




An Applied Contextual Model for Promoting Self-Regulation Enactment Across Development: Implications for Prevention, Public Health and Future Research

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Abstract

This theoretical paper presents a public health approach for promoting self-regulation across development that is based in cross-disciplinary theory and research. The self-regulation promotion model includes three key approaches that are each dependent on the relationship that children and youth have with caregivers: teaching self-regulation skills, building supportive environments, and providing co-regulation. This model extends the science of self-regulation insofar as it: (1) focuses on promoting wellbeing (not only reducing risks) across domains of functioning, (2) addresses self-regulation intervention across childhood and through young adulthood, (3) integrates multiple theories and applies them to intervention in meaningful ways, and (4) identifies specific strategies that can be used in natural developmental contexts and that address the social ecological environment as well as the individual child. We describe seven key principles that support the model including a description of self-regulation processes and implications for promoting self-regulation at each developmental stage. We end with broad implications for intervention, highlighting the relevance of the self-regulation promotion model for practitioners, policy makers, and prevention researchers.

Keywords Self-regulation · Co-regulation · Translational · Developmental · Social ecological

The views expressed in this publication do not necessarily reflect the views or policies of the Institute of Education Sciences, the Office of Planning, Research and Evaluation, the Administration for Children and Families, or the U.S. Department of Health and Human Services. Portions of this manuscript are available as an online report (Murray et al. 2015).

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Introduction

Self-regulation has received increasing attention in both the scientific literature and public media, generating over 10,000 peer-reviewed papers published in the past 15 years. This growing focus stems from evidence that self-regulation plays a foundational role in life-long functioning across domains, from mental health and social-emotional wellbeing to physical health, academic achievement, and socio-economic success (e.g., Buckner, Mezzacappa, & Beardslee, 2009; Dishion & Connell, 2006; Moffitt et al., 2011; Shonkoff & Garner, 2012). At the same time, self-regulation has proven responsive to interventions, making it a powerful target for change (Greenberg, 2006; Piquero, Jennings, & Farrington, 2010). While several theoretical models of self-regulatory processes have been suggested by scholars (e.g., Hoyle & Gallagher, 2015), little translational work has been done to integrate theories and apply them to intervention in useful and usable ways. Indeed, work towards making the complex science of self-regulation understandable and accessible is considered a priority for prevention science (Shonkoff, 2018). Our intention with this paper is to help move the science of self-regulation into explicit recommendations for the field. Our applied contextual model for promoting self-regulation in children and youth, identified as the Self-Regulation Promotion Model, is designed to enable prevention scientists, educators, program administrators, and policy makers to enhance existing approaches that target the social ecological environment as well as at the child.

While providing a framework for prevention and intervention, we also emphasize that a focus on self-regulation skills and strategies can promote healthy development and wellbeing on a population level. This broad, strengths-based orientation is grounded in the belief that self-regulation is a normative developmental process that can be strengthened with systematic and intentional effort. This perspective differs from much of the self-regulation literature that focuses on mechanisms explaining risk behaviors and poor developmental trajectories (e.g., Heatherton & Wagner, 2011). Instead, our model is designed to promote wellbeing, not merely to inhibit impulses. This reflects a conceptualization of self-regulation as flexible and adaptive in response to situational demands and social norms (Berger, 2011). Finally, our model concentrates on promoting self-regulation in day-to-day contexts using strategies that extend beyond packaged intervention programs to mimic those found in natural developmental contexts.

This model encompasses self-regulation development across the lifespan, with specific applications at each developmental stage. The self-regulation literature to date has focused primarily on early childhood functions, processes, and interventions (Diamond, 2012; Greenberg, 2006). Considerably less research has addressed the ongoing development of self-regulation across childhood and through young adulthood, particularly with regard to preventive approaches for older youth and young adults. This appears to us to be a significant gap given the self-regulation challenges and risk behaviors that occur during adolescence and young adulthood, which are also age groups for which fewer effective intervention programs are available than for younger children (Murray, Rosanbalm, &

Christopoulos, 2016). In this paper we present a conceptualization of self-regulation across developmental age groups from birth through young adulthood, identifying multiple opportunities for promoting self-regulatory competencies and skills for coping with adversity.

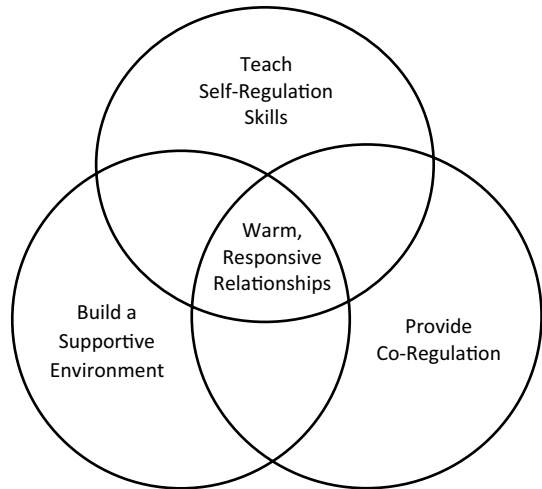
As will be described throughout this paper, our Self-Regulation Promotion Model is analogous to the ways our society promotes the development of literacy. With literacy, we provide universal supports across multiple settings, including intentional instruction in a hierarchy of skills that build on each other over time, increase in complexity, and are responsive to situational factors and contexts. We reinforce skills through ongoing modeling, coaching, and responsive teaching from caregivers across a variety of settings, and provide special interventions for children who need additional assistance. We propose that self-regulation develops most successfully through just such a model. We will use this literacy metaphor to inform and illustrate recommendations for intervention, with the understanding that “intervention” in this paper reflects the Institute of Medicine’s view of interventions as occurring along a continuum including promotion and prevention (National Research Council [US] and Institute of Medicine [US] Committee on the Prevention of Mental Disorders and Substance Abuse Among Children, Youth, and Young Adults: Research Advances and Promising Interventions, 2009, p. 67).

The following section introduces our applied contextual model, with a brief description of the review methodology that formed the basis for this work. We then present the seven key principles that explain and support our model. Within the principles, we first make the case for a strategic focus on self-regulation interventions by describing the value of self-regulation for broadly defined wellbeing across the lifespan (Principle 1). We then specify our definition of self-regulation and describe how our conceptualization relates to foundational self-regulation processes (Principle 2). We next consider a range of biopsychosocial factors that influence self-regulation, including biology, skills, motivation, caregiving, and environmental supports and demands (Principle 3). We more explicitly describe self-regulation as a skill that can be strengthened (Principle 4), but that is dependent on ‘co-regulation’ provided by caregiving adults (Principle 5). Next, we review how self-regulation development may be disrupted by adversity and stress (Principle 6). Finally, we describe how developmental self-regulation processes can be translated into approaches for promoting self-regulation from birth through young adulthood (Principle 7). The paper ends with intervention recommendations and implications for public health and future research.

An Applied Contextual Model for Promoting Self-Regulation Enactment

Consistent with recommendations for designing strong interventions for children and youth (Kellam, Koretz, & Mościcki, 1999), our Self-Regulation Promotion Model aims to link developmental science with intervention theory. We developed this model based on an examination of cross-disciplinary theoretical literature (Murray, Rosanbalm, Christopoulos, & Hamoudi, 2015); current empirical studies of

Fig. 1 Self-regulation promotion model. Theoretical model of key intervention components for building self-regulation in children and adolescents. The overlapping circles represent that each component is inter-related, and warm responsive relationships with caregivers are central to each component



underlying self-regulation processes and mechanisms; and self-regulation intervention effects from a comprehensive review of 299 interventions studied in the past 20 years (Murray et al., 2016). Within the intervention review, we coded each study on a variety of characteristics including target population, methodology, intervention components, outcomes examined, and effect sizes obtained. Within each developmental age group, we summarized these findings to establish both the average intervention effects and the types of programs eliciting these effects (for detailed methodology and findings, see Murray et al., 2016).

Based on these reviews, we identified three key intervention components with strong support for promoting self-regulation across development and contexts (see Fig. 1): (1) Teach self-regulation skills through proactive targeted and intentional skills instruction; (2) Build a supportive environment that provides expectations, positive norms, and limit setting to support self-regulation and ensure stress is manageable for any given child; and (3) Provide “co-regulation,” defined as the manner in which caring adults interact with children and youth to help them regulate in day-to-day situations. Importantly, warm, responsive relationships with caring adults (e.g., parents, teachers, childcare providers, other mentors) are central to the implementation of all three components and, as such, are represented in the area where the three concentric circles representing the three components overlap. An adult’s use of skills instruction, modeling, prompting, and reinforcement will not be effective if the child does not have a relationship with that caregiver in which they feel respected, valued, supported, and understood.

As can be seen in Fig. 1, the three intervention components are overlapping, suggesting that they are interrelated and should be addressed in a coordinated way for maximally effective interventions. Skills instruction and establishment of a supportive environmental context are proactive strategies designed to systematically lay the foundations for effective self-regulation. Co-regulation is an in-the-moment strategy for helping a child regulate as challenges arise. These components can affect each other in complex and bidirectional ways. For example, building skills in children can

promote positive norms related to self-regulation, such as how children are expected to treat each other, how adolescents navigate complex relationships with peers, and how young adults participate in a civil society. Positive classroom or family norms can likewise foster self-regulation skills. Similarly, co-regulation effectiveness will be greatly affected by the extent to which children have learned skills, are buffered by a supportive environment, and have a connected relationship with the co-regulating adult. Each of these intervention strategies will be examined more thoroughly within our seven principles in the sections to follow.

Our applied contextual model incorporates growing knowledge of the importance of caregivers and other significant adults as external regulators of children's emotion, cognition, and behavior, highlighting the importance of caregivers as critical intervention targets. This is consistent with developmental contextualism (Lerner, 1986, 1991, 1992), a systems theory that considers development to be an ongoing process of bidirectional interactions between an individual and his or her complex and changing environment. The changes and complexities of the social environment include situational factors in the moment that demand flexibility and adaptability, as well as social pressures related to the increasing freedom and responsibility related to growing up. Our model emphasizes the role of family, school, peers, neighborhood, and the broader socio-cultural environment in the self-regulation process, consistent with Bronfenbrenner's concentric nested structures of ecological influences (Bronfenbrenner, 1979). It aligns well with the growing field of relationship science, which highlights the influence of close relationships on wellbeing and health (Schetter, 2017). Finally, our model is responsive to calls to advance social connection as a public health priority (Holt-Lunstad, Robles, & Sbarra, 2017). To support, contextualize, and expand upon this model, we present our seven key principles for promoting self-regulation enactment across contexts and development.

