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The Development of Self-Regulation in Young Children

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INTRODUCTION

Self-regulation has been established as a key mechanism associated with a variety of outcomes, including school readiness (Blair & Razza, 2007; McClelland, Cameron, Connor, et al., 2007; Morrison, Ponitz, & McClelland, 2010), academic achievement (Cameron Ponitz, McClelland, Matthews, & Morrison, 2009; Duckworth, Tsukayama, & May, 2010; Li-Grining, Votruba-Drzal, Maldonado-Carreño, & Haas, 2010; McClelland, Acock, & Morrison, 2006), and long-term health and educational outcomes (McClelland, Acock, Piccinin, Rhea, & Stallings, 2013; Moffitt et al., 2011). Researchers have described self-regulation from a diverse set of perspectives and experts agree that self-regulation has important implications for individual health and well-being starting early in life (Geldhof, Little, & Colombo, 2010; McClelland, Cameron Ponitz, Messersmith, & Tominey, 2010).

In this chapter, we describe the development of self-regulation in young children. We begin by defining self-regulation and related constructs, and then discuss how self-regulation develops over time and how socio-demographic risk plays a role in this development. We then focus on the importance of self-regulation for school success and as a protective factor. Although we highlight children living in a North American context, we also connect findings and research to children in other countries. We discuss how to best measure these skills in young children and advances in interventions to promote self-regulation. Finally, we discuss implications for research and practice.

DEFINITIONS OF SELF-REGULATION AND RELATED CONCEPTS

Self-regulation includes both top-down processes (also called executive functions or EF) and bottom-up regulation of thoughts, feelings, and behavior (Blair & Raver, 2012b;

Zelazo & Cunningham, 2007). EF includes attentional or cognitive flexibility, working memory, and inhibitory control, and enables individuals to plan, organize, and problem-solve as well as to manage emotions and behavior (Best & Miller, 2010). The overlap in constructs related to self-regulation and EF (e.g., executive attention, effortful control) has been referred to as 'conceptual clutter' (Morrison & Grammer, 2016). A considerable source of the confusion arises from the various ways that the constructs of EF and self-regulation are measured: from direct assessments that tap multiple cognitive skills, to observations of overt behavior, to observer (parent and teacher) reports of typical behaviors over time (Best & Miller, 2010; McClelland et al., 2010; Morrison & Grammer, 2016).

EF often includes foundational cognitive components (Best & Miller, 2010), and *self-regulation* refers to a broader set of children's regulation skills and behavior in real-world settings or as reported by caregivers. This convention may oversimplify some of the intricate theoretical issues in this research area, but it also simplifies in helpful ways. The EF-cognitive/self-regulation-behavioral distinction aligns with cognitive psychologists' emphasis of EFs as 'those cognitive *processes* that underlie goal-directed behavior' (Best & Miller, 2010, p. 1641, emphasis added). In addition, the bi-directional model proposed by Ursache, Blair, and Raver (2012) specifies self-regulation as an encompassing system that characterizes the child's *behavioral functioning over time* (inclusive of EF).

Definitions of Executive Function (EF)

The role played by each EF component in regulating behavior is still debated (Barkley, 1997; Müller, Dick, Gela, Overton, & Zelazo, 2006). EF is argued to comprise three components: attentional or cognitive flexibility, working memory, and inhibitory control. *Executive attention*, or the ability to voluntarily focus on a particular task while simultaneously ignoring environmental distractions (Barkley, 1997; Rothbart & Posner, 2005), may form the foundation for executive function and problem-solving (Rothbart & Posner, 2005; Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005; Zelazo & Müller, 2002). Similarly, *attentional or cognitive flexibility* allows children to shift focus and pay attention to new details. *Working memory* allows children to remember and follow directions and helps them plan solutions to problems (Gathercole & Pickering, 2000; Kail, 2003). *Inhibitory control* helps children stop one response in favor of a more adaptive behavior (Carlson & Moses, 2001; Dowsett & Livesey, 2000; Rennie, Bull, & Diamond, 2004).

Integrating multiple aspects of EF allows children to control their behavior, remember instructions, pay attention, and complete tasks in classroom settings. For instance, the application of EF to overt behavioral responses is important for remembering to raise one's hand and wait to be called upon instead of shouting out an answer in class (Cameron Ponitz et al., 2008; McClelland, Cameron, Wanless, & Murray, 2007; Morrison et al., 2010). Furthermore, research suggests that applying EF to ecologically relevant behaviors is important for children's ability to self-regulate and successfully navigate early learning environments (Best & Miller, 2010; McClelland & Cameron, 2012; Ursache et al., 2012). The present chapter primarily discusses executive function components that fall under a broader concept of self-regulation.

DEVELOPMENT OF SELF-REGULATION IN CHILDREN

Self-regulation and executive function, measured as early as preschool, can predict children's later academic skills, persistence, and

socio-emotional behaviors. Working with children during sensitive periods of their development, such as when they are initially creating schemas regarding social interactions, can help them function in a more controlled and planned manner. Being proficient in these skills can have many transfer effects outside of the academic setting, which can be beneficial to aspects of later life, such as employment (Moffitt et al., 2011). This shows how important self-regulation is throughout all stages of the lifespan. The development of self-regulation can often be promoted by intentional positive parenting, purposeful teaching, and early interventions (Brotman et al., 2013; Sanders & Mazzucchelli, 2013).

Not all children develop at the same pace, but the average age that children are able to begin to regulate their actions and behaviors in the presence of changing situations (which reflects the *inhibitory control* component of EF) is around thirty-six months (Kopp, 1982). Most often, initial aspects of self-regulation manifest through external regulation from a caregiver. For example, so-called 'other regulation' may involve learning to listen and follow directions from a parent, relative, or daycare provider. Simple directions, such as asking a child to put a toy in a toy bin or use an inside voice while inside, allow the child to process the instruction then complete the task that is being asked of them. These initial developments in self-regulation are supported by research showing that compliance in children increases between 12–18 months as their comprehension also improves (Kaler & Kopp, 1990). As the child continues to develop, requests often become more complicated; for example, taking turns with a peer or sibling during a game, or completing a multistep set of directions (put your toys away and then clean up the paint activity). Regulatory processes gradually evolve from being 'other-regulated' by a caregiver, to a self-guided but external process (e.g., the child repeats to him or herself each step of a task), to a fully internalized internal process (e.g., the child works through a math problem silently to him or herself). The transition from *other* to *self*-regulation signifies the advancement of self-regulatory skills (Kochanska, Coy, & Murray, 2001; Kopp, 1982).

Self-regulatory skills also demonstrate significant plasticity, or capacity for change, especially in the early childhood years (McClelland, Geldhof, Cameron, & Wanless, 2015). While the potential for change is relative and constrained by mutually influencing biological and environmental processes (termed *relative plasticity*), the potential for change exists (Lerner, 1996). Moreover, context and environmental resources can be a great asset to the development of self-regulation. For example, a child who struggles with self-regulation in the classroom context can benefit from a patient and warm classroom teacher who can individualize instruction (Day, Connor, & McClelland, 2015). Safe neighborhoods, quality school programs, and effective teachers are also important factors for maintaining and strengthening self-regulatory skills (Blair & Raver, 2015; McClelland et al., 2015). Although it is always important to keep in mind the dynamic interplay of genetic information and environmental context that influences children's capacity for self-regulation, the impact that positive contextual changes can have on children at various developmental stages instills hope regarding the potential impact of early intervention (Lerner, 2006).

THE ROLE OF SOCIO-DEMOGRAPHIC RISK AND SELF-REGULATION IN EARLY DEVELOPMENT

The role of the environment can have both positive and negative effects on children's development. In particular, researchers have documented the role that socio-demographic risk plays in the development of self-regulation (Blair & Raver, 2012a, 2012b). For example, low socio-economic status (SES) is related to poorer self-regulation on a variety

of measures (e.g., caregiver report, direct assessments) and may indicate children's responses to chronic stress and/or to being exposed to fewer optimal learning experiences than children from more advantaged backgrounds (Blair & Diamond, 2008; Blair & Raver, 2012a). Differences in children's self-regulation are evident based on the degree and number of risk factors present, such as coming from a single-parent home, having low parent education, or being of minority status (Evans & Rosenbaum, 2008; Galindo & Fuller, 2010; Raver, Blair, & Willoughby, 2012; Sektnan, McClelland, Acock, & Morrison, 2010).

In the United States (US), individuals from certain ethnic minority backgrounds disproportionally experience educational disparities and poverty (US Census Bureau, 2011). For example, English Language Learners (ELLs) in the US are likely to be Spanish-speaking (National Center on Immigrant Integration and Policy, 2010), be low-income, and have lower academic achievement compared to their peers (De Feyter & Winsler, 2009; US Census Bureau, 2011). This socio-demographic group is also experiencing rapid growth in the US (US Census Bureau, 2012).

In one study, children who were Spanish-speaking ELLs from low-income families began preschool with significantly lower EF and exhibited a slower rate of growth than English-speaking low-income children through kindergarten (Wanless, McClelland, Tominey, & Acock, 2011). In another study, self-regulation mediated relations between early socio-demographic risk and later academic success (Sektnan et al., 2010). Specifically, children who experienced risk between birth and 54 months (e.g., chronic poverty, mothers with chronic maternal depressive symptoms, being of minority status) were more likely to be rated significantly lower on self-regulation in preschool and kindergarten, which was related to performing significantly lower on academic outcomes at the end of first grade (e.g., 6–7 years). This research suggests that children experiencing multiple risk factors may enter school with less adaptive self-regulation, have more difficulty on academic tasks and may be more likely to disengage from school and learning compared to more advantaged peers (Blair & Diamond, 2008).

SELF-REGULATION INTERVENTIONS FOR SCHOOL SUCCESS

The influence of socio-demographic risk on self-regulation is evident because research suggests that self-regulation is an important foundational learning skill. Research has demonstrated that self-regulation significantly predicts achievement and social outcomes prior to formal schooling (Blair, 2002; Blair & Razza, 2007; McClelland, Cameron, Connor, et al., 2007) throughout elementary school (McClelland et al., 2006; McClelland, Morrison, & Holmes, 2000; Pears, Fisher, Heywood, & Bronz, 2007; Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009) and into adulthood (McClelland et al., 2013). In contrast, children who struggle with behaviors such as talking out of turn and failing to complete assignments have more difficulty in classroom settings (Ladd, 2003; McClelland et al., 2006).

Notably, in many studies, self-regulation contributes to achievement even after controlling for initial achievement levels and other background variables such as child IQ, age, ethnicity, and parent education level (Duncan et al., 2007; von Suchodoletz, Trommsdorff, Heikamp, Wieber, & Gollwitzer, 2009). One study documented that children with strong self-regulation in preschool had higher school age achievement after controlling for child IQ ($\beta = .54$) (von Suchodoletz et al., 2009). In another study, a child with one standard deviation higher parent ratings of attention and persistence at age 4 had 49% higher odds of completing college by age 25 than a child at the mean of these variables (McClelland et al., 2013). Much of this work has been done

on children in North America, but a number of studies have also found a similar pattern of results with children in Europe and Asia (Gestsdottir et al., 2014; von Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011; Wanless et al., 2013).

This strong link identified between self-regulation and school performance suggests a potential avenue for improving academic achievement through self-regulation interventions. These results provide compelling evidence for the idea that teaching children self-regulatory skills early on can be a protective factor to children from various socioeconomic backgrounds. In the Setknan et al. (2010) study above, regardless of the presence of a risk factor, children with stronger self-regulation on teacher/parent ratings had significantly greater achievement than children rated as having weaker skills. For children with the same number of risk factors, those with strong self-regulation ratings performed better academically than children with low self-regulation ratings. Another study found similar results with a sample of homeless children (Obradovic, 2010). Thus, even when children are exposed to considerable risk, those with stronger self-regulation have better school outcomes than those with weak regulatory skills. To examine how self-regulation functions as a protective factor, however, we need to accurately measure this set of skills. We turn to this issue next.

MEASUREMENT OF SELF-REGULATION IN YOUNG CHILDREN

Using reliable and valid measures that are able to capture variability within children's performance on tasks is extremely important when measuring self-regulation. Individually administered tasks often focus on measuring specific cognitive components such as cognitive flexibility or working memory. This approach helps increase precision, but can also be a challenge considering that many tasks require multiple aspects of EF or self-regulation – a problem also known as *task impurity* (Best, Miller, & Jones, 2009). In the early childhood period, this is also evident in research showing that the individual EF components aren't readily distinguishable; it's only later, in middle childhood that they emerge as separate (Wiebe et al., 2011). Recent research has worked to address these issues including strengthening existing measures and creating new measures to more accurately capture self-regulation in early childhood.

Recent Advances in Measures of EF

Many measures of preschoolers' self-regulation and EF currently exist, most of which were developed in laboratory settings and adapted for use in educational contexts. Carlson (2005) documented the EF measures available for children aged 2 to 6 years and found that many measures exhibited a binary (pass/fail) distribution. This is consistent with Diamond and colleagues' (Diamond, Kirkham, & Amso, 2002) conceptualization of when children can keep track of multiple rules, which depends on their ability to inhibit an initial impulse long enough to remember the rule and respond correctly.

Although many strong measures exist, a number of practical and psychometric problems have precluded their widespread use, especially in school settings. Schools and classrooms represent an important context to measure these skills because children's EF helps lay the foundation for learning, and assessing EF in school can help identify children at risk (Blair, 2002). Many measures take a long time to administer or require materials such as a computer or an electronic tablet, however (Hughes, 1998; Zelazo, Blair, & Willoughby, 2016).

A number of recent measures have addressed some of these issues: the EF Battery, (Willoughby, Blair, Wirth, & Greenberg, 2010, 2012; Willoughby, Wirth, & Blair, 2012), the

NIH Toolbox Cognition Battery (Zelazo et al., 2013) and the Head-Toes-Knees-Shoulders (HTKS) measure (McClelland et al., 2014). As with any measure, each of these assessments has strengths and weaknesses. For example, the EF Battery comprehensively assesses cognitive flexibility, working memory, and inhibitory control in children aged 3–5 years. The main drawback of the EF Battery is its length and the fact that some components show floor effects. Recent papers (Willoughby et al., 2010; Willoughby, Blair, et al., 2012; Willoughby, Wirth, et al., 2012) note that the battery takes up to 45 minutes. This length is problematic when assessing low-income children or young children facing multiple risk factors because such children typically show the lowest levels of self-regulation and have the most difficulty completing the tasks. In one study examining the EF Battery in 3-year-olds, only 30% of children in the sample could complete all five tasks (Willoughby et al., 2010).

The NIH Toolbox measure has been validated for ages 3 through 85, and includes norming data. Because it is administered on a laptop, it also incorporates reaction time data for children with strong self-regulation, which increases score variability. However, there is a cost to using the measure, as it requires a computer or tablet to administer, and in a recent monograph some children received scores that were considered outliers and were excluded from analyses: 14%, or 28 out of 194 children for the Toolbox DCCS task (Zelazo et al., 2013). Therefore, it is unclear whether this measure is appropriate for children with the lowest levels of EF.

The Head-Toes-Knees-Shoulders (HTKS) task integrates EF components into a game-like self-regulation task appropriate for children aged 4 to 8 years. Using no specialized materials, relying instead on interactions between the examiner and the child, the current HTKS has three sections with up to four paired behavioral rules: 'touch your head' and 'touch your toes'; 'touch your shoulders' and 'touch your knees'. Children first respond naturally, and then are instructed to switch rules by responding in the 'opposite' way (e.g., touch their head when told to touch their toes). If children respond correctly after all four paired behavioral rules are introduced, the pairings are switched in the third section (i.e., head goes with knees and shoulders go with toes).

The task taps EF by requiring children to integrate multiple cognitive skills: (1) paying *attention* to the instructions, (2) using *working memory* to remember and execute new rules while processing the commands, (3) using *inhibitory control* to inhibit their natural response to the test command while initiating the correct, unnatural response, and (4) using *attentional or cognitive flexibility* when rules change in the third section. The HTKS is moderately to strongly correlated with other EF assessments (Allan & Lonigan, 2011; Lipsey et al., 2017) and is available in over 20 languages. It has also been evaluated in research studies around the world and with diverse samples of children (e.g., Cadima, Gamelas, McClelland, & Peixoto, 2015; Gestsdottir et al., 2014; Størksen, Ellingsen, Wanless, & McClelland, 2014; von Salisch, Haenel, & Denham, 2015; von Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011). Importantly, the task is short (5–7 minutes) and easy to administer with good inter-rater reliability (Cameron Ponitz et al., 2009; McClelland & Cameron, 2012), which makes it a practical tool for use in classrooms and across cultures. Continued work on the measure shows that the HTKS was one of the strongest performing measures predicting academic outcomes among commonly used EF and self-regulation measures (Fuhs, Nesbitt, Farran, & Dong, 2014; Lipsey et al., 2017).

Drawbacks of the HTKS measure include the relatively narrow age range, floor effects found with children with low skills, and only using a single task to assess the multiple components of EF. In order to address this issue, our research team is currently working to revise this measure to capture a wider range of variability of skills. An in-process revised

version of the measure (the HTKS-R) has added an easier section to the measure, which significantly reduces floor effects in younger children and in at-risk children (McClelland, Cameron, Bowles, & Geldhof, 2015–2019).

Overall, advances in the measurement of self-regulation in young children have succeeded in making measures reliable, valid, and predictive of outcomes of interest such as school performance. Researchers have also focused on the feasibility and practical uses of such measures to broaden the potential scalability so that they can be more easily used in real-world settings (McClelland & Cameron, 2012). Although all measures have limitations, progress has been made in ways that better capture children's self-regulation and connect it to relevant developmental outcomes.

Although self-regulation tasks that focus on EF are becoming increasingly widespread, there are other measures of self-regulation that include metacognitive elements. Measures such as The Train Track Task (Bryce & Whitebread, 2012) ask children to create a train track that matches a shape based on a predetermined plan. This task challenges children's visuo-spatial memory and monitoring based on how well they can build the requested train track with the materials given (and sometimes after taking away the plan). Other measures of self-regulation, such as the Children's Independent Learning Development or CHILD (Whitebread et al., 2009) rely on teacher ratings to determine children's emotional, prosocial, cognitive, and motivational regulation. Overall, the CHILD measure has shown good external validity as a measure of self-regulation and metacognition in young children.

INTERVENTIONS TO IMPROVE SELF-REGULATION AND SCHOOL SUCCESS IN CHILDREN

Many existing interventions attempt to improve children's self-regulation and social and emotional learning skills inside and outside of the classroom. Examples of these interventions include the Promoting Alternative THinking Strategies (PATHS) program and a related program called Head Start Research-based Developmentally Informed (REDI) intervention (Bierman et al., 2008; Domitrovich, Cortes, & Greenberg, 2007). The PATHS intervention includes 30 classroom-administered sessions, which focus on self-regulation and socio-emotional skills in young children. Results from this intervention include small to large effects on children's socio-emotional competence (Domitrovich et al., 2007). In addition to improving problem-solving skills and reducing aggressive social behaviors, children who experienced the REDI intervention had higher engagement with learning and better early literacy skills (Bierman et al., 2014).

Another self-regulation intervention called the Kids in Transition (KITS) program targets the way that children process social information. Target outcomes are improved school readiness and early literacy skills among children with developmental disabilities, behavioral problems, or who are in the foster care system in the United States. Results from a number of experimental studies indicate improvements for children participating in KITS in social competence and decreases in negative behaviors (Pears et al., 2013; Pears, Kim, Fisher, & Yoerger, 2016).

Finally, the Red Light, Purple Light Circle Time games (RLPL) intervention focuses on improving aspects of self-regulation (e.g., attention, working memory, and inhibitory control) using movement- and music-based games in early childhood settings (McClelland & Tominey, 2015; Schmitt, McClelland, Tominey, & Acock, 2015; Tominey & McClelland, 2011). The intervention requires little training or materials. The RLPL intervention has been evaluated in three randomized control trials (RCTs) (Duncan, Schmitt, Burke, & McClelland, 2018; Schmitt et al., 2015; Tominey & McClelland, 2011). In one initial study, participation in the intervention was associated

with gains in self-regulation for children with the lowest initial levels of these skills and gains in literacy for the full sample (Tominey & McClelland, 2011). Results from a larger efficacy study with children from low-income families suggested that participation in the intervention was significantly related to gains in self-regulation for the full sample and gains in math for English language learners (Schmitt et al., 2015). A recent study also examined the RLPL games when delivered by teachers and included as part of a summer school readiness program (Duncan et al., 2018). Children who participated in the summer program with the RLPL games experienced more gains in self-regulation relative to children who participated in the summer program alone. There were no significant effects on math or literacy at the end of the program. However, when examining change during the kindergarten transition period, participation in the summer program with the self-regulation intervention was related to improved growth in self-regulation, math, and literacy into the fall of kindergarten compared to children's expected development (Duncan et al., 2018).

These results indicate that combining self-regulation interventions with school readiness programs can be effective ways to improve self-regulation and school readiness as children enter formal schooling. Moreover, because the RLPL intervention is focused on feasibility and scalability, it may be easily adaptable to other contexts and settings. For example, the intervention has been used in combination with parenting programs, such as Vroom or Mind in the Making, which work to help children improve self-regulation during brain-building activities with parents and caregivers (Galinsky, Bezos, McClelland, Carlson, & Zelazo, 2017). The RLPL games have also been used to improve self-regulation in children in other countries. A recent study used the RLPL games in Slovakia and Vanuatu to improve children's EF and delay of gratification in the context of social ritualistic behaviors (i.e., speaking and behaving properly in various situations). Results indicated improvements to EF, which was then related to better delayed gratification (Rybanska, McKay, Jong, & Whitehouse, 2017). Overall, these studies suggest that targeted self-regulation interventions may have strong scalability and can be adapted to other languages and cultural contexts around the world.

NEW DIRECTIONS FOR RESEARCH AND PRACTICE

The research base on children's self-regulation has expanded rapidly in recent years with significant progress made in our understanding of how self-regulation develops and in identifying important influences on children's development. Although debate remains, a growing body of evidence supports the importance of self-regulation for a variety of short- and long-term outcomes. Moreover, self-regulation may be a protective factor for children growing up in the context of different types of socio-demographic risk, which has implications for intervening with children at-risk for school difficulty (Bierman et al., 2014; Schmitt et al., 2015). Future research and practice efforts should examine how self-regulation interventions of differing intensity (e.g., tiered interventions) may be effective for children. In these models, teachers provide children with differing levels of support depending on their skill levels. Thus, children with stronger levels of self-regulation would receive some exposure to an intervention whereas children needing more support in self-regulation would receive more intensive levels of support. This model has been effectively used in literacy research (Fuchs & Fuchs, 2006) and is also supported by self-regulation intervention research demonstrating differential treatment effects for individual children (Bierman et al., 2014; Schmitt et al., 2015).

Researchers have also identified other key constructs that develop alongside self-regulation during early childhood. For example, research indicates that self-regulation and visuo-motor integration (related to fine motor skills) each predict children's academic outcomes across multiple domains (Cameron, 2018). Domain-specificity is also evident in both concurrent and longitudinal work on these skills. For example, in one study of assessments collected at the same time point, visuo-motor integration was a stronger predictor of early literacy skills whereas self-regulation was a stronger predictor of early math skills (Becker, McClelland, Loprinzi, & Trost, 2014). Similarly, aspects of self-regulation are robustly associated with the development of mathematics skills in early elementary school (Cameron et al., 2012; Kim et al., 2016), whereas visuo-motor integration contributes consistently to literacy gains over time (Cameron et al., 2012).

There is also evidence that strong visuo-motor integration may compensate for learning disadvantages in the early childhood years (Liew, Chen, & Hughes, 2010). In one large study of 3- to 5-year-olds, children who were low in visuo-motor integration but had above-average inhibitory control skills – or vice versa – enjoyed the same learning gains as children who were above-average in both (Cameron et al., 2015). In addition to visuo-motor integration, early math skills have been found to co-develop with early self-regulation or EF skills (McClelland & Cameron, 2018; Schmitt, Geldhof, Purpura, Duncan, & McClelland, 2017). This research supports the importance of considering how early skills work together in young children rather than pitting one set of skills against the other. Together with the Becker et al. (2014) study finding that preschool-age children need self-regulation to perform visuo-motor integration tasks, a cognitive load explanation is appropriate for explaining how cognitive and academic skills inter-relate in early childhood. Cognitive load refers to the idea that when learning a new skill, children's cognitive resources are burdened until they practice the new skill long enough to demonstrate mastery (also known as automaticity). Children who have relative strengths in certain areas may rely on those strengths to acquire skills that are still nascent. Awareness of the need for children to practice self-regulation and visuo-motor integration along with academic skills can guide research efforts and the development of intervention strategies to support school readiness in young children.

Recent advances in measurement have focused on better capturing self-regulation in real-world contexts such as schools. Such work has implications for improving our conceptual understanding of self-regulation and for developing ways to better assess self-regulation in children who are at-risk for school difficulty. Current research is focusing increasing attention on the feasibility and scalability of measures and how to adapt measures for diverse groups of children around the world.

Finally, intervention efforts to improve self-regulation continue to move forward at a rapid pace. We have specified ways to target these skills in classroom settings in some of our research (McClelland, Cameron, Wanless, et al., 2007; Schmitt et al., 2015; Tominey & McClelland, 2011), and other work has found evidence for effective preschool interventions promoting self-regulation (Bierman et al., 2014; Diamond & Lee, 2011). More work is needed to examine the long-term effectiveness of these interventions and to better specify for whom interventions work best and under what conditions (McClelland, Tominey, Schmitt, & Duncan, 2017). Overall, this work suggests that with appropriate activities that give children engaging opportunities to practice their emerging skills, self-regulation can be improved during early childhood in easy and feasible ways.

CONCLUSION

The development of self-regulation in young children is dynamic and influenced by individual and contextual factors. A large body of research has focused on this set of skills because of evidence supporting their role in predicting short- and long-term success in children (McClelland et al., 2013; Moffitt et al., 2011). However, children growing up in the context of socio-demographic risk are more likely to struggle with self-regulation. Moreover, measuring self-regulation at early ages has presented considerable challenges although progress has been made on a number of fronts. There is also evidence that self-regulation is malleable and can be improved (Bierman et al., 2014; Schmitt et al., 2015). Although more work is needed, research has indicated that interventions to promote self-regulation can be effective at improving children's outcomes. Thus, increasing efforts to promote this set of skills has the potential to support children's learning and development starting early in life.

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