua—and horizontally, that is, across domains of function (i.e., biological, behavioral, social), as well as longitudinally (e.g., across life stages and/or generations). This is especially relevant here because the capacity for self-regulation has been shown to be highly malleable and because interventions to promote such skills have been shown to be more effective when they are integrated across different levels and contexts (Diamond and Lee 2011; Raver et al. 2011).

Together, the LCHD principles will guide our discussion of self-regulation, which are also consistent with an RDS perspective. After providing a theoretical framework based on RDST, we will view the seven principles of LCHD to better understand the determinants and pathways of self-regulation, methods for studying self-regulation, and translational issues. We conclude by providing recommendations for better integrating the principles of LCHD with the study of self-regulation.

## 1.1 Relational Developmental Systems Theory as a Framework for Self-Regulation

While many processes currently subsumed under the “self-regulation” moniker have been studied from the earliest days of psychology (e.g., James 1890), the modern study of self-regulation truly emerged as psychologists moved away from the mechanistic neopositivism that dominated their field during the middle part of the twentieth century. Work by Bandura (1969) and Mischel (1968), for instance, rejected the notion of the

“black box” and instead emphasized the self (and vicariously behavioral regulation by the self) as the object of valid scientific inquiry. This renewed focus on the self has made way for many of the core concepts that frame modern developmental science (e.g., that individuals are proactive agents capable of influencing their own development; Lerner 1982). Much of the recent work on self-regulation can be subsumed under the meta-theoretical stance that Overton (e.g., 2010, 2013) has termed relational developmental systems (RDS) theory.

Similar to the principles of LCHD, RDS represents an approach to human development that rejects the dualistic separation of individual and context (Overton 2013). Instead, like the principles of LCHD, RDST specifies that the individual is completely embedded as a locally self-organized component of his or her larger context. Development of the individual therefore necessarily influences and is influenced by his or her surrounding environment. These mutual influences can be thought of co-regulation (i.e., action and development of the individual partially “regulate” and are partially “regulated” by the surrounding context), resulting in what Brandstädter (e.g., 2006) has called developmental regulations. Similarly, Lerner (e.g., 1985; Lerner et al. 2011) has heuristically decomposed this person-context system and has described developmental regulations as mutually influential, bidirectional person-context interactions—similar to LCHD Principle 3. Accordingly, across the life span, individuals are active agents in the mutually influential interactions among the variables from the integrated biological, social, cultural, and historical (or temporal) levels of the dynamic developmental system (as in LCHD Principles 1, 2, 7).

The co-regulative nature of the person-context system described in RDST directly informs the contemporary study of self-regulation. While person and context are truly inseparable from the RDST perspective, Gestsdottir and Lerner (e.g., 2008) note that we can heuristically separate developmental regulations into those that primarily arise from the individual (i.e., the self) and those that primarily arise from the context. Using

this logic, they proceed to define self-regulation as comprised of “the attributes involved in and the means through which the individual contributes to developmental regulations...” (p. 203). As a broadly defined construct, self-regulation therefore entails cognitions, emotions, and actions that arise within the individual and do not differentiate between conscious and subconscious (or even automatic) action.

Differentiating between consciousness and sub- or (non)conscious behavior has been a recurring issue in the study of self-regulation, and it is now widely acknowledged that all self-regulated action falls along a continuum ranging from fully intentional to fully automatic. For instance, work done by Bargh and colleagues (e.g., Bargh et al. 2001) clearly shows that subconscious goals can influence (i.e., regulate) behavior outside of the actor’s explicit awareness. Similarly, Gestsdottir and Lerner (2008) differentiate between organismic and intentional self-regulation. Here, organismic self-regulation occurs below the threshold of consciousness and includes diverse actions ranging from the cardiovascular regulation of blood oxygen levels to the regulation of outwardly directed behavior through automatized goal structures. In contrast, intentional self-regulation includes behavior that the individual is consciously aware of, representing an agent’s intentional influence over the person-context system. The remainder of this chapter focuses specifically on intentional self-regulation. In total, self-regulation may be defined as “the ability to flexibly activate, monitor, inhibit, persevere and/or adapt one’s behavior, attention, emotions and cognitive strategies in response to directions from internal cues, environmental stimuli and feedback from others, in an attempt to attain personally-relevant goals” (Moilanen 2007, p. 835).

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## 2 Definitions of Self-Regulation

The study of self-regulation lacks integration across the life span. Theories that approach self-regulation within a given period of the life

span are often not integrated with each other nor are they usually integrated with theories that focus on subsequent or preceding life periods. In this section, we briefly review several of the major conceptualizations of self-regulation in an attempt to highlight the complexity of self-regulated processes in children and youth. Inherent in these conceptualizations and definitions are the seven principles of LCHD, which have important implications for the concepts of turning points and transitions, how mismatches can occur in development, and the need to integrate interventions across multiple levels of influence.

## 2.1 Executive Functioning

As an instantiation of self-regulation, the study of executive function (EF) emphasizes the fluid, cognitive processes that underlie self-regulated action. While the precise definition of which skills and processes constitute EF may vary across studies, researchers studying self-regulation have emphasized a few key skills. In particular, researchers have studied the importance and development of agentic control over one's attention, inhibitory control, and working memory (McClelland et al. 2010). Research addressing the development of attentional control describes the transition from simple arousal to fully endogenous attention across the first few years of life (e.g., Colombo 2001) and the subsequent development of attentional capacities from childhood to late life (e.g., Posner and Rothbart 1998). Attentional processes play a major role in self-regulated action (e.g., Norman and Shallice's (1986) Supervisory Attentional System) and may especially relate to emotion regulation in infants and children (Sheese et al. 2008). Children begin to display inhibitory control by approximately 3 years of age (Posner and Rothbart 1998), a time that corresponds to the onset of endogenous attention and also corresponds to the transition out of Piaget's preoperational stage (see Geldhof et al. 2010 for a brief discussion). Inhibitory control continues to develop throughout childhood (e.g., Backen Jones et al. 2003) and continues to

increase throughout adolescence and into early adulthood (e.g., Hooper et al. 2004). Finally, working memory is an aspect of executive functioning that includes the ability to actively work on and process information. In young children, it is demonstrated by children's ability to remember and follow instructions (Gathercole et al. 2004; Kail 2003).

The early years are a sensitive period of brain development, which closely parallel the development of EF. Understanding how EF develops during this developmental window has important implications for biological, cognitive, and social development.

## 2.2 Self-Regulation Versus Self-Control

The literature does not consistently distinguish between the concepts of self-regulation and self-control, with many authors using the terms interchangeably. Other authors consider self-regulation and self-control as distinct processes, which follow a sensitive period of development in infancy. For instance, Kopp (1982) describes self-control as developing at around 24 months of age and as including the ability to behave according to a caregiver's requests and to adhere to social expectations in the absence of external monitors. She distinguishes this from self-regulation, which instead develops when a child is approximately 36 months old and represents an internalization of self-control that allows for a degree of flexibility, allowing children to meet the changing demands of a dynamic context. According to Kopp, the distinction between self-control and self-regulation is therefore "a difference in degree, not in kind" (Kopp 1982, p. 207). In other words, self-regulation is an outgrowth of self-control that allows for flexible adaptation to real-world demands but which develops rapidly over the infant and toddler years. As such, this progression reflects the principles of LCHD especially for our understanding of how transitions and sensitive periods influence self-regulation development.

### 2.3 Effortful Control

In addition to the terms executive functions, self-regulation, and self-control, effortful control is a related construct that stems from the temperament literature. Rothbart and colleagues have defined the effortful control dimension of childhood temperament as “the ability to inhibit a dominant response to perform a subdominant response” (Rothbart and Bates 1998, p.137). Measures of effortful control for preschool children encompass several facets, including attention focusing and inhibitory control over inappropriate impulses (Rothbart et al. 2001). Rothbart distinguishes effortful control from two temperament factors that encompass more reactive (i.e., less voluntary) tendencies: surgency/extraversion and negative affect. Moreover, effortful control seems highly related, both conceptually and empirically, to self-control and conscientiousness in adolescents and adults (Eisenberg et al. (2012), under review). While this definition closely reflects cognitive inhibition, effortful control is instead considered an aspect of children’s temperament that develops in tandem with the development of endogenous attention. Research on infant temperament has not found a complete analogue to effortful control, for instance, with factor analyses instead uncovering a factor called orienting/regulation (e.g., Garstein and Rothbart 2003). Orienting/regulation contains many “regulatory” components similar to effortful control (e.g., orienting, soothability) but lacks a truly effortful component.

Effortful control incorporates the influence of temperament that infants are born with, along with the influence of the environment, including quality of caregiving. This dynamic coaction can be seen in the temperamental concept of “goodness of fit.” Goodness of fit refers to the match (or mismatch) between children’s temperamental states and the quality of caregiving and temperament of their parents/caregivers. When there is a positive fit or match between children and caregivers, children’s development of self-regulation is optimized. In contrast, when a mismatch occurs, there is greater potential for difficulty with self-regulation and related

outcomes. Thus, effortful control is especially relevant to understanding self-regulation through an LCHD framework.

### 2.4 Delay of Gratification

Delay of gratification is another approach to self-regulation with close ties to both inhibition and attention. Mischel and colleagues (e.g., Mischel and Ebbesen 1970) originally studied delay of gratification using the now-famous delay of gratification task with children. In this task, a researcher shows a child two rewards (e.g., a single marshmallow versus several marshmallows) and asks the child which reward he or she would prefer. Subsequent research has adapted this task for adults by varying the value of the rewards—sometimes making them hypothetical—and by extending the delay time to a month or longer (e.g., Fortsmeier et al. 2011; Duckworth and Seligman 2005).

Regardless of the delivery, inherent in the construct is the integration of emotion with cognition in their understanding of self-regulation. Mischel’s research especially links the ability to delay gratification to endogenous attention through what he and his colleagues have called the cognitive-affective processing system (e.g., Mischel and Ayduk 2004). This work has shown that when the rewards are visible to children during the delay period, children who distract their attention away from the reward delay longer than children that do not (Mischel et al. 1972). Similarly, children who attend only to the cool, non-motivating, features of the reward (e.g., by treating the actual reward as if it is instead a picture of the reward) delay longer than children who do not (Moore et al. 1976). Delay of gratification thus complements the principles of LCHD by assuming that self-regulated behavior includes the transactional processes of emotion and cognition.

### 2.5 Emotion Regulation

Although the study of emotion regulation is a complete area of the literature unto itself, there is some important overlap with the study of

self-regulation more generally defined. Infants' early regulatory tasks involve regulating their reactions to stimuli, including affective, temperament-based reactions that fall under the emotion regulation umbrella (Eisenberg et al. 2004). Emotion regulation means that children can modulate their strong emotional reactions with an appropriate strategy or combination of strategies (Bridges et al. 2004). Stansbury and Zimmerman (1999) describe four types of emotion regulatory strategies: instrumental or trying to change the situation (e.g., bidding for caregiver attention), comforting or soothing oneself without changing the situation (e.g., thumb-sucking), distraction or redirecting attention elsewhere (e.g., looking away), or cognitive, which is thought to be the most sophisticated and includes reframing the situation in a positive light, bargaining, or compromising. Importantly, children use different strategies depending on their individual characteristics as well as the situational context (Zimmermann and Stansbury 2003). This line of work demonstrates that the regulation of attention and emotion is closely interrelated and also reflects the principles of LCHD.

Together, the different definitions of self-regulation share many common conceptual underpinnings and are relevant to how these skills develop in individuals across the life span. They also apply to the key principles of LCHD. In the next section, we apply these principles to the developmental processes of self-regulation.

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### **3 Developmental Processes of Self-Regulation**

As noted above, the principles of LCHD can help to inform our understanding of the development of self-regulation. We orient our discussion around these principles by employing three lenses through which to view the development of self-regulation: (1) the lens of transitions and turning points, (2) the lens of mismatches, and (3) the lens of intervention integration. We include important individual, contextual, and sociocultural factors that influence the development of these skills over time

since such information is critical for developing effective ways to help promote strong self-regulation in individuals.

#### **3.1 Transitions and Turning Points in the Development of Self-Regulation**

Because of the malleability in self-regulation evident throughout the life course, there are many transitions and turning points for the development of these skills. The early childhood years represent one important time in the life course because they constitute a sensitive period for the development of self-regulation and underlying executive function skills. This makes it especially important for children's early biological, cognitive, and social-emotional development (Diamond 2002; Carlson et al. 2013). As noted above, children's self-regulation undergoes rapid change during early childhood, which parallels brain development, especially of the prefrontal cortex (e.g., Diamond 2002). The translation of this development can be seen in turning points in development, one of which is the transition to formal schooling for young children.

##### **3.1.1 The Transition to Schooling as a Turning Point for Self-Regulation**

Several lines of research point to relations between schooling and self-regulation as a developmental turning point for children. Evidence points to bidirectional relations between the biological and cognitive factors predicting development of self-regulation as well as the influence of context such as the schooling environment (e.g., Diamond 2002; Carlson et al. 2013; Morrison et al. 2010). Although much research focuses on how individual factors influence self-regulation (e.g., temperament, neurodevelopment of the prefrontal cortex), research has also examined how contextual factors such as schooling may influence self-regulation. For example, researchers have suggested that differences in self-regulation across cultures may be due to early instructional environments (Morrison et al. 2010)

as well as other factors such as temperamental variables (Hsu et al. 1981) or the prevalence of particular genes (Chang et al. 1996) that might contribute to observed advantages in self-regulation (Sabbagh et al. 2006).

Research looking at the transition to formal schooling has also used a natural experiment (designated “school cutoff”) design, which examines children whose birth dates cluster closely on either side of the cutoff date for entering formal schooling (e.g., kindergarten in the United States). This method effectively equates the two groups of children on age (Morrison et al. 2010). Using this methodology, results from recent quasi-experimental and experimental investigations have provided further evidence for the importance of schooling in the development of self-regulation. For example, Burrage et al. (2008) examined the influence of experience in preschool on growth of word decoding, working memory, and inhibitory control. This quasi-experimental work suggests that schooling, and more specifically the years of prekindergarten and kindergarten, improves working memory for children who attend school compared with same-age peers who, because of arbitrary school cutoff dates, do not attend at the same time (Burrage et al. 2008). Together this research suggests that the early childhood years provide a sensitive period for the development of self-regulation, which is influenced by both individual and contextual factors.

### 3.1.2 Adolescence as a Turning Point for Self-Regulation

In adolescence, children experience another sensitive period of development, especially for self-regulation. Adolescence, the second decade of life, is a period of ontogeny characterized by extraordinary biological, social, and ecological changes (Lerner and Steinberg 2009). Cognitive and social development means that the capacities necessary for advanced, adult-like self-regulation may for the most part emerge in adolescence. This is in large part due to the gradual maturation of the prefrontal cortex. In particular, as the frontal lobe develops, so does higher-order, regulation-relevant cognition, such as metacogni-

tion and internalized control. In turn, these skills enable adolescents to make better interpretations, choices, and decisions about how to interact with their environment, especially in accordance with long-term goals (Brandstädter 2006; Larson 2011; Steinberg 2010). In addition, the formulation of an adaptive identity, which is a major developmental task of adolescence, allows for the construction of a personal future that informs long-term decision-making and goal pursuit (Brandstädter 2006; McClelland et al. 2010). After all, it is impossible to formulate a plan to reach a long-term goal that has not yet been determined. Finally, during adolescence, young people may, for the first time, face decreased probabilities of achieving major life goals (e.g., graduating from high school) that have long-term consequences. This fact makes self-regulation particularly pertinent during the adolescent period (McClelland et al. 2010).

A growing body of research has confirmed the relation between adolescents’ self-regulation skills and positive and problematic behaviors. In the last decade, a body of research has advanced our understanding of how adolescents regulate their own learning (Zimmerman 2002; Zimmerman and Schunk 2001). Self-regulated learning involves many goal-related skills, such as the ability to set proximal learning goals, use appropriate strategies for attaining the goal, self-evaluate the method one has chosen to achieve a goal, and monitor one’s performance toward that goal. The use of self-regulated learning skills has repeatedly been related to school achievement (Miller and Byrnes 2001; Zimmerman and Schunk 2001). Similarly, the use of self-regulatory behaviors of youth is positively related to other positive outcomes, such as measures of social competence and mental well-being, and negatively related to indicators of problematic development, such as sexual risk behaviors, substance abuse, depression, and anxiety (e.g., Gestsdottir et al. 2009; Massey et al. 2008; Quinn and Fromme 2010). In addition, self-regulatory skills may have particular significance for youth living in high-risk environments. For instance, Buckner et al. (2009) found that youth from very low-income families fared better on a wide range

of developmental outcomes, ranging from academic achievement to anxiety, if they had adaptive self-regulation skills. The authors emphasize that such skills help youth to cope with stressful life events, making them less likely to be overwhelmed by the difficulties that they are faced with, and as such, high levels of self-regulation are considered a key factor in supporting youth's resiliency (Buckner et al. 2009; Quinn and Fromme 2010). In spite of the growing evidence that self-regulation has important implications for healthy functioning in adolescence, as it does in childhood, there has been limited developmental research on how such important, adult-like processes develop in adolescence.

In sum, although the understanding about the nature and development of self-regulatory processes is not complete, recent research confirms the contribution of adaptive self-regulation to the healthy development of children and youth. Furthermore, some recent findings point to an emerging theme and match both the principles of LCHD and the RDS framework: complex, adult-like, self-regulatory processes appear to develop in middle adolescence and continue to grow through adolescence and early adulthood. In addition, the function of self-regulation in adolescence may differ in function from that of childhood and adulthood. As such, the structure and function of self-regulation may be specific to this age period and constitute a sensitive period in development.

### **3.2 Mismatches (and Matches) in the Development of Self-Regulation**

In addition to research pointing to the importance of examining the transaction of how self-regulation develops across multiple levels of analysis, the match (or mismatch) between different aspects of development is also important. This can be seen in the notion of goodness of fit, taken from the child temperament literature, where an individual's characteristics and skills may not fit with those of the environment, such as the characteristics of caregivers. In the develop-

ment of self-regulation, a child's individual characteristics and skills may be adversely influenced by the aspects of their environment, such as adverse childhood experiences, stress, poor parenting, maternal depression, and the influence of the media and technology use.

#### **3.2.1 Adverse Childhood Experiences and Cumulative Risk**

Recent research on adverse childhood experiences (ACEs) and toxic stress suggests that multiple and chronic environmental stressors can have significant and adverse effects on the development of a host of outcomes throughout the life span (Blair and Raver 2012; Shonkoff et al. 2012). For example, the early and chronic stress experienced by children living in poverty can have a profound influence on areas of the brain most involved in the development of self-regulation (the prefrontal cortex [PFC]; e.g., Blair 2010; Blair and Raver 2012). One study found that low-income children exhibited lower prefrontal functioning compared to higher-income children. Specifically, the PFC functioning of low-income children in the study was similar to the level of functioning of individuals with damage to the PFC (Kishiyama et al. 2009).

In addition to effects on the developing brain, ACEs are related to poorer executive function and self-regulation, increased substance use, obesity, and risk-taking behaviors in adolescents and adults (see Table 1). For example, one study found that children with cumulative risk exposure (e.g., poverty, family turmoil, substandard housing) gain more weight during the transition to adolescence than their more advantaged peers, an effect mediated by lower levels of self-regulation (Evans et al. 2012). Such pernicious effects were predicted by Walter Mischel and colleagues, whose hot/cool model of self-control specified that stressful life events would potentiate impulsive ("hot") system activity and attenuate slower, more reflective and voluntary ("cool") system activity (Metcalf and Mischel 1999).

Research has also indicated that children from low-income families are more likely to experience family and housing instability, a lack of resources,

**Table 1** Examples of direct and/or indirect relations between self-regulation and health-related outcomes

Predictor	Health-related outcomes
Self-regulation	Obesity
	Weight gain and loss
	Addiction and substance use
	Risk-taking behaviors
	Cardiovascular disease
	Asthma
	Autoimmune diseases
	Depression
	Liver cancer
	Academic achievement
	School readiness
	Educational attainment
	Economic well-being (savings behavior, financial security, occupational prestige)
	Lack of criminal convictions
	Health behaviors
	Physical activity
	Nutritious eating
ADHD	

and lower-quality learning environments in the home (e.g., Gershoff et al. 2007; Mistry et al. 2010; Obradovic 2010; Sektnan et al. 2010), all of which have been linked to lower levels of self-regulation. For example, children facing cumulative risk factors may experience significant difficulty with self-regulation in early childhood (Wanless et al. 2011).

Partly because of this, children with chronic environmental stressors are more likely to experience school failure, unemployment, poverty, violent crime, and incarceration as adults. Moreover, and perhaps most important for the long-term implications of ACEs, these children are less likely as adults to provide supportive environments for their own children, who in turn are at significant risk of demonstrating some of these same issues. In addition to behavioral and economic effects, chronic and toxic stresses have been linked to biological changes including premature aging and death, alterations in immune functioning, and significant increases in inflammatory markers. Related to this, ACEs have been associated with a host of physical health outcomes, including cardiovascular dis-

ease, liver cancer, asthma, autoimmune diseases, and depression (Committee on Psychosocial Aspects of Child and Family Health et al. 2012; Shonkoff et al. 2012).

Together, this research suggests that ACEs, toxic stress, and cumulative risk can significantly impair the development of self-regulation in children. This is also an example of a potential mismatch between children's own development and the context in which they live. For example, it is possible that children facing cumulative risk have parents who provide fewer opportunities to practice self-regulation (Fuller et al. 2010; Wachs et al. 2004). These children may also have higher levels of stress, which interfere with the development of prefrontal cortex, experience more family and housing instability, and have fewer learning and economic resources (Blair 2010; Blair and Raver 2012). Thus, there may be few opportunities for children to experience a positive match between their own developing skills and those of the environment in which they live.

### 3.2.2 Parenting and Caregiving

As the research above indicates, poor parenting can have significant and detrimental effects on their children's own self-regulation. For example, extensive research documents the negative effects that maternal depression can have on a range of child outcomes, including self-regulation (Center on the Developing Child 2011).

In contrast to the conflicted and non-supportive parent-child relationships that undermine children's ability to self-regulate, organized and predictable home environments and emotionally positive parent-child relationships provide a context that allows for the development of self-regulatory competencies (e.g., Bowers et al. 2011; Brody and Ge 2001; Grolnick et al. 2000; Lewin-Bizan et al. 2010; Moilanen et al. 2010). For example, parenting that includes a focus on supporting autonomy and setting limits has significantly predicted stronger self-regulation in children compared to parenting that is more controlling and focused on compliance (Bernier et al. 2010; Lengua et al. 2007). A similar line of work in early childhood classrooms has established the importance of orienting and organizing

teacher behaviors for children's self-regulation, engagement, and academic outcomes (Cameron and Morrison, 2011; Cameron Ponitz et al. 2009). Taken together, this work indicates the importance of structured and predictable environments for helping children's emerging self-regulatory capacities. It also demonstrates the importance of matches between children's characteristics and parenting characteristics and behaviors, which complement the principles of the LCHD perspective.

### 3.2.3 Media and Technology Use

Another example of a possible mismatch is the increasing structure in school settings paired with the high prevalence of media and television use by children and adults. Children's media and technology use is rapidly increasing, but there remains little evidence on the positive effects of such media on children's development, especially for very young children (Radesky et al. 2014). Many studies have found persistent negative effects of extended television and media viewing on children's short- and long-term development (Robertson et al. 2013), including inattention and attention deficit hyperactivity disorder (ADHD)-related behaviors (Christakis et al. 2004; Nikkelen et al. 2014). These findings indicate that media use is related to poorer self-regulation and that households with heavy media use may be a poor context for supporting children's self-regulatory development. Thus, children's increased media use may run counter to the increased demands for self-regulated behavior in schools and society.

In addition to the issue of child media use is the high prevalence of media use by adults and parents. For example, parents who are distracted by texting and being on mobile devices may not be able to adequately respond to and parent their children. Although limited research exists, one study found that caregivers who used mobile devices at a restaurant while with their children were most often highly absorbed in the content and were less attentive to the children they were with. Those caregivers who were highly absorbed in their mobile devices were also more

likely to respond harshly to child misbehavior (Radesky et al. 2014). Thus, an increased inattention and distraction on the part of parents and caregivers may provide children with fewer opportunities to learn how to self-regulate themselves. Moreover, it is possible that although children's self-regulation is needed to successfully navigate increasing structured school settings, children and parents are using media to a much greater extent than ever before, which could be detrimental to the development of these skills. This potential mismatch may have significant long-term implications and is an area ripe for additional research.

## 3.3 Integrating Levels of Influence in Self-Regulation Interventions

Another LCHD lens through which to view self-regulation processes is the importance of integration across multiple levels of influence, especially in the context of interventions. This integration includes lateral integration or integration across subject domains, vertical integration or integration across levels of analysis, and developmental integration or integration across time. Because of the evidence pointing to the malleability of self-regulation, there has been an explosion in recent years in interventions aiming to foster the development of these skills.

Accumulating evidence suggests that interventions targeting children's self-regulation at various levels can be effective at improving self-regulation and other outcomes. For example, at the sociocultural level, preschool curricula, such as Tools of the Mind, focus on social, emotional, and executive function skills in addition to literacy and math. Research suggests that program participation is related to significant improvement in children's self-regulation (Blair and Raver 2014; Diamond et al. 2007), social behavior (Barnett et al. 2008), academic outcomes (Blair and Raver 2014), and neuroendocrine function (e.g., levels of salivary cortisol and alpha amylase; Blair and Raver 2014).

Some work, however, has not found significant intervention effects (Farran et al. 2013), suggesting that more work is needed to fully understand the key components of intervention effectiveness.

Other interventions that include multiple levels of integration (e.g., at the parent, teacher, and child level) are the Promoting Alternative Thinking Strategies (PATHS) and the Head Start REDI (Research-based, Developmentally Informed) programs (Bierman et al. 2008a), which focus on social-emotional skills and self-regulation. Children receiving these interventions have demonstrated more socially competent behavior (Domitrovich et al. 2007) and significant improvements in self-regulation (Bierman et al. 2008b) compared to children in a control group. Another recent study examining a broad intervention targeting social-emotional learning and literacy development found that children in intervention schools demonstrated improvements in a variety of social behaviors and self-regulation skills (e.g., attention). Improvements were also found in children's early math and reading achievement for those initially most at risk for behavior problems (Jones et al. 2011).

Further evidence from a school-based intervention that included multiple levels of integration with teachers, mental health consultants, and children (Raver et al. 2011) reveals that preschool children participating in the Chicago School Readiness Project exhibited significantly higher performance on self-regulation tasks than did their peers in a control group. Moreover, there was a mediating role of children's EF on pre-academic literacy and math skills. These findings complement those of Connor and colleagues (2010) who also found that an instructional intervention—which emphasized teacher planning, organization, classroom management, and opportunities for students to work independently—was most beneficial for children who started first grade with weaker self-regulation. Similarly, a recent intervention focusing on aspects of self-regulation (attentional flexibility, working memory, and inhibitory control) integrated into classroom games found that partici-

pation in the intervention was significantly related to gains in self-regulation skills and academic achievement compared to children in the control group (Tominey and McClelland 2011; Schmitt et al. 2015).

For children with ADHD, research has also documented that interventions that focus on strengthening aspects of self-regulation and underlying executive function skills can be beneficial (Reid et al. 2005). Such interventions have been found to help children improve on task behavior, decrease inappropriate behavior, and increase academic achievement, although results have been somewhat weaker for lasting improvement in academic skills (DuPaul et al. 2011).

Overall, results from a growing number of randomized control trials suggest that interventions designed to strengthen self-regulation can improve children's self-regulation, social behavior, and academic achievement. It is not known, however, if these effects persist over time. More research is needed on the long-term effects of such interventions and how interventions may work for different subgroups of children (e.g., those most at risk). Moreover, following the principles of LCHD, interventions tend to be most effective when they include multiple levels of influence and are integrated across domains of functioning and over time (Jones and Bouffard 2012).

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## 4 Self-Regulation and Health-Related Outcomes

Although self-regulation has been conceptualized differently in a variety of fields and at different developmental periods, accumulating evidence demonstrates the importance of self-regulation for a variety of outcomes. Moreover, our view of self-regulation reflects both the principles of LCHD and the RDS perspective. Below we review research on predictive relations between self-regulation and important outcomes such as academic achievement and educational attainment and health and well-being (see also Table 1).

#### 4.1 Academic Achievement, Educational Attainment, and Economic Well-Being

Over a century ago, in a series of lectures for schoolteachers near his home institution of Harvard University, William James (1899) declared that much of schoolwork was necessarily “dull and unexciting” in comparison with other things children might be doing (pp. 104–105). Consequently, James reasoned that students who could voluntarily control their attention enjoyed a distinct advantage over students who regularly succumbed to the “temptation to serve aside to other subjects” (p.112). Alfred Binet, Charles Spearman, and David Wechsler all made similar observations. That three of the most important figures in the history of intelligence testing would individually highlight the importance of “will” as a necessary complement to talent is somewhat ironic, given that intellectual aptitude, rather than self-regulation, was until very recently given disproportionate emphasis in the educational psychology literature.

Prospective longitudinal studies have confirmed James’s earlier intuitions. For young children, a large body of evidence now demonstrates that self-regulation sets the stage for learning in children even prior to formal schooling. For example, self-regulation in preschool and during the transition to kindergarten has uniquely predicted gains in academic achievement after controlling for child IQ and initial achievement levels (von Suchodoletz et al. 2013; Blair and Razza 2007; McClelland et al. 2007). In elementary school, strong kindergarten learning-related skills (including self-regulation and social competence) significantly predicted higher reading and mathematics achievement between kindergarten and sixth grade and growth in literacy and mathematics from kindergarten to second grade after controlling for prior achievement levels, child IQ, and a host of background variables (McClelland et al. 2006; see also Duncan et al. 2007; McClelland et al. 2006; McClelland et al. 2007; McClelland et al. 2000). Studies have also documented the long-term contributions of self-regulation to practically significant outcomes

such as high school graduation and college completion (McClelland et al. 2013; Moffitt et al. 2011). In one recent study, a 4-year-old child with one standard deviation higher ratings of attention (one aspect of self-regulation) than average had 49% greater odds of completing college by age 25 (McClelland et al. 2013).

In terms of economic well-being, the best evidence for the importance of self-regulation comes from a longitudinal study by Moffitt et al. (2011). Self-regulation was assessed using parent, teacher, observer, and self-report ratings at multiple time points in the first decade of life in a nationally representative sample of New Zealanders who were followed into adulthood. Childhood self-regulation predicted income, savings behavior, financial security, occupational prestige, lack of substance use, and lack of criminal convictions. These benefits were partially mediated by better decisions in adolescence, including staying in high school, not becoming a teenage parent, and not smoking. For a review of the relevance of self-regulation to academic achievement, including school readiness and lifetime educational attainment, see Duckworth and Allred (2012).

#### 4.2 Health and Well-Being

Self-regulation has been shown to be related to a variety of health behaviors, including recovery from physical illness or disabilities (e.g., exercise during and after cardiac rehabilitation (Blanchard et al. 2002), functional activity of patients undergoing surgical replacement of the hip or knee (Orbell and Sheeran 2000), physical activity for individuals in orthopedic rehabilitation (e.g., Ziegelmann et al. 2006, 2007), disease prevention (e.g., attendance for cervical cancer screenings, Sheeran and Orbell 2000; performance of breast self-examinations, Orbell et al. 1997), and general health (e.g., regulation of body weight via dieting and exercising/sport activities, Bagozzi and Edwards 1998; and increased consumption of nutritious foods and other dietary behaviors [Anderson et al. 2001; Calfas et al. 2002; Jackson et al. 2005]). Many of these stud-

ies are framed by Gollwitzer's model of action phases (Gollwitzer 1990, 1996).

As an action theory, Gollwitzer's model of action phases focuses on the factors that determine how effective one is during the process of setting a goal to actual goal attainment. A key construct distinction within this model—and ultimately in predicting one's success in behavior change or goal attainment—is between goal intentions and implementation intentions. A goal intention indicates a desired behavior or outcome and is a declaration of one's commitment to a goal. Implementation intentions, on the other hand, specify the “when, where, and how of responses leading to goal attainment...and thus link anticipated opportunities with goal-directed responses” (Gollwitzer 1999, p. 494). As a goal intention states an individual's commitment to a specific goal, the implementation intention states the individual's commitment to certain actions in an effort to attain that particular goal. Gollwitzer's model also highlights the contention that self-regulated actions fall along an intentional-automatic continuum; forming implementation intentions allows people to “strategically switch from conscious and effortful control of their goal-directed behaviors to being automatically controlled by selected situational cues” (Gollwitzer 1999, p. 495). In turn, implementation intentions promote goal attainment by helping to initiate action, above and beyond the effects of goal intentions alone.

Studies applying Gollwitzer's model to health behavior have indicated that it is not only important for participants to have goal intentions, but it is also imperative for them to form implementation intentions and make subsequent planning strategies to work toward their goals. These strategies allow individuals to pinpoint when, where, and how they will enact specific goal-related behaviors. For example, Luszczynska (2006) examined how well patients who suffered a myocardial infarction utilized physical activity planning strategy and performed moderate physical activity after engaging in an implementation intention intervention program. The results indicated that as compared to controls, patients who participated in the implementation intention

intervention more frequently used their planning strategies and maintained the same levels of physical activity at 8 months after their infarction as they did at 2 weeks after rehabilitation. Furthermore, implementation intentions (as compared to goal intentions) may be more predictive of health behaviors at later time points (Orbell and Sheeran 2000; Ziegelmann et al. 2007). When participants were asked to perform breast self-examinations, those who made such planning strategies were more likely to perform the behavior in the manner in which they originally specified (i.e., time and place) and were less likely to report forgetting to perform the behavior (e.g., Orbell et al. 1997). Likewise, the formation of such plans for breast self-examinations or to attend cervical cancer screenings can lead to earlier enactment of goal intentions even among a sample of highly motivated individuals (Orbell and Sheeran 2000; Sheeran and Orbell 2000) and influence motivation and adherence (Levack et al. 2006).

Another work examining the role of intentional self-regulation in health-related behaviors also focuses on specific self-regulatory cognitions and behaviors. Many studies have highlighted the importance of developing action and coping plans for successful adoption and maintenance of healthy behaviors such as physical activity and nutritious eating (e.g., Calfas et al. 2002; Sniehotta et al. 2005; Zeigelmann and Lippke 2007). Behavioral interventions aimed at initiating or increasing certain health behaviors—or aiding participants in reaching certain health goals—were often more effective when they included the creation of “action plans” (e.g., Calfas et al. 2002). The development of these plans often included having the participant explicitly identify the goals to pursue and sources for social support or resources to be utilized for achieving those goals. In some cases, the action plans also included identifying possible obstacles or barriers that might interfere with the implementation of their plans and solutions to overcome them (e.g., Calfas et al. 2002), but separate “coping plans” were also used for that purpose. For example, in a sample of 352 cardiac patients undergoing rehabilitation, Sniehotta et al. (2005)

provided evidence that action planning and coping planning can be identified as distinct strategies; in addition, the combination of forming both action plans and coping plans was more effective in increasing health behaviors over time than forming action plans alone. The additive benefit of action and coping plans was replicated in experimental designs (Sniehotta et al. 2006; Sniehotta et al. 2005; Scholz et al. 2007).

A large body of research also points to the importance of self-regulation for weight gain and loss (e.g., Evans et al. 2012; Francis and Susman 2009; Hofmann et al. 2014), addiction (Baumeister and Vonasch 2014), and other health-related outcomes (Moffitt et al. 2011). Several recent studies have demonstrated that poor self-regulation predicts unhealthy weight gain, particularly in adolescence, a period marked by pubertal changes that influence adiposity and greater latitude to make diet and exercise choices independent of parental control (Duckworth et al. 2010a; Tsukayama et al. 2010). In one study, children exposed to a number of risk factors were significantly more likely to gain weight during adolescence, which was mediated by having significantly lower levels of self-regulation (Evans et al. 2012). Adiposity, in turn, is a robust predictor of physical vitality later in life, suggesting one causal pathway linking childhood self-regulation to adult physical health and, ultimately, mortality.

Issues with self-regulation have also been implicated in ADHD, with ADHD often characterized as a disorder of self-regulation and underlying executive function components (Barkley 1997, 2011). For example, many individuals with ADHD exhibit significant difficulties with the core executive function components of self-regulation, including attentional or cognitive flexibility, working memory, and inhibitory control. This can be seen in individuals who are inattentive, who lack behavioral inhibition, and who have difficulty with planning, organizing, and being goal-oriented. These issues can also lead to difficulty with emotion regulation. Thus, individuals with ADHD are more likely to have problems with impulse control, be more reactive, and

have diminished social perspective taking abilities (Barkley 2011; Berwid et al. 2005). This means that children with ADHD may have a harder time stopping and thinking about a situation before reacting and illustrates why these children are more at risk for peer rejection and other behavior problems (Molina et al. 2009). Children with ADHD also demonstrate significant problems with academic achievement, which can also be linked back to difficulties with behavioral and emotional aspects of self-regulation (DuPaul and Kern 2011).

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## 5 Methods for Studying Self-Regulation

As demonstrated by how self-regulation relates to the principles of LCHD and RDS, self-regulation shows important transitions and sensitive periods, multiple levels of influence, and person-context fit in the form of matches or mismatches that can affect health development. Our understanding of these issues, however, hinges on how self-regulation is measured and analyzed in health-related research. In this section, we examine recent research on ways to measure and analyze self-regulation.

### 5.1 Measuring Self-Regulation

Self-regulation is generally treated as a slowly developing phenomenon, meaning studies that target the development of self-regulation can easily take advantage of the large sample, small time point analyses that dominate research in health-related fields. Self-regulation research can accordingly draw on the strengths of modern statistical methods such as latent variable structural equation modeling, multilevel modeling, and mixture modeling. In this vein, researchers readily acknowledge that one size rarely fits all people. Advances in mixture modeling have allowed us to appropriately model theories that stem from the person-centered movement and systems theories. Large sample research can be

facilitated by utilizing advances in modern missing data procedures to incorporate planned missing data collection designs. Such designs allow researchers to collect all the data needed to utilize modern analytic methods without burdening parents, teachers, or individuals with excessively long surveys.

It is also important to note, however, that challenges exist with some of these methods because self-regulation measures change over the developmental years and are often not strongly related with each other. Thus, developing self-regulation measures that are reliable and valid over a broad age range and at important points of transition is of particular importance. Some progress, however, has been made on this front. For example, the National Institutes of Health (NIH) Toolbox has developed brief assessments for a variety of skills, including aspects of self-regulation, which are appropriate to use with individuals throughout the life span (Zelazo et al. 2013).

In addition to measures that span a large age range, other measures capture a broad set of children's developmental skills, especially at school entry. Some research has focused on population-based measures that are based on teacher or caregiver ratings. One example is the Early Developmental Instrument (EDI; Janus and Offord 2007), which measures five developmental domains: social, emotional, physical, cognitive, and communicative. Although not specifically focused on measuring self-regulation, the measure includes items tapping aspects of self-regulation mostly in the social and emotional domains. The measure has been shown to be reliable and valid and significantly related to broad measures of school readiness, although less strongly related to direct assessments of children's skills (Hymel et al. 2011). A strength of this type of measure is the potential to capture a range of children's skills. A weakness, however, is that there may be considerable construct overlap and variability in how teachers rate children.

An example of a more targeted measure is the Head-Toes-Knees-Shoulders (HTKS) task (McClelland et al. 2014), which specifically measures behavioral aspects of self-regulation. The

HTKS taps children's ability to pay attention, use working memory, and demonstrate inhibitory control by doing the opposite of what was asked. The task is most appropriate for young children during the transition to formal schooling, which is important because this time is a crucial period for the development of self-regulation. A number of studies have shown that the HTKS is reliable and valid and significantly predicts academic achievement in diverse groups of children in the US, Asian, and European countries (McClelland et al. 2007, 2014; von Suchodoletz et al. 2013; Wanless et al. 2011).

In youth and adults, self-regulation is often measured either using self-report, parent-report, or teacher-report questionnaires, delay of gratification tasks, or, ideally, a multi-method battery of measures. Such measures predict report card grades and changes in report card grades over time (Duckworth and Seligman 2005), but the predictive validity of self-regulation for standardized achievement test scores, in contrast, is less dramatic (Duckworth et al. 2012). One reason that report card grades are differentially sensitive to self-regulation may be their relatively greater emphasis on effort on the part of the student, to complete homework assignments on time and with care, to come to class prepared and pay attention when present, and to study for quizzes and tests from provided materials. Notably, report card grades predict persistence through college better than standardized test scores, a testament to the continued importance of self-regulation as students move through the formal education system (Bowen et al. 2009).

### 5.1.1 Construct Diversity

The major limitation to measure self-regulation stems from the fact that self-regulation is not a single globally measurable construct. Instead, self-regulation represents an individual's agentic attempts to reach distal outcomes by influencing what Lerner (e.g., Gestsdottir and Lerner 2008) has called person-context relations. The extant diversity of theories and measures of self-regulation suggest that the apparently unitary domain of self-regulation actually consists of

many oblique fragments that differentially influence behavior as a function of context. We therefore need refinements in the measures of and theories about context-specific self-regulation. Here, better measurement of the parts will better inform the whole.

### 5.1.2 Complementing Nomothetic Analyses with Idiographic Analyses

In addition, if we truly see self-regulation as part of an ongoing process that is unique to each individual, we must begin to complement our existing analyses with more idiographic examinations of self-regulation over a variety of time spans (e.g., moments, days). Idiographic analyses such as dynamic factor analysis and p-technique have a place in research, and it is important that self-regulation researchers begin to acknowledge this role. We currently have a poor understanding of self-regulation as an idiographic phenomenon. A better understanding of intraindividual differences will allow greater insight into interindividual phenomena related to self-regulation as well as its intraindividual development.

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## 6 Issues for Future Research

The previous sections demonstrate that, across a broad spectrum of disciplines, interest has steadily mounted in self-regulation and related constructs—executive function (EF), self-control, and effortful control. A growing body of research has shown the importance of self-regulation for children’s success in school, as well as for subsequent health, wealth, and criminality (e.g., Moffitt et al. 2011). In addition, the study of self-regulation can be informed by a closer appreciation of the principles of LCHD and RDS, including how turning points and transitions, mismatches, and intervention integration influence self-regulation trajectories. Despite advances in many areas, our understanding of aspects of self-regulation, including the neurological underpinnings of these skills, and efforts to intervene in the development of self-regulation for children at risk remains limited. In this sec-

tion, we suggest key issues and next steps for self-regulation research.

### 6.1 Integration in Conceptualizing and Measuring Self-Regulation

When studied from multiple perspectives and fields, differences in how self-regulation is defined and conceptualized arise in part because its study stems from diverse research traditions that use distinct methods to examine phenomena across the life course. For example, research has burgeoned in basic investigations of self-regulation, including understanding the underlying neurological and behavioral mechanisms driving these skills in children, adolescents, and adults (Blair and Raver 2012). It is also the case that the particular domain of inquiry informs where and how phenomena and individuals are studied. Scholars sometimes refer to different levels of analysis (e.g., neurological activation, physiological responses, observed behavior, or self-report) to clarify some of these differences. More could be done, however, to provide better integration across different disciplines and contexts to study the development and measurement of these skills. For example, although the knowledge base of research on different aspects of self-regulation is deep, it lacks breadth, and most of the work in this area has been conducted in convenience samples of middle-SES North Americans. More research is needed on how self-regulation develops within different groups and populations especially as it relates to the principles of LCHD.

Another critical issue is the need to move away from deficit models of self-regulation (e.g., attribution of undesirable outcomes to having “poor” self-regulation) and instead take a strength-based perspective. Each individual carries a unique set of self-regulatory strengths. By understanding how to maximize these strengths and the fit between these strengths and an individual’s contextual resources, the continued study of self-regulation will help researchers promote thriving and positive outcomes across the life course.

## 6.2 Examining Developmental Changes in Self-Regulation Over Time

In addition to issues with conceptualization, it is also not clear if constructs, as operationalized across disciplines, are all measuring the same underlying skills. In addition, longitudinal measurement of the developmental course (both behavioral and neurological) of the underlying components of self-regulation over different transitions and turning points is lacking at present. Although a number of recent investigations provide insight into the structure of self-regulation in young children (i.e., unitary vs. componential), very little of this work has involved repeated assessments over time. As a result, we know a great deal about the performance of children before and early in preschool (e.g., Carlson 2005) but much less about self-regulation as children move through formal schooling. It is also important to examine whether and how these changing abilities relate to behavior in real-world contexts. Indeed, it could be the case that children who come into school with stronger self-regulation skills—as assessed from using tasks derived from cognitive neuroscience—also exhibit stronger self-regulation on classroom-based measures (Rimm-Kaufman et al. 2009). It is also possible that the relations between these sets of skills are more limited than anticipated and that these different types of tasks tap into different abilities altogether. Finally, the malleability of self-regulation—and its components, such as working memory, inhibitory control, and attention control, and particularly the impact of different intervention efforts on these abilities—has not been extensively charted. We turn to this next.

## 6.3 Improving Intervention Efforts

As the research reviewed suggests, there has been a sharp increase in the number of applied investigations targeting self-regulation, including a plethora of new programs for young children (Bierman et al. 2008a; Diamond and Lee 2011;

Jones et al. 2011; Raver et al. 2011; Schmitt et al. 2015; Tominey and McClelland 2011). Along with these changes, there has been an increase in interdisciplinary collaborations. These collaborations have led to new developments in measurements, analyses, and interventions related to understanding and promoting self-regulation skills early in the life course as a way to optimize development and prevent future difficulties. Moreover, researchers have started to examine the complex and dynamic relations among self-regulation and important variables that together influence individual health and well-being across the life course (McClelland et al. 2010).

Although research has documented the stability of self-regulation trajectories over time, the malleability of these skills is also evident. Thus, although more research is needed to examine the key components of effective interventions to promote self-regulation and the long-term effects of such interventions, a few recommendations can be made. First, in accordance with the principles of LCHD, self-regulation interventions are likely most effective when administered to individuals at turning points or sensitive periods of development, such as the early childhood years (Blair and Raver 2012). In addition, interventions are most effective when they integrate multiple levels of influence across different contexts (e.g., Jones and Bouffard 2012) and involve repeated practice of skills that are relevant to behavior in everyday settings and which increase in complexity over time (e.g., Diamond and Lee 2011). There is also support for interventions to be most effective for groups of children who are at the most risk, such as those living in poverty and/or experiencing toxic stress and ACEs (Blair and Raver 2014; Schmitt et al. 2015). Finally, recent work has examined the impact of additional intervention components, such as mindfulness practices and yoga, on children's self-regulation, with some encouraging results (Diamond and Lee 2011; Zelazo and Lyons 2012).

It is also clear that more needs to be done to translate research and interventions into practice. From a public health perspective, clinicians and pediatricians need better tools for assessing children's self-regulation especially in the early

childhood years. Based on the importance of developing strong self-regulation, it seems plausible that well-child visits include screening of self-regulation starting when children are 3 years of age. There are some measures available that assess aspects of self-regulation such as the EDI (Janus and Offord 2007), but more work is needed in this area. In the research realm, some progress has been made in developing ecologically valid and sensitive measures of self-regulation and in recognizing the roles of context in the development of these skills (e.g., McClelland and Cameron 2012). As noted above, however, it is unclear if self-regulation measured in one context relates to self-regulation in another context and how these relations change over time.

Finally, it is critical that the results of basic and applied research get translated into policy. Some efforts are ongoing to bridge the science of self-regulation and child development with policy and between a diverse number of fields (see, e.g., Halfon 2012; Halfon and Inkelas 2003; Shonkoff 2011; Shonkoff and Bales 2011; Shonkoff et al. 2012). Thus, there is great momentum in this arena. Although more work remains, there is an increasing energy around translating the importance of self-regulation for important health and developmental outcomes into policy and practice. Framing our understanding of self-regulation within the principles of LCHD and the RDS perspective is a promising way to improve research and translational efforts and promote healthy development across the life span.

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