Principle 1: Self-Regulation Serves as the Foundation for Lifelong Functioning Across a Wide Range of Domains

This first principle highlights the focus of our model on the application of self-regulation to real-world functioning, moving beyond a theoretical focus on the processes and mechanisms that underlie self-regulation. The importance of self-regulation enactment for long-term functioning across a wide range of domains, from psychological and social to academic and health, has been clearly established (Berger, 2011; Ciairano, Visu-Petra, & Settanni, 2007; Moffitt et al., 2011; Raver et al., 2012). Indeed, self-regulation has been identified as the foundation for lifelong physical and mental health (Shonkoff & Garner, 2012). In other words, it matters in real life in very fundamental ways, making self-regulation a highly relevant target for intervention.

Poor self-regulation is associated with major societal problems such as violence and substance use (Dishion & Connell, 2006; Garland, Boettiger, & Howard, 2011), mental health concerns and psychiatric diagnoses (Buckner et al., 2009), and health problems such as excessive weight gain (Francis & Susman, 2009). Moreover, self-regulation predicts academic outcomes like grades, attendance, and test scores

(Duckworth & Seligman, 2005), and socio-economic success as defined by income and financial planning (Moffitt et al., 2011). The impact of self-regulation in childhood on such long-term adult outcomes is notable even when IQ and social class are taken into consideration (Duckworth & Seligman, 2005; Raver, McCoy, Lowenstein, & Pess, 2013). Clearly, a focus on optimal development of self-regulation skills and strategies holds great promise for moving the needle on a wide range of individual and societal outcomes.

Principle 2: Self-Regulation is Defined From an Applied Perspective as the Act of Managing Cognition and Emotion to Enable Goal-Directed Actions

Our first translational task is to clearly define what we mean by self-regulation. Self-regulation is a broad multi-disciplinary concept that can be challenging to specify across conceptual models and different fields of literature. It has strong roots in neurobiology, cognitive and social neuroscience, and developmental psychology (Bell & Deater-Deckard, 2007; Berger, Kofman, Livneh, & Henik, 2007; Heatherton & Wagner, 2011; Kelley, Wagner, & Heatherton, 2015), and more recently has been defined within social ecology (Raver et al., 2013; Shonkoff & Garner, 2012) and behavioral economics (Mullainathan, 2013; Mullainathan & Shafir, 2013). Components of self-regulation have been referred to by a number of terms, including “willpower,” “grit,” “self-control,” “executive control,” “effortful control,” and “self-management.” To facilitate cross-disciplinary application, we use “self-regulation” as a broader umbrella term that includes all of these cognitive, emotional, and behavioral constructs. We define self-regulation from an applied perspective as *the act of managing cognition and emotion to enable goal-directed actions, such as organizing behavior, controlling impulses, and solving problems constructively.*

This conceptualization builds on an extensive literature describing theoretical self-regulation processes and mechanisms. Consistent with cognitive, developmental, and social-psychological models of self-regulation (Blair & Ursache, 2011; Davisson & Hoyle, 2017; Eisenberg & Zhou, 2016), our definition of self-regulation highlights its importance for goal achievement. It also identifies both cognitive and emotional components as critical processes (e.g., Eisenberg, Spinrad, & Eggum, 2010; Goldstein, Naglieri, Princiotta, & Otero, 2014; Jones & Foster, 2009; Miyake & Friedman, 2012), with an understanding that the integration of these processes is a significant developmental task (Eisenberg & Zhou, 2016).

To provide clear application for intervention, however, our model supports translation of self-regulation processes into observable skills. One way we do so is by defining self-regulation as an action rather than simply a capacity. How an individual reacts or responds in any situation is determined by factors beyond their capacity for self-regulation, and it is the *enactment* of self-regulation that affects goal achievement and wellbeing. Indeed, one may have adequate self-regulation capacity to achieve a goal or complete a task, but may not actually do so because of a lack of motivation or because stress is disrupting one’s focus in the moment (Blair, 2010). Alternately, a child may lack strong self-regulation capacity, but within a supportive

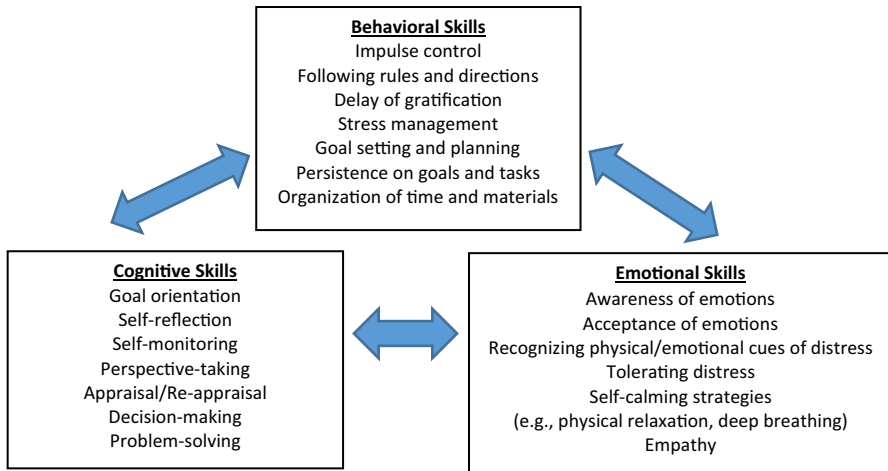


Fig. 2 Specific skills to target for promoting self-regulation. Model of cognitive, emotional, and behavioral self-regulation skills and their interrelationships. Cognitive and emotional skills are depicted as having a bidirectional relationship with each other, and together support behavioral regulation skills. Behavioral regulation skills, in turn, may influence cognitive and emotional skills

context with caregiver scaffolding, may be able to regulate quite adequately. Thus, capacity in our model is considered necessary but not sufficient for self-regulation, a distinction with great importance in the development of comprehensive intervention models.

Our paradigm differs from other definitions that describe self-regulation as an individual's limited capacity that can be depleted (Baumeister & Vohs, 2007). Although Baumeister's strength model of self-regulation has garnered support in a large meta-analysis (Hagger, Wood, Stiff, & Chatzisarantis, 2010) and been used to understand disorders of dysregulation (Heatherton & Wagner, 2011), recent rigorous experimentation has not supported the theory of depletion (Xu et al., 2014). On the other hand, what we can gain from this model is the proposition that self-regulation can be increased with practice (just like a muscle), which is consistent with a large body of intervention research as well as our own literature review (Murray et al., 2016). We incorporate self-regulation capacity into our model as one layer of the biopsychosocial factors influencing self-regulation enactment, as described in Principle 3.

Self-Regulation Skills to Target for Promotion

In order to provide a framework for promoting self-regulation through intervention, we have also conceptualized self-regulation as comprising the three overlapping skill areas depicted in Fig. 2: cognitive, emotional, and behavioral. Components of each skill set draw on underlying self-regulation processes, but are operationalized as specific, teachable skills. Cognitive self-regulation skills include goal orientation

and self-awareness/self-monitoring, perspective-taking, appraisal/re-appraisal, problem-solving, and decision-making. Emotional self-regulation involves actively managing strong feelings and results in adaptive functioning in emotionally arousing situations. It requires skills that enable awareness and acceptance of feelings, recognizing physical and emotional cues of internal distress or dysregulation, tolerating distress, self-calming strategies such as deep breathing, and empathy. Behavioral self-regulation is the result of the integration of cognitive and emotional regulation, manifested as impulse control, following directions and rules, delay of gratification, stress management, goal setting and planning, persistence, and organization. We recognize that these skills often draw from more than one domain. For instance, self-calming strategies require behavioral enactment, and impulse control requires regulation of both thoughts and feelings along with behaviors. Though the separation is artificial, we believe grouping skills in each category when providing instruction and coaching will support clear communication about and enactment of self-regulation in that domain.

Although perhaps oversimplified, we argue that this model has clear translational value and may help inform future self-regulation intervention development and research. In particular, it emphasizes that both cognitive and emotional regulation should be directly addressed in any self-regulation intervention. In addition, it recognizes that behavioral regulation skills can create a positive feedback loop, calming emotions and providing a different perspective on a given situation. Thus, all three components of self-regulation are inextricably linked, and each warrants consideration in comprehensive self-regulation interventions.

Foundational Self-Regulation Processes

To more explicitly connect our conceptualization to the rich, cross-disciplinary literature on self-regulation, we next briefly address some foundational processes that have implications for intervention. First, we acknowledge the importance of executive functioning, typically defined as shifting and sustaining attention, working memory, cognitive flexibility, and inhibitory control (Eisenberg & Zhou, 2016; Zhou, Chen, & Main, 2012). These processes provide a “top–down” influence on emotion through effortful or intentional activation (Raver et al., 2012) to support self-regulation. Executive functioning directly supports what we are describing as cognitive self-regulation skills, which can be strengthened through intervention. For example, cognitive flexibility is required for perspective-taking and re-appraisal, and attentional control enables self-monitoring.

Less intentional and more reactive “approach and avoidance” processes related to emotion, sometimes called “bottom–up” influences (Metcalfe & Mischel, 1999; Zelazo & Carlson, 2012), are typically believed to disrupt self-regulation (e.g., a young child who is angry may strike out). This process is evidenced in studies showing that strong impulses activate dopamine receptors in areas of the brain associated with rewards, and emotional stimuli activate the amygdala and bypass cognitive controls (Heatherton & Wagner, 2011). Although such developmental and neuroscience research clearly document how emotional processes can disrupt cognitive control,

emotion can also support self-regulation in ways that few models of self-regulation address. For instance, emotional acceptance may reduce negative thoughts and attributions and strengthen attention and problem-solving (Zelazo & Cunningham, 2007). Emotions such as anxiety and eagerness to please can motivate goal attainment (Bretherton, Fritz, Zahn-Waxler, & Ridgeway, 1986; Campos, Barrett, Lamb, Goldsmith, & Stenberg, 1983).

In addition, emotional awareness can support the initiation and execution of prosocial goals and behaviors (e.g., a young child shares a toy when he or she sees a friend who is sad without one), as well as interpersonal processes like attachment and empathy. Feelings of emotional connectedness may also prompt individuals to foster healthy relationships and promote social justice by encouraging respect, kindness, compassion, and understanding of others, further supporting self-regulation in relationships. These relationships cross social contexts and get increasingly complex as one ages, beginning with family relationships, moving to friendships, getting along with peers in schools, collaborating with colleagues in work settings, and getting involved with the broader community and civics. These positive aspects of emotional processes suggest that strengthening emotional awareness and connections may be valuable, and that interventions should address emotions as more than just a disruptive process. At the same time, approaches that strengthen executive functioning will clearly support cognitive regulation as we have conceptualized it.

Another related foundational self-regulation mechanism is the integration of cognitive and emotional processes (Blair & Razza, 2007), considered a key developmental task (Ernst, Pine, & Hardin, 2006). On a neurobiological level, there is evidence that self-regulation reflects a balance between brain regions sensitive to reward and emotional arousal and the prefrontal area associated with self-control (Heatherton & Wagner, 2011). Interestingly, the neurological pathways involved in achieving this balance may vary across contexts and the nature of self-regulatory demands (Heatherton & Wagner, 2011), highlighting the adaptive nature of self-regulation, consistent with our conceptualization. One intervention implication here is that skill enactment may require environmental supports to ensure arousal is at a manageable level for a particular child or youth. In addition, self-regulation skills should be taught in context (i.e., applied to specific, relevant situations). This leads us to the understanding that self-regulation enactment relies on inputs from multiple levels of biopsychosocial influence, rather than simply the internal processes described in traditional models of self-regulation. It is this multi-level structure that we explore in Principle 3.

Principle 3: Self-Regulation Enactment Is Influenced by a Combination of Individual and External Factors

The act of self-regulating is dependent on several factors, those that are individual to the child or youth and those that are external or environmental (Blair & Ursache, 2011), including biology, skills, motivation, caregiver support, and environmental context. These factors interact with one another to influence self-regulation enactment. For example, environment may influence a child's biology by shaping brain

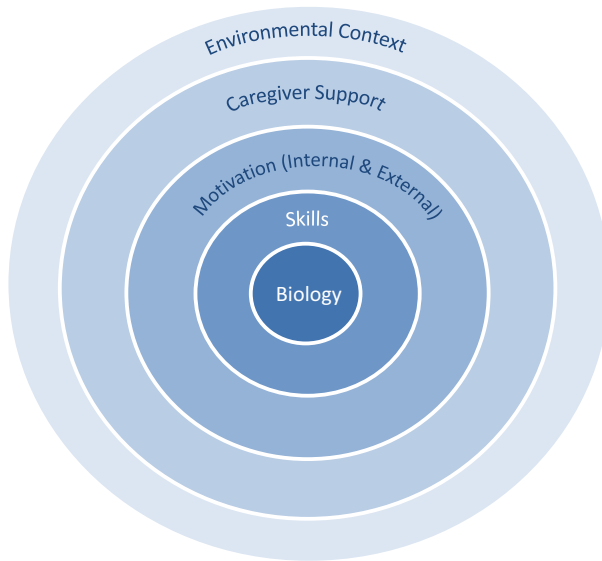


Fig. 3 Factors influencing self-regulation enactment. Model of factors believed to influence self-regulation enactment including biology, skills, motivation, caregiver support, and environmental context. The most internal factors are depicted in the center, with concentric circles indicating additional factors that reflect more external factors

circuitry, and a child's biology or temperament may influence how a caregiver interacts with him or her (Murray et al., 2015). These interactive factors also create numerous opportunities for intervention. For example, medication may be considered in addressing biological factors, skill-building to strengthen youths' skills, and parent education or preschool enrollment to strengthen caregiver and environmental supports. However, one-to-one correspondence with a specific intervention approach may not always be the first or best option. Indeed, the strongest interventions may impact multiple layers of our ecological model.

As seen in Fig. 3, the most internal concentric circle or layer influencing whether an individual will self-regulate in any given situation comprises *biology, genetics, and temperament*, which contribute to individual differences in self-regulation. The next major influence is the *self-regulation skills* that the child or youth has developed over time, which often serve as a target for interventions. Next is an individual's *motivation* to self-regulate (Baumeister & Vohs, 2007), which can be derived from either external sources (e.g., rewards and consequences) or internal goals and values (e.g., intrinsic motivation). *Caregiver support* (provided by parents, teachers, or mentors) is the next layer in our model, which can strengthen children's self-regulation skills and also buffer them from adverse experiences. Finally, the *environmental context* including the demands or stressors placed on an individual as well as the external resources available has a significant influence on self-regulation.

Some of these factors (skills, caregiver support, and environmental context) will be only briefly touched on in this section, as they pertain to specific model principles and will be addressed in detail in other sections of this paper. However, we will

more deeply consider biological factors and motivation, two layers of our ecological model that reflect individual differences and may inform selection of intervention approaches as well as explain response to intervention.

Biological Factors

The most internal layer in Fig. 3 is represented by the term “biological factors,” which includes foundational temperament and personality factors as described by Davisson and Hoyle (2017). Even at very early ages, children can be identified as having different thresholds of responsiveness to stimuli that may result in dysregulation as well as different styles of reacting to negative stimuli and regulating emotion (Han & Shaffer, 2013). This is often referred to as “temperament,” which has moderate heritability across early and middle childhood (Braungart, Fulker, & Plomin, 1992; Goldsmith, Buss, & Lemery, 1997; Goldsmith, Pollak, & Davidson, 2008). Consistent with temperamental stability, self-regulation in the absence of intervention appears to be relatively stable across childhood (Raffaelli, Crockett, & Shen, 2005), at least after preschool (Deater-Deckard, Petrill, Thompson, & DeThorne, 2005).

Another factor with biological origins that has been explored as a contributor to self-regulation is the sex of the child. Some studies show that boys score lower on measures of executive functioning than do girls of similar age (Raver et al., 2013; Stifter & Spinrad, 2002), consistent with higher ratings of inattention and aggression in boys (Coie & Dodge, 1998). However, these sex differences tend to be small and are not found consistently (Anderson, 2002). Moreover, self-regulation seems to develop similarly for boys and girls (Raffaelli et al., 2005).

Behavioral and molecular research has also demonstrated a substantial genetic component to self-regulation (Bell & Deater-Deckard, 2007; Eisenberg et al., 2010). Indeed, there is an indication that some of the most heritable brain regions are regulatory structures such as the dorsal prefrontal cortex, orbital frontal cortex, superior parietal cortex, and temporal lobe (Lenroot et al., 2009; Paus, 2005). Multiple genes and gene polymorphisms involved in the production and utilization of neurotransmitters have also been implicated in individual differences in self-regulation (Bishop, Cohen, Fossella, Casey, & Farah, 2006; Canli et al., 2005). Although this suggests that some variance in self-regulation is related to genetic differences, it does not mean that other factors and influences such as the environment are not important; self-regulation is clearly malleable and responsive to intervention. Instead, this work highlights the fact that individuals differ in their baseline self-regulatory capacity and may not achieve optimal self-regulation without targeted, strategic intervention and support.

Skills

The second factor influencing self-regulation pertains to the specific set of skills an individual has developed to enable self-regulation. As described in Principle 2 and depicted in Fig. 2, these include skills for emotional, cognitive, and behavioral

regulation that grow in complexity and sophistication as developmental capacity matures. These skills can be taught, modeled, rehearsed, and coached in the moment to strengthen a child's success at enacting them independently and flexibly in ways that fit situational demands and long-term goals. Strategies for skills promotion will be discussed in greater detail in Principle 4.

Motivation

The next layer in our figure of self-regulation influences is motivation. Motivation is often conflated with skills in measures of self-regulation, but is an important separable concept (Baumeister & Vohs, 2007; Rhodes et al., 2013). Motivation can be broadly defined as the drive to act or behave in a particular way. As described by Higgins' self-discrepancy theory (1989), motivation reflects the drive to obtain wants or needs or achieve desired outcomes. In contrast, motivation can be driven by the desire to prevent or avoid outcomes perceived as negative. In the context of self-regulation, motivation refers more specifically to the drive to achieve a goal *following recognition* that one's behavior is not aligned with the goal achievement, or to avoid a consequence that current behavior might lead to in the short- or long-term. Thus, consistent with the control theory model (Carver & Scheier, 1982), motivation for self-regulation requires both awareness of goals and self-monitoring of current behavior to identify alignment or discrepancy with one's individual goals and one's goals for the broader social ecology.

In more concrete terms relevant to self-regulation enactment, the extent to which an individual is motivated to achieve a goal can make it easier or harder for them to self-regulate. If someone lacks this awareness and motivation, they may not self-regulate in a particular situation, even with adequate skills to do so. Alternately, an individual may be very goal-focused and motivated, but may lack the skills and therefore fail to perform a particular task or self-regulate.

As noted, motivation can be prompted by a range of internal or external factors, including thoughts and feelings about one's goals. Consistent with the Belief-Expectancy-Control framework (Clark & Saxberg, 2018), internal motivation is influenced by values and needs as well as one's sense of competence and control over the outcomes. First, we are motivated by those things we find important or have a need for. This can include basic needs such as food and safety, material wants, or social needs for attention, acceptance, intimacy, or control. Caregivers can encourage children to identify and focus on goals (particularly long-term goals) to enhance value-based internal motivation. Even with strong values for a goal, however, children's sense of control and self-efficacy to perform the tasks necessary to achieve the goal will affect motivation. Individuals are motivated to exert effort and persist on difficult tasks when they believe their efforts are useful, will be effective, and will be rewarded (Dweck, 2008).

External motivation is provided by rewards and consequences, which may come from caregivers or the environment and take different forms based upon the individual's age. For children and youth, this is often connected to their relationships with caregivers (motivating them to seek approval), tangible or intangible incentives, or

removal of something desirable. Indeed, behavior management systems are based in the logic that behavior can be changed when such external motivators are manipulated (assuming, of course, that underlying skills are also present).

Caregiver Support

Caregivers play a critical role in self-regulation promotion, particularly in early childhood, but never cease to be important. They are responsible for teaching the skills of self-regulation, encouraging motivation for self-regulation, providing in-the-moment co-regulation support, and buffering children from adversity and related stress from the environment. Their role, particularly within the context of co-regulation, will be discussed in greater detail in Principle 5.

Environmental Context

Finally, the outer layer of Fig. 3 pertains to the environmental context in which children and youth live their lives, which will be described in detail in Principle 6. A calm, positive, well-structured environment is likely to minimize regulatory demands on a child. Available supports and resources in schools and communities might promote the development and enactment of self-regulation skills. In contrast, environments with high levels of stress and adversity place higher demands on self-regulation while at the same time impairing self-regulation development. As discussed in Principle 6, children and youth with higher rates of adverse experiences need environmental interventions to minimize exposure to stress, but will also benefit from more intensive caregiver support and skills instruction to successfully self-regulate.

Principle 4: Self-Regulation Can Be Strengthened and Taught Like Literacy, With Systematic and Intentional Support Provided Across Contexts

In our comprehensive review of 299 preventive interventions from birth through early adulthood, we found clear evidence that self-regulation can be responsive to intervention (Murray et al., 2016). Results show that a variety of programs create meaningful positive effects on multiple aspects of cognitive, emotional, and behavioral self-regulation as well as broader functional outcomes like mental health and academic achievement. For the two-thirds of studies in this review with control groups, the average intervention effect size was small to medium for each child self-regulation domain. Even stronger outcomes were evident for parents and teachers, with average effect sizes that were moderate to large for caregiver skills and behaviors that support children's self-regulation development and enactment. These findings are comparable to those seen in a meta-analysis of universal school-based prevention programs (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011), which target similar outcomes.

Importantly, there is considerable variability in results from one study to another, with some finding no self-regulation outcomes and some finding large effects across domains (see Murray et al., 2016 for a full summary of findings by domain and intervention). Results were based in part on the type of intervention, intervention duration, and alignment with the outcomes measured. This suggests that self-regulation *can* be improved with intervention, but that the selection of intervention is an important consideration. In addition, individual differences in intervention effectiveness are expected given unique profiles of biology, skills, motivation, caregiver support, and environmental context (including adversity). Though effects of a given intervention for a given individual may vary considerably, these findings as a whole validate the malleable nature of self-regulation as well as the translation of self-regulation interventions into functional changes in behavior and social-emotional wellbeing.

Teaching Self-Regulation Like Literacy

As noted in the introduction, a metaphor that may be helpful in understanding self-regulation is that of literacy.¹ Literacy requires a set of skills developed over time in a sequential manner that ultimately enable an individual to read and comprehend a range of texts. Literacy starts with building blocks like phonemic awareness and letter-sound relationships and progresses to fluency and comprehension of complex ideas. Likewise, self-regulation requires a series of sub-component skills that build upon one another to enable effective coping and adaptability in complex situations. As with literacy, these skills require developmental scaffolding across time to achieve long-term competence. Also similar to literacy, an individual's ability to self-regulate is influenced by the structure, support, instruction, and reinforcement that one has received from the environment. These self-regulation skills are represented by the second concentric circle titled 'skills' in Fig. 3.

Just as literacy develops earlier when children are immersed in rich literacy environments, self-regulation skills will develop earlier in environments with a stronger foundation of support, i.e., nurturing, stability, security, structure, and modeling. On the other hand, there will be children who struggle with literacy early on for a variety of reasons, such as individual learning differences or inadequate instruction and support. These individuals may become literate later, even in adulthood, if they are provided with effective, developmentally-matched instruction in a supportive environment. Likewise, children who have early self-regulation difficulties are capable of acquiring these skills at later ages, but will need intervention and support matched to their developmental needs (Murray et al., 2015).

This metaphor suggests that there are multiple opportunities for intervention across development. It also suggests that: (1) universal supports for healthy self-regulation development embedded in ongoing interactions between children and their caregivers and service providers are necessary; (2) instruction and coaching over time are needed to build the sophisticated skills required in adulthood; and (3)

¹ This metaphor is attributed to Ken Dodge at Duke University, who was involved in initial conversations about our model.

some children may need more intensive, targeted interventions to overcome biological or environmental adversity that have disrupted their self-regulation abilities. Just as we would not expect complex literacy skills to emerge independently or after brief time-limited instruction, self-regulation is likely to require intentional instruction and support in an ongoing way, building skills of increasing complexity across development. Although no metaphor can have absolute application to something as complex as self-regulation, the model of literacy has considerable value in informing intervention design and implementation.

Principle 5: Development of Self-Regulation Is Dependent on “Co-Regulation” Provided by Parents or Other Caregiving Adults Through Warm and Responsive Interactions

Although child factors represented by the three innermost layers in Fig. 3 clearly play a role in self-regulation enactment, the environment also has a significant influence on self-regulation. In particular, caregivers including parents, teachers, child-care providers and other mentors (represented by ‘caregiver support’ in Fig. 3) can promote self-regulation development and enactment in the moment by providing “co-regulation.” This term was initially used as a description of adult support for infants (Evans & Porter, 2009; Fogel & Garvey, 2007), but is now being applied more broadly to describe an interactive process of support within the context of caring relationships across the lifespan (Sbarra & Hazan, 2008). For this broader span of development, co-regulation describes how caregivers promote self-regulation skill development and enactment through day-to-day interactions and modeling (Biglan, Flay, Embry, & Sandler, 2012). Specifically, caregiving adults assist children and youth to understand, express, and modulate their thoughts, feelings and behaviors during times of distress by: (1) providing emotional support; (2) modifying the environment to reduce regulatory demands; and (3) *in vivo* teaching and coaching of self-regulation skills, including modeling, instruction, prompts, and reinforcement (Murray et al., 2015). This real-world support and skills coaching bridges the gap between regulatory demands and existing child skills, enabling children and youth to experience scaffolded success in self-regulating.

As supported by over 100 parenting studies (Hamoudi, Murray, Sorenson, & Fontaine, 2015; Rueda et al., 2004), this in-the-moment coaching needs to occur within the context of warm, responsive relationships where caregivers are attuned to children’s needs and provide an appropriate level of challenge and support, including clear and consistent rules, expectations, and consequences. In the context of stressful environments, this structure and support helps children balance emotional arousal with their self-regulation skills so they can cope effectively, promoting resilience (Buckner et al., 2009).

Empirical support for the benefits of co-regulation is well-established, with hundreds of studies linking discipline, sensitivity, family routines, and parent–child relations to children’s self-regulation (Grolnick & Farkas, 2002; Karreman, van Tuijl, van Aken, & Deković, 2006). Even in conditions of extreme adversity, the quality of caregiver co-regulation can serve as a buffer, mediating the effects on child

development (McLoyd, 1998). Likewise, co-regulation appears responsive to parenting interventions, with subsequent effects on child self-regulation (Sanders & Mazzucchelli, 2013).

Co-regulation will look different at different ages as child capacity for self-regulation grows, with specific interaction strategies being more and less effective at different ages (Landry, Smith, Swank, & Miller-Loncar, 2000). Generally, greater external regulation by caregivers is needed at younger ages, and less caregiver regulation is required as a child's ability to self-regulate increases. Importantly, however, some external support is important through young adulthood (at least), which may be well beyond the time this is typically considered necessary. For children with self-regulation difficulties, greater levels of caregiver support may be needed for optimal self-regulation. This does not imply that a lack of caregiver support is the cause of children's difficulties, but without co-regulation a greater burden is placed on the child's own skills and capacities to achieve an adaptive level of regulation.

It is also possible for peers to provide co-regulation through "developmental relationships" (Search Institute, 2014) particularly as youth traverse adolescence and enter adulthood. In such relationships, a caring peer challenges and expands positive development through encouragement, modeling, guidance, and advocacy. Engaging in such proactive and cooperative relationships may build adolescents' interpersonal skills in a way that supports future relational success. However, adolescents should not be expected to independently provide co-regulation for their friends given their own developmental state and the complexity they face in navigating their own thoughts and feelings. Indeed, peers may have a negative influence on self-regulation by reinforcing risk taking, poor decision-making, and emotional and behavioral dysregulation (Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; Davey, Allen, Harrison, Dwyer, & Yücel, 2010). Caregiving adults should therefore assume responsibility for monitoring and facilitating peer relationships in a way that best supports self-regulation development.

Finally, interventions aimed at supporting caregiver co-regulation should also consider caregivers' own abilities to self-regulate (Shonkoff, 2012). To successfully co-regulate, caregivers must be able to pay attention to their own thoughts, feelings and reactions during stressful interactions with a child, youth, or young adult and use strategies to self-calm and respond effectively and compassionately. Caregivers may need support, practice, and coaching from friends, family or professionals to build their own coping and self-regulation skills, which in turn will aid them in promoting these skills for the children, youth, and young adults in their care.

Principle 6: Self-Regulation Can Be Disrupted by Prolonged or Pronounced Stress and Adversity in the Environment

This principle considers how environmental experiences like poverty and adversity, along with environmental systems like schools and neighborhoods, can influence underlying stress mechanisms within individuals, which then can interfere with self-regulation development. At the same time, environmental factors may be

‘protective’ and facilitate stress management, which then supports resilience in the face of adversity.

The Context of Poverty

Poverty is an environmental factor with a well-established-link to self-regulation (Raver et al., 2013). More specifically, poverty and its associated stressors (e.g., food insecurity, inconsistent or unstable living environments) have been related to a myriad of adverse childhood experiences that predict negative long-term health and economic effects (Felitti et al., 1998; Metzler, Merrick, Klevens, Ports, & Ford, 2017). One proposed mechanism of this link is the “psychology of scarcity,” which suggests that a lack of money, food, time, or even companionship may reduce one’s “mental bandwidth” or ability to focus, plan, and problem-solve (Mullainathan & Shafir, 2013). The stress, fatigue, and worries that can accompany living in poverty reduce the energy and resources available for self-regulation and co-regulation. Evidence of this effect from natural and laboratory experiments (Mani, Mullainathan, Shafir, & Zhao, 2013) suggests that individuals who appear to struggle with self-regulation under conditions of scarcity (e.g., living in poverty) may be just as capable as others when they have more wealth (Mullainathan, 2013). Poverty also appears to account for some of the few differences that have been found in self-regulation among children from minority backgrounds (Barbarin, 2013).

The Role of Toxic Stress

Poverty is one aspect of the environment that contributes to the experience of toxic stress. Although stress is a normal part of development and can teach children and youth to problem-solve and cope with typical challenges (Aspinwall & Taylor, 1997; Eisenberg, Fabes, & Guthrie, 1997), when stress exceeds what is tolerable because it is not buffered by caregivers or because it overwhelms a child’s self-regulation skills, it can have toxic effects (Shonkoff & Garner, 2012). As summarized by Shonkoff and Garner (2012), stress has a variety of physiological effects, including activation of the hypothalamic-pituitary-adrenocortical axis and the sympathetic-adrenomedullary system, which then increase levels of stress hormones, such as corticotropin-releasing hormone, cortisol, norepinephrine, and adrenaline. Excessively high levels or prolonged exposure to such hormones has deleterious effects on multiple organ systems, including the brain. Indeed, it can structurally alter areas of the brain involved in self-regulation, including the hippocampus, prefrontal cortex, and amygdala (McEwen, 2007).

Such stress can be chronic (such as that associated with poverty), or acute, such as might be associated with child maltreatment (Odgers & Jaffee, 2013). When an individual’s stress response system stays activated for extended periods of time, their baseline level of stress and ability to return to a calm state is altered, making them more reactive to changes in the environment and normal stressors (Fremont & Bird, 2000; McEwen & Wingfield, 2003; Miller, Chen, & Zhou, 2007). This may lead to increased emotional reactivity, i.e., a quicker or

more intense reaction to a stressor or reaction to a lower level stressor that may otherwise have been perceived as benign. This then increases the need to self-regulate while simultaneously making it more difficult to do so.

A recent review of the relationship between stress and self-regulation based on almost 400 studies (Hamoudi et al., 2015) summarizes the biologically toxic effects of stress on self-regulation in laboratory and observational studies of human development. Importantly for the model presented here, there is evidence that previous exposure to stress may sensitize individuals to have more difficulties self-regulating when faced with acute stress later (Cowan, Callaghan, & Richardson, 2013; Green et al., 2011). For children whose stress systems are continually activated by adversity, long-term disruptions in developing brain architecture may occur (Lupien, McEwen, Gunnar, & Heim, 2009; Shonkoff & Garner, 2012), leading to negative developmental outcomes (Boyce & Ellis, 2005). This may be buffered by decreasing stressors in the environment, strengthening a child's self-regulation skills, and/or fostering the level of adult support available for co-regulation that will buffer against the stress response; ideally all three approaches would be utilized in intervention.

The Influence of Schools, Neighborhoods, and Social Systems

The environment also plays a role in self-regulation development through the influence of social structures such as neighborhoods and schools. Schools have a critical influence on children and youth, with considerable evidence documenting the benefits of positive student–teacher relationships and positive discipline systems (Baker, Grant, & Morlock, 2008; Downer, Sabol, & Hamre, 2010). The effects of a well-managed and predictable classroom environment on children's self-regulation are evident even in high poverty neighborhoods (Raver et al., 2011). Supportive school environments can help children feel safe and secure, buffering them from the impact of stressors in other areas of their lives. In contrast, schools with bullying, violence, and harassment can negatively affect children's long-term adjustment (McEvoy & Welker, 2000). Children's self-regulation development may lag in schools with adverse environments defined by limited institutional resources, high teacher turnover rates, negative climate, and teachers with limited individual capacity for providing co-regulation (Samdal, Nutbeam, Wold, & Kannas, 1998; Wang & Holcombe, 2010).

Similarly, neighborhoods with high crime rates and a lack of resources for healthy child development such as safe play spaces, access to fresh foods, medical care, libraries, and economic stability are likely to impair the development of self-regulation (McCoy, Roy, & Raver, 2016; Shonkoff & Garner, 2012). High household instability is also found to be negatively related to certain aspects of children's self-regulation (McCoy & Raver, 2014). Finally, racial/ethnic discrimination or even implicit bias on the part of teachers or those in the community may negatively impact social-emotional and academic adjustment (Wong, Eccles, & Sameroff, 2003), factors related to self-regulation.

Principle 7: Self-Regulation Develops Over an Extended Period From Birth Through Young Adulthood (and Beyond)

Self-regulation capacity significantly increases across childhood (Raffaelli et al., 2005), through adolescence (Steinberg et al., 2008), and into early adulthood (Romer, Duckworth, Sznitman, & Park, 2010). There are rapid changes in areas of the brain associated with executive functioning during the first 5 years of life (Berger et al., 2007) and again during adolescence (Luciana, 2010). Given these changes and the varying self-regulation demands across development, intervention approaches need to be adjusted for children and youth of different ages just as they would for literacy instruction. Yet the underlying principles, particularly the importance of co-regulation across development, applies across age groups. To facilitate design of intervention programs and practice, this section therefore reviews key aspects of normative development of self-regulation processes at each age in order to specify implications for how caregivers (i.e., parents, teachers, child care providers, mentors, etc.) can promote skills development and enactment (summarized in Table 1).

Infancy

Developmental Processes There are early indicators of self-regulation in infancy such as orienting attention away from a stressor (Posner & Rothbart, 2007) or self-soothing through thumb-sucking (Stifter & Braungart, 1995); however, infants' emotions are largely stimulus-driven (Woltering & Lewis, 2009). The capacity to focus attention becomes more voluntary between 9 and 18 months of age (Ruff & Rothbart, 1996) when young children begin looking at their attachment figures for cues to respond to novel or ambiguous situations, a phenomenon called 'social referencing' (Campos & Stenberg, 1981).

Implications for Skills Promotion Given that self-regulation is largely dependent on external factors in infancy, interventions should focus on supporting caregivers' use of co-regulation strategies, i.e., modifying the environment to maintain manageable arousal levels and calming children when upset through physical comfort. In order for caregivers to provide this level of support and avoid inadvertently increasing infants' dysregulation through their own emotional distress, interventions that address caregivers' own self-regulation skills may also be needed. Existing self-regulation interventions for infants typically target those whose caregivers are identified as having some risk factors such as substance use, and are provided primarily through home visits (Murray et al., 2016), but there is clearly opportunity for larger-scale prevention through parent education programs.

Toddlerhood (Ages ~ 1–3 Years)

Developmental Processes Between 1 and 3 years of age, children greatly increase their ability to adjust behavior to achieve goals and meet behavioral expectations. Performance on attention switching and response inhibition tasks improves (Posner

Table 1 Self-regulation skills and processes and co-regulation supports across development

<p>Characteristics of self-regulation infancy (birth to ~ age 1)</p> <ul style="list-style-type: none"> • Orient attention away from stressors • Engage caregivers as resources for comfort • Begin to self-soothe 	<p>How caregivers can provide co-regulation</p> <ul style="list-style-type: none"> • Interact in warm and responsive ways • Anticipate and respond quickly to child's needs • Provide physical and emotional comfort when child is stressed • Modify environment to decrease demands and stress
<p>Characteristics of self-regulation toddlerhood (~ 1–2 years)</p> <ul style="list-style-type: none"> • Begin to select and shift attention (attentional control) • Adjust behavior to achieve simple goals • Delay gratification and inhibit responses for short periods when there is structure and support • Emotions are stronger than cognitive regulation • Feelings of attachment support prosocial goals 	<p>How caregivers can provide co-regulation</p> <ul style="list-style-type: none"> • Reassure and calm child when upset by removing child from situations or speaking calmly and giving affection • Model self-calming strategies • Teach rules and redirecting to regulate behavior
<p>Characteristics of self-regulation preschool years (~ ages 3–5)</p> <ul style="list-style-type: none"> • Focused attention increases but is still brief • Begin to use rules, strategies and planning to guide behavior appropriate to situation • Delay gratification and inhibit responses for longer periods • Perspective-taking and empathy support prosocial goals • Language begins to control emotional responses and actions • Tolerate some frustration and distress apart from caregiver (self-calming skills emerge) 	<p>How caregivers can provide co-regulation</p> <ul style="list-style-type: none"> • Model, prompt, and reinforce (or “coach”) self-calming strategies when child is upset • Instruct and coach use of words to express emotion and identify solutions to simple problems • Coach rule-following and task completion • Provide external consequences to support emerging self-regulation skills
<p>Characteristics of self-regulation middle childhood (~ ages 6–10)</p> <ul style="list-style-type: none"> • Use of cognitive strategies and internal speech to control behavior • Increased cognitive flexibility, attentional control, and more accurate appraisal of situations • Emerging ability to manage emotion “in the moment” • Empathy and concern for others may motivate behavior • Social problem-solving emerges • Increased ability to organize behavior in complex ways to achieve goals 	<p>How caregivers can provide co-regulation</p> <ul style="list-style-type: none"> • Teach problem-solving • Model conflict resolution strategies • Provide time, space, and support to manage emotions • Model, prompt, and reinforce (“coach”) organization and time management skills • Monitor task completion while encouraging independence and providing external consequences as needed

Table 1 (continued)

Characteristics of self-regulation early adolescence (ages ~ 11–14)	How caregivers can support co-regulation
<ul style="list-style-type: none"> • Increased focus and task completion • More goal-oriented behavior and self-monitoring • More complex behaviors and more independent time management • Use of strategies to manage distress • Emotional arousal stronger than cognitive controls • Strong reward-seeking with relatively low fear • Poor decisions made “in the moment” 	<ul style="list-style-type: none"> • Monitor and reinforce task completion as needed given the youth’s abilities and need for independence • Continue to coach organizational skills • Teach planning and prioritization • Collaboratively problem-solve social and academic issues • Coach healthy stress management • Encourage decision-making when less emotional • Review future goals • Set limits to reduce risks related to increased reward-seeking • Reduce the emotional intensity of interactions and situations exceeding coping skills
Characteristics of self-regulation later adolescence (ages ~ 15–17)	How caregivers can support co-regulation
<ul style="list-style-type: none"> • Focus and persist on complex and challenging tasks • More complex and independent planning, time management, and prioritization • Future orientation may influence behavior • Consideration of others’ perspectives in goal-setting • Making less emotional decisions • Managing distress more effectively with support 	<ul style="list-style-type: none"> • Monitor achievement of goals • Provide problem-solving support as needed • Prompt and reinforce effective time management and goal completion • Help anticipate difficult decisions before they arise • Encourage future perspective • Prompt and support healthy stress management • Reduce risks that may exceed coping skills or provide “safe” risks
Characteristics of self-regulation young adulthood (ages ~ 18–25)	How caregivers can support co-regulation
<ul style="list-style-type: none"> • Persist on long-term projects • Manage time independently • Self-monitor, self-reinforce, and overcome challenges to goals • Delay gratification to achieve goals • Future orientation begins to guide behavior • Make decisions with broader perspective and compassion for self and others • Organize complex behaviors in context and independently • Manage frustration and distress independently • Maintain emotional balance in response to normative stressors 	<ul style="list-style-type: none"> • Provide consultation on important decisions • Provide guidance for complex problem-solving • Provide support in coping with significant stressors and negotiating more complex life situations

& Rothbart, 2007), and the ability to delay gratification can be seen in laboratory activities such as those where children are asked not to peek during a gift-delay task (Carlson, 2009) and to wait to earn two marshmallows rather than one (Mischel et al., 2011). An increased sense of self, i.e., “knowing that I know” and “knowing that I feel” (Kopp, 2009) and understanding of the connection between action and goals also support the growth of self-regulation capacity at this age (Jennings et al., 2008). Emergent self-regulation skills include actively engaging parent/caregiver assistance in fearful or frustrating situations (Gross, 2002) and adjusting behavior

to achieve short-term goals. However, toddlers have strong emotions, and cognitive regulation skills are only just emerging. As a result, they typically require adult support to manage frustration and other strong emotions (Berger, 2011).

Implications for Skills Promotion Interventions at this age should continue to focus on caregivers' providing co-regulation through strategies such as removing a child who is upset to a quiet area and using a reassuring voice and calm touch, teaching feelings words and positive behavior expectations, and modeling self-regulation skills such as waiting. Typical interventions include parenting programs, which may be provided through agencies such as Early Head Start, often targeting young children living in adverse environments (Murray et al., 2016).

Preschool Years (~ 3–5 Years)

Developmental Processes Between 3 and 5 years of age, dramatic development occurs in children's self-regulation abilities, during what is considered the greatest period of brain "plasticity" (Berger, 2011). During this time period, children's performance greatly increases on a range of executive functioning tasks assessing working memory, delay of gratification, and response inhibition (Kannass, Oakes, & Shaddy, 2006). This appears related to the ability to integrate two attentional systems, selective attention and set shifting (Garon, Bryson, & Smith, 2008), a critical milestone in cognitive regulation capacity. This ability underlies cognitive flexibility and perspective-taking and supports emotion regulation (Rueda, Posner, & Rothbart, 2004) by enabling children to provide more deliberate and reflective responses (Woltering & Lewis, 2009). Relatedly, preschoolers become better able to use rules, strategies and plans to guide their behavior and match their behavior to the context (Zelazo et al., 2003). Perspective-taking is supported by the development of "theory of mind" (i.e., the ability to attribute beliefs, intention, desire, etc. to oneself and others and to recognize that others may have different mental states), which fosters empathy and motivates prosocial behaviors with peers and parents (Kopp, 2009).

Another critical process in self-regulation development with intervention implications is the increase in language abilities during the preschool years, which mediates behavior and helps manage emotions (Bryck & Fisher, 2012; Carlson, 2003; Carlson & Beck, 2009). Language skills enable children to understand directions and rationales for desired behavior, and facilitate self-reflection and interpersonal communication including negotiating parental demands and resolving disputes with peers. The relationship between children's expressive and receptive verbal abilities and executive functioning and impulse control is well-established (Matte-Gagné & Bernier, 2011).

Implications for Skills Promotion Due to increased cognitive abilities, preschoolers can be taught simple strategies to delay gratification, calm down, solve problems, and achieve goals (Garon et al., 2008), making skills instruction interventions very relevant. However, such strategies should involve linear steps such as stopping, looking and listening (Kopp, 2009), and should be brief given preschoolers' limited attention spans (Ruff & Capozzoli, 2003). Given that preschoolers' emotions easily disrupt their goal-oriented behaviors, caregivers need to repeatedly model, teach, and reinforce skills that target emotion regulation at this age (Bernier, Carlson,

Deschênes, & Matte-Gagné, 2012). For example, caregivers may provide labels for observed emotions, demonstrate taking deep breaths to calm down, and prompt use of self-talk when waiting. In addition, caregivers need to provide external structure and clear, consistent consequences for using self-regulation skills to encourage motivation for enactment. Existing interventions address both skills-instruction and co-regulation supports, with several well-established social-emotional curricula and parenting programs available (Murray et al., 2016).

Middle Childhood (~ 6–10 Years)

Developmental Processes Notable growth in self-regulation continues until around age seven (Rueda et al., 2004), followed by a more stable period of development during middle childhood (Raffaelli et al., 2005). As summarized in Berger (2011), early elementary-aged children demonstrate increased control of their emotions and behavior, with further neurocognitive maturation and integration of emotional and cognitive systems (Mischel, Shoda, & Rodriguez, 1989) supporting the capacity for skills building. Critical to this increased regulation is the use of internal speech and the development of meta-cognition, or the ability to reflect on one's own thinking processes. This allows children to be more conscious of their behavior and make more deliberate decisions. Increased cognitive flexibility, inhibition, and attentional control contribute to the ability to reason, manage emotions "in the moment," organize behavior for simple, routine tasks, and exhibit socially appropriate behavior in more complex situations. These executive functioning abilities support social competence, which requires that children understand and respond to others' goals, perceptions, and beliefs; self-monitor and inhibit inappropriate behavior; and plan and change behavior based upon feedback (Carlson & Moses, 2001).

Implications for Skills Promotion With regard to self-regulation interventions, more complex cognitive modification and problem-solving approaches, and even mindfulness techniques, can be taught in elementary school, such as those used in a large number of recently reviewed programs (Murray et al., 2016). Although self-regulation becomes more independent from parental influence at this age (Zalewski, Lengua, Wilson, Trancik, & Bazinet, 2011), co-regulation remains critical for children to manage challenging emotions, organize themselves to be successful in school, and achieve goals in other areas of their lives. Ideally, caregivers should allow children time and space to make some decisions related to their interests and preferences and self-monitor tasks like homework, while providing structure, coaching, and consequences as needed.

Early Adolescence (~ 11–14 Years)

Developmental Processes Adolescence has become recognized as a second critical period of developmental plasticity (Steinberg, 2010). Neurobiological changes supporting increased functional efficiency in the prefrontal cortex are particularly dramatic between approximately 11–14 years of age (Luciana, 2010), coinciding with the onset of puberty. These brain changes enhance information processing, attentional control, and problem-solving capacity (Eldreth, Hardin, Pavletic, & Ernst,

2013), which are necessary for complex decision-making, completion of multi-step tasks, and long-term goal attainment. At the same time, reward-seeking emotional systems related to increased dopamine activity are stronger than cognitive regulation systems (Steinberg, 2012), and stress reactivity is enhanced (Romeo, 2010), leading to increased risk taking and emotionality. Thus, despite adolescents' growing cognitive regulation abilities, self-regulation is viewed as "out of balance" at this age (Bradshaw, Goldweber, Fishbein, & Greenberg, 2012; Steinberg, 2010). This contributes to engagement in risk behaviors such as substance use, which can create lasting structural and functional changes in the brain that further interfere with effective self-regulation (Squeglia, Jacobus, & Tapert, 2009).

Coincidental with these neurobiological changes, there are increased self-regulatory demands and changes in social context during early adolescence. School-related stress increases, particularly around the transition to middle school (Jacobshagen, Rigotti, Semmer, & Mohr, 2009) and there is increased time spent with peers and less adult supervision. Of particular concern is that the presence of peers increases emotional arousal (Steinberg, 2012) and changes perceptions of risk and reward (Steinberg & Monahan, 2007) in a manner that contributes to poor decisions and impulsive behaviors (Chein et al., 2011). Peer interactions and perceptions of being liked also activate regions of the brain associated with incentive processing (Chein et al., 2011; Davey et al., 2010).

Implications for Skills Promotion Self-regulation interventions at this age should ideally include caregiver monitoring to reduce youths' exposure to risk situations, support for stress management skills, and scaffolding around more complex organizational and planning tasks. Interventions at this age should also consider the role of peers, who in addition to negative influences, also have potential to strengthen self-regulation skills through proactive and supportive "developmental relationships" (Search Institute, 2014). Skills-focused interventions should attend to emotional regulation skills in addition to goal-setting and problem-solving; emotion regulation is not a strong focus in existing interventions for adolescents, perhaps contributing to the lowered efficacy of programs in early adolescence relative to those for younger children (Murray et al., 2016).

Later Adolescence (~ 15–17 Years)

Developmental Processes Continued developmental growth is seen in inhibitory control and its structural and functional neural substrates throughout adolescence (Eldreth et al., 2013). By age 15–16, cognitive maturity as measured by many indicators is comparable to that of adults (Steinberg, 2014), yet underlying regulatory and motivational processes contribute to reward sensitivity, sensation seeking, and reduced avoidance (Cauffman et al., 2010; Steinberg et al., 2009). Thus, although older adolescents are capable of delaying gratification for relatively long periods of time and engaging in goal-oriented behavior with increased internalization of external demands and expectations (Bradshaw et al., 2012), they are not always effective in managing high levels of emotional arousal or distress. This contributes to risky

decision-making, particularly in the context of peers as previously noted (Steinberg, 2014).

Implications for Skills Promotion One important implication for interventions at this age is that reward sensitivity might be leveraged to strengthen inhibitory controls (especially social rewards related to peer regard or status), which is not an approach that adolescent prevention programs have typically adopted (Bradshaw et al., 2012; Eldreth et al., 2013). Rather, many existing self-regulation interventions for high schoolers rely heavily on cognitive skills approaches that support planning and problem-solving or are more diffuse (e.g., leadership or stress management programs) and not well-aligned with current self-regulation theories. This is particularly salient in the area of emotion regulation, given the increased saliency of developmental tasks related to intimacy and sexuality during adolescence (Steinberg, 2014). In addition to skills instruction, adolescents continue to benefit from some structure and adult support around tasks such as creating and implementing plans to achieve longer-term goals, complex decision-making, healthy stress management, and monitoring risky behavior. The importance of interventions in adolescence is underscored by data showing that experiences at this age shape neuronal pathways that set the stage for long-term risk and resilience (Zeigler et al., 2005).

Young (Emerging) Adulthood (~ 18–25 Years)

Developmental Processes Although neurocognitive plasticity decreases during adulthood, there is evidence that maturation of the frontal cortex is not complete until the third decade of life (Steinberg et al., 2008). Relative to adolescents, young adults demonstrate increased neural activity in areas of the brain associated with complex cognitive processes such as reappraisal (McRae et al., 2012) and are more effective in regulating negative emotions (Silvers et al., 2012). Yet connections between regions of the brain involved in emotional learning and executive decision-making are still maturing (Kelley, Schochet, & Landry, 2004), contributing to ongoing risk taking and novelty seeking. Self-regulation difficulties at this age have been related to substance use (Griffin, Lowe, Acevedo, & Botvin, 2015; Kuvaas, Dvorak, Pearson, Lamis, & Sargent, 2014), sexual risk-taking (Moilanen, 2015), physical activity (Zhou, Wang, Knoll, & Schwarzer, 2016) and emotional eating in college-aged youth (Tan & Chow, 2014).

During young adulthood, there are also a range of complex and demanding tasks that require executive functioning skills, including completing a technical or post-secondary degree and starting a career, financially supporting and managing independent living, and for some, caring for a child or dealing with military service. Coping with these normative challenges and establishing healthy, lasting intimate relationships also requires effective emotion regulation. All of these transitions can compromise regulatory success, even for those with well-developed self-regulation skills. Given these demands, self-regulation supports at this age remain relevant, particularly for those who are developmentally vulnerable who also tend to experience the most stressors (e.g., early pregnancy, school or job failures).

Implications for Skills Promotion There are continued opportunities for promoting self-regulation in young adulthood that may have been previously unrecognized (Steinberg, 2014). In order to navigate this transition period successfully, young adults need consultation and guidance in making important decisions (e.g., related to post-secondary education, jobs) and solving complex problems (e.g., conflicts or challenges at work or in relationships, managing finances to support independent living). They may also need support in coping with significant stressors when they arise (e.g., relationship break-up, being fired). As such, co-regulation from caring adults, mentors, and partners in intimate relationships remain relevant (Hofmann, Finkel, & Fitzsimons, 2015; Sbarra & Hazan, 2008).

Research on self-regulation interventions for young adults is relatively limited, particularly for risk populations (Murray et al., 2016). However, a number of promising approaches are being explored (Blair & Raver, 2014), including mobility mentoring to strengthen executive functioning (Babcock, 2012), attention bias modification training, implementation intentions with mental contrasting (Gollwitzer & Sheeran, 2006; Oettingen, Pak, & Schnetter, 2001), and mindfulness interventions (Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010; Kabat-Zinn, 1999; Segal, Williams, & Teasdale, 2002).

Implications for Public Health and Future Research

This paper presents our newly-developed Self-Regulation Promotion Model for promoting self-regulation across development based on theoretical and empirical support, including cross-disciplinary research on self-regulation processes. This model includes three key approaches depicted in Fig. 1: (1) Teach self-regulation skills, (2) Build a supportive environment, and (3) Provide “co-regulation,” with the understanding that each of these approaches depends on the relationships that children and youth have with caregivers. We believe this approach holds potential for substantively strengthening self-regulation skills across development and thereby enhancing wellbeing on a population level, particularly if promotion is systematically implemented across settings and developmental stages. We have also distilled numerous, complex self-regulation concepts into seven principles that we hope will facilitate communication about self-regulation promotion across researchers, practitioners, and policy makers and support our public health goal of promoting self-regulation just as we build literacy.

Implications for Broad Intervention

Based on our seven principles, we have a few key recommendations to promote self-regulation from a public health perspective:

1. Caregivers (e.g., parents, teachers, mentors, etc.) should be actively engaged in systematically and intentionally teaching self-regulation across development, not just during early childhood. Analogous to promoting literacy, this involves

universal supports across multiple contexts, and direct and proactive instruction across developmental stages that builds in complexity over time and is adaptive to situational demands, with intervention adjustment as needed to meet the needs of specific children and youth. Such an approach may require that caregivers understand the impact of adversity on self-regulation capacity and enactment. For older youth, the role of peers and romantic partners in co-regulation should also be explored.

2. Caregivers should likewise identify opportunities for promoting self-regulation in children's day-to-day lives, outside of the context of specific time-limited intervention programs. In particular, this should involve building and maintaining warm responsive relationships; providing safe, supportive, and consistent home and school environments; and modeling and coaching self-regulation in situations as they arise (i.e., providing "co-regulation"). The co-regulation provided by caregivers across contexts should be sensitive to the developmental stages of children and youth, providing warm supportive relationships that encourage navigation through increasingly complex situational demands in light of competing motivations and long-term goals.
3. Individually-focused interventions that include prevention and promotion should target both emotion regulation and cognitive regulation, with particular attention to emotional awareness and acceptance, which promote prosocial behavior and interpersonal connections. The approach for this strategy should include strategies for traversing the predictable environments with long-term consequences that youth will encounter given their increasing freedom and responsibility.
4. Multi-level interventions should also work towards reducing sources of toxic stress in the environment (e.g., abuse, poverty) that may overwhelm the ability of children and youth to self-regulate and limit the benefit of interventions focused on skills instruction. Children and youth in these contexts may also need more intensive skills instruction and co-regulation support in order to effectively enact self-regulation.
5. Policy makers and communities should utilize social policies to create social environments for children and youth (e.g., within schools, extracurricular activities, child care settings) that support wellbeing, including self-regulation enactment across developmental phases. This would include creating a culture and norms that value and promote delay of gratification and healthy stress management strategies, among other self-regulation skills. Policy could also reduce excessive self-regulation demands by structuring environments for youth (e.g., through consistent and predictable routines and expectations, incentives for self-regulation, ensuring youth are safe and supervised as needed, and instituting laws that reduce excessive risk situations) and more fully preparing them for upcoming predictable developmental tasks (e.g., productive use of leisure time; decision-making related to intimacy and sexual health).

Future Research Agenda

This work suggests several next steps in self-regulation intervention research. First, although we have strong theoretical support for our recommended approach of combining skills instruction and co-regulation, data supporting their additive value is lacking. Second, methods for teaching co-regulation to caregivers, particularly caregivers for older youth, need to be developed and validated. Such research should also address strategies to support caregivers' own self-regulation capacity, which may be needed for them to support youths' self-regulation development. Third, it is unclear whether interventions provided at particular developmental periods (e.g., early childhood, adolescence) may provide greater benefits than those at other ages, or what type of "booster" supports may be needed and for whom. Self-regulation intervention research for adolescents and young adults also has many gaps warranting further research, including limited consideration of important developmental processes like reward sensitivity and peer influence and a lack of focus on outcomes related to employment goals and negotiating healthy relationships. Finally, rigorous implementation research is needed to determine how to coordinate broader interventions across time and systems and how to integrate these (or enhance existing programs) within educational, human service and mental health organizations.

There are also several questions and areas where more research is needed regarding self-regulation mechanisms that have important implications for intervention. Specifically, more work is needed on the causes of variation in stress reactivity across individuals, to determine if specific developmental periods are more or less sensitive to stress, and identify how environmental protective factors beyond parenting (e.g., supportive schools and teachers) may buffer the long-term impact of stress on children and youth.

Conclusions

To truly promote self-regulation like literacy as a public health goal, it will be necessary to obtain stakeholder buy-into the importance of providing systematic and intentional supports to enhance the way in which caregivers interact with children and youth in day-to-day contexts. Funders and policymakers will need to coordinate intervention systems across settings and developmental stages. Local and national partnerships are needed across human services agencies, out-of-school programs and public school systems to provide systematic skills instruction while simultaneously building supports for co-regulation and social norms for self-regulation enactment from early childhood through young adulthood.

In sum, we hope this work will encourage prevention scientists to move beyond designing and studying specific interventions to examining the systems and structures that impact children (e.g., child care, schools, family and youth programs, media), where small shifts towards more supportive contexts could result in measurable enhancements. Similarly, reducing exposure to stress and adversity, which disrupt self-regulation development, could have a powerful impact. Building understanding of such a comprehensive multi-level approach to public health—where

responsibility for promoting self-regulation enactment is shared by families, schools, and adults in the broader community—could have significant benefits for the well-being of children, youth, and young adults across multiple areas of functioning.

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Compliance With Ethical Standards

Conflict of Interest Dr. Murray has received research grants from the Institute of Education Sciences to develop and evaluate self-regulation interventions. She receives compensation for consulting with the Office of Planning Research and Evaluation (OPRE) in the Administration for Children and Families (DHHS) and Public Strategies, Inc. in applying some of the concepts presented in this paper. She is also a trained mentor in the Incredible Years Teacher Classroom Management Program, and receives compensation from community organizations for providing trainings and consultation. Dr. Meyer oversaw the work presented in this paper in her role as a senior social science research analyst at OPRE. She also serves on the Editorial Board for the Journal of Primary Prevention. None of the other authors has any conflicts of interest to disclose.

References

- Anderson, P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology*, 8(2), 71–82. <https://doi.org/10.1076/chin.8.2.71.8724>.
- Aspinwall, L. G., & Taylor, S. E. (1997). A stitch in time: Self-regulation and proactive coping. *Psychological Bulletin*, 121(3), 417–436. <https://doi.org/10.1037/0033-2909.121.3.417>.
- Babcock, E. D. (2012). *Mobility mentoring*. Retrieved January 11, 2018 from <http://s3.amazonaws.com/empath-website/pdf/Research-MobilityMentoring-0512.pdf>.
- Baker, J. A., Grant, S., & Morlock, L. (2008). The teacher-student relationship as a developmental context for children with internalizing or externalizing behavior problems. *School Psychology Quarterly*, 23(1), 3. <https://doi.org/10.1037/1045-3830.23.1.3>.
- Barbarin, O. (2013). A longitudinal examination of socioemotional learning in African American and Latino boys across the transition from pre-K to kindergarten. *The American Journal of Orthopsychiatry*, 83(2 Pt 3), 156–164. <https://doi.org/10.1111/ajop.12024>.
- Baumeister, R. F., & Vohs, K. D. (2007). Self-regulation, ego depletion, and motivation. *Social and Personality Psychology Compass*, 1(1), 115–128. <https://doi.org/10.1111/j.1751-9004.2007.00001.x>.
- Bell, M. A., & Deater-Deckard, K. (2007). Biological systems and the development of self-regulation: Integrating behavior, genetics, and psychophysiology. *Journal of Developmental and Behavioral Pediatrics*, 28(5), 409–420. <https://doi.org/10.1097/DBP.0b013e31811131fc7>.
- Berger, A. (2011). *Self-regulation: Brain, cognition, and development*. Washington, DC: American Psychological Association.
- Berger, A., Kofman, O., Livneh, U., & Henik, A. (2007). Multidisciplinary perspectives on attention and the development of self-regulation. *Progress in Neurobiology*, 82(5), 256–286. <https://doi.org/10.1016/j.pneurobio.2007.06.004>.
- Bernier, A., Carlson, S. M., Deschênes, M., & Matte-Gagné, C. (2012). Social factors in the development of early executive functioning: A closer look at the caregiving environment. *Developmental Science*, 15(1), 12–24. <https://doi.org/10.1111/j.1467-7687.2011.01093.x>.
- Biglan, A., Flay, B. R., Embry, D. D., & Sandler, I. N. (2012). The critical role of nurturing environments for promoting human well-being. *American Psychologist*, 67(4), 257–271. <https://doi.org/10.1037/a0026796>.

- Bishop, S. J., Cohen, J. D., Fossella, J., Casey, B. J., & Farah, M. J. (2006). COMT genotype influences prefrontal response to emotional distraction. *Cognitive, Affective & Behavioral Neuroscience*, 6(1), 62–70. <https://doi.org/10.3758/CABN.6.1.62>.
- Blair, C. (2010). Stress and the development of self-regulation in context. *Child Development Perspectives*, 4(3), 181–188. <https://doi.org/10.1111/j.1750-8606.2010.00145.x>.
- Blair, C., & Raver, C. C. (2014). Closing the achievement gap through modification of neurocognitive and neuroendocrine function: Results from a cluster randomized controlled trial of an innovative approach to the education of children in kindergarten. *PLoS ONE*, 9(11), e112393. <https://doi.org/10.1371/journal.pone.0112393>.
- Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development*, 78(2), 647–663. <https://doi.org/10.1111/j.1467-8624.2007.01019.x>.
- Blair, C., & Ursache, A. (2011). A bidirectional theory of executive functions and self-regulation. In K. Vohs & R. Baumeister (Eds.), *Handbook of self-regulation* (2nd ed., pp. 300–320). New York: Guilford Press.
- Boyce, W. T., & Ellis, B. J. (2005). Biological sensitivity to context: I. An evolutionary-developmental theory of the origins and functions of stress reactivity. *Development and Psychopathology*, 17(2), 271–301. <https://doi.org/10.1017/S0954579405050145>.
- Bradshaw, C. P., Goldweber, A., Fishbein, D., & Greenberg, M. T. (2012). Infusing developmental neuroscience into school-based preventive interventions: Implications and future directions. *The Journal of Adolescent Health*, 51(2 Suppl), S41–S47. <https://doi.org/10.1016/j.jadohealth.2012.04.020>.
- Braungart, J. M., Fulker, D. W., & Plomin, R. (1992). Genetic mediation of the home environment during infancy: A sibling adoption study of the HOME. *Developmental Psychology*, 28(6), 1048–1055. <https://doi.org/10.1037/0012-1649.28.6.1048>.
- Bretherton, I., Fritz, J., Zahn-Waxler, C., & Ridgeway, D. (1986). Learning to talk about emotions: A functionalist perspective. *Child Development*, 57(3), 529. <https://doi.org/10.2307/1130334>.
- Bronfenbrenner, U. (1979). *The ecology of human development*. Cambridge: Harvard University Press. (illustrated, reprint, revised).
- Bryck, R. L., & Fisher, P. A. (2012). Training the brain: Practical applications of neural plasticity from the intersection of cognitive neuroscience, developmental psychology, and prevention science. *The American Psychologist*, 67(2), 87–100. <https://doi.org/10.1037/a0024657>.
- Buckner, J. C., Mezzacappa, E., & Beardslee, W. R. (2009). Self-regulation and its relations to adaptive functioning in low income youths. *The American Journal of Orthopsychiatry*, 79(1), 19–30. <https://doi.org/10.1037/a0014796>.
- Campos, J. J., Barrett, K. C., Lamb, M. E., Goldsmith, H. H., & Stenberg, C. (1983). Socioemotional development. In E. H. Mussen (Ed.), *Infancy and developmental psychobiology* (pp. 783–915). New York: Wiley.
- Campos, J. J., & Stenberg, C. R. (1981). Perception, appraisal and emotion: The onset of social referencing. In M. E. Lamb & L. R. Sherrod (Eds.), *Infant social cognition* (pp. 273–310). Hillsdale, NJ: Erlbaum.
- Canli, T., Omura, K., Haas, B. W., Fallgatter, A., Constable, R. T., & Lesch, K. P. (2005). Beyond affect: A role for genetic variation of the serotonin transporter in neural activation during a cognitive attention task. *Proceedings of the National Academy of Sciences of the United States of America*, 102(34), 12224–12229. <https://doi.org/10.1073/pnas.0503880102>.
- Carlson, S. M. (2003). Executive function in context: Development, measurement, theory, and experience. *Monographs of the Society for Research in Child Development*, 68(3), 138–151. <https://doi.org/10.1111/j.1540-5834.2003.06803012.x>.
- Carlson, S. M. (2009). Social origins of executive function development. *New Directions for Child and Adolescent Development*, 123, 87–98. <https://doi.org/10.1002/cd.237>.
- Carlson, S. M., & Beck, D. M. (2009). Symbols as tools in the development of executive function. In A. Winsler, C. Fernyhough, & I. Montero (Eds.), *Private speech, executive functioning, and the development of verbal self-regulation*. Cambridge: Cambridge University Press.
- Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development*, 72, 1032–1053. <https://doi.org/10.1111/1467-8624.00333>.
- Carver, C. S., & Scheier, M. F. (1982). Control theory: A useful conceptual framework for personality-social, clinical, and health psychology. *Psychological Bulletin*, 92(1), 111–135. <https://doi.org/10.1037//0033-2909.92.1.111>.

- Cauffman, E., Shulman, E. P., Steinberg, L., Claus, E., Banich, M. T., Graham, S., et al. (2010). Age differences in affective decision making as indexed by performance on the Iowa Gambling Task. *Developmental Psychology*, *46*(1), 193–207. <https://doi.org/10.1037/a0016128>.
- Chein, J., Albert, D., O'Brien, L., Uckert, K., & Steinberg, L. (2011). Peers increase adolescent risk taking by enhancing activity in the brain's reward circuitry. *Developmental Science*, *14*(2), F1–F10. <https://doi.org/10.1111/j.1467-7687.2010.01035.x>.
- Ciairano, S., Visu-Petra, L., & Settanni, M. (2007). Executive inhibitory control and cooperative behavior during early school years: A follow-up study. *Journal of Abnormal Child Psychology*, *35*(3), 335–345. <https://doi.org/10.1007/s10802-006-9094-z>.
- Clark, R. E., & Saxberg, B. (2018). Engineering motivation using the belief-expectancy-control framework. *Interdisciplinary Education and Psychology*, *2*(1), 1–26. <https://doi.org/10.31532/InterdiscipEducPsychol.2.1.004>.
- Coie, J. D., & Dodge, K. A. (1998). Aggression and antisocial behavior. In N. Eisenberg & W. Damon (Eds.), *Handbook of child psychology: Social, emotional, and personality development* (Vol. 3, pp. 779–862). New York: Wiley.
- Cowan, C. S. M., Callaghan, B. L., & Richardson, R. (2013). Acute early-life stress results in premature emergence of adult-like fear retention and extinction relapse in infant rats. *Behavioral Neuroscience*, *127*(5), 703–711. <https://doi.org/10.1037/a0034118>.
- Davey, C. G., Allen, N. B., Harrison, B. J., Dwyer, D. B., & Yücel, M. (2010). Being liked activates primary reward and midline self-related brain regions. *Human Brain Mapping*, *31*(4), 660–668. <https://doi.org/10.1002/hbm.20895>.
- Davissou, E. K., & Hoyle, R. H. (2017). The social-psychological perspective on self-regulation. In T. Egner (Ed.), *The Wiley handbook of cognitive control* (pp. 440–453). Chichester: Wiley. <https://doi.org/10.1002/9781118920497.ch25>.
- Deater-Deckard, K., Petrill, S. A., Thompson, L. A., & DeThorne, L. S. (2005). A cross-sectional behavioral genetic analysis of task persistence in the transition to middle childhood. *Developmental Science*, *8*(3), F21–F26. <https://doi.org/10.1111/j.1467-7687.2005.00407.x>.
- Diamond, A. (2012). Activities and programs that improve children's executive functions. *Current Directions in Psychological Science: A Journal of the American Psychological Society*, *21*(5), 335–341. <https://doi.org/10.1177/0963721412453722>.
- Dishion, T. J., & Connell, A. (2006). Adolescents' resilience as a self-regulatory process: Promising themes for linking intervention with developmental science. *Annals of the New York Academy of Sciences*, *1094*, 125–138. <https://doi.org/10.1196/annals.1376.012>.
- Downer, J., Sabol, T. J., & Hamre, B. (2010). Teacher-child interactions in the classroom: Toward a theory of within and cross-domain links to children's developmental outcomes. *Early Education and Development*, *21*(5), 699–723. <https://doi.org/10.1080/10409289.2010.497453>.
- Duckworth, A. L., & Seligman, M. E. P. (2005). Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychological Science*, *16*(12), 939–944. <https://doi.org/10.1111/j.1467-9280.2005.01641.x>.
- Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. *Child Development*, *82*(1), 405–432. <https://doi.org/10.1111/j.1467-8624.2010.01564.x>.
- Dweck, C. S. (2008). *Mindset: The new psychology of success*. New York: Random House Digital Inc.
- Eisenberg, N., Fabes, R. A., & Guthrie, I. K. (1997). Coping with stress: The role of regulation and development. In S. A. Wolchik & I. N. Sandler (Eds.), *Handbook of children's coping: Linking theory and intervention* (pp. 41–70). New York: Plenum Press.
- Eisenberg, N., Spinrad, T. L., & Eggum, N. D. (2010). Emotion-related self-regulation and its relation to children's maladjustment. *Annual Review of Clinical Psychology*, *6*, 495–525. <https://doi.org/10.1146/annurev.clinpsy.121208.131208>.
- Eisenberg, N., & Zhou, Q. (2016). Conceptions of executive function and regulation: When and to what degree do they overlap? In J. A. Griffin, P. McCardle, & L. S. Freund (Eds.), *Executive function in preschool-age children: Integrating measurement, neurodevelopment, and translational research* (pp. 115–136). Washington: American Psychological Association. <https://doi.org/10.1037/14797-006>.
- Eldredh, D., Hardin, M. G., Pavletic, N., & Ernst, M. (2013). Adolescent transformations of behavioral and neural processes as potential targets for prevention. *Prevention Science: The Official Journal of the Society for Prevention Research*, *14*(3), 257–266. <https://doi.org/10.1007/s1121-012-0322-1>.

- Ernst, M., Pine, D. S., & Hardin, M. (2006). Triadic model of the neurobiology of motivated behavior in adolescence. *Psychological Medicine*, *36*(3), 299–312. <https://doi.org/10.1017/S0033291705005891>.
- Evans, C. A., & Porter, C. L. (2009). The emergence of mother-infant co-regulation during the first year: Links to infants' developmental status and attachment. *Infant Behavior & Development*, *32*(2), 147–158. <https://doi.org/10.1016/j.infbeh.2008.12.005>.
- Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., et al. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventive Medicine*, *14*(4), 245–258. [https://doi.org/10.1016/S0749-3797\(98\)00017-8](https://doi.org/10.1016/S0749-3797(98)00017-8).
- Fogel, A., & Garvey, A. (2007). Alive communication. *Infant Behavior & Development*, *30*(2), 251–257. <https://doi.org/10.1016/j.infbeh.2007.02.007>.
- Francis, L. A., & Susman, E. J. (2009). Self-regulation and rapid weight gain in children from age 3 to 12 years. *Archives of Pediatrics and Adolescent Medicine*, *163*(4), 297–302. <https://doi.org/10.1001/archpediatrics.2008.579>.
- Fremont, A. M., & Bird, C. E. (2000). Social and psychological factors, physiological processes, and physical health. In C. E. Bird, P. Conrad, & A. M. Fremont (Eds.), *Handbook of medical sociology* (5th ed., pp. 334–364). Upper Saddle River, NJ: Prentice Hall.
- Garland, E. L., Boettiger, C. A., & Howard, M. O. (2011). Targeting cognitive-affective risk mechanisms in stress-precipitated alcohol dependence: An integrated, biopsychosocial model of automaticity, allostasis, and addiction. *Medical Hypotheses*, *76*(5), 745–754. <https://doi.org/10.1016/j.mehy.2011.02.014>.
- Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, *134*(1), 31–60. <https://doi.org/10.1037/0033-2909.134.1.31>.
- Goldsmith, H. H., Buss, K. A., & Lemery, K. S. (1997). Toddler and childhood temperament: Expanded content, stronger genetic evidence, new evidence for the importance of environment. *Developmental Psychology*, *33*(6), 891–905. <https://doi.org/10.1037/0012-1649.33.6.891>.
- Goldsmith, H. H., Pollak, S. D., & Davidson, R. J. (2008). Developmental neuroscience perspectives on emotion regulation. *Child Development Perspectives*, *2*(3), 132–140. <https://doi.org/10.1111/j.1750-8606.2008.00055.x>.
- Goldstein, S., Naglieri, J. A., Princiotta, D., & Otero, T. M. (2014). Introduction: A history of executive functioning as a theoretical and clinical construct. In S. Goldstein & J. A. Naglieri (Eds.), *Handbook of executive functioning* (pp. 3–12). New York: Springer. https://doi.org/10.1007/978-1-4614-8106-5_1.
- Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. In M. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 38, pp. 69–119). Amsterdam: Elsevier. [https://doi.org/10.1016/s0065-2601\(06\)38002-1](https://doi.org/10.1016/s0065-2601(06)38002-1).
- Green, M. K., Rani, C. S. S., Joshi, A., Soto-Piña, A. E., Martinez, P. A., Frazer, A., et al. (2011). Prenatal stress induces long term stress vulnerability, compromising stress response systems in the brain and impairing extinction of conditioned fear after adult stress. *Neuroscience*, *192*, 438–451. <https://doi.org/10.1016/j.neuroscience.2011.06.041>.
- Greenberg, M. T. (2006). Promoting resilience in children and youth: Preventive interventions and their interface with neuroscience. *Annals of the New York Academy of Sciences*, *1094*, 139–150. <https://doi.org/10.1196/annals.1376.013>.
- Griffin, K. W., Lowe, S. R., Acevedo, B. P., & Botvin, G. J. (2015). Affective self-regulation trajectories during secondary school predict substance use among urban minority young adults. *Journal of Child & Adolescent Substance Abuse*, *24*(4), 228–234. <https://doi.org/10.1080/1067828X.2013.812530>.
- Grolnick, W. S., & Farkas, M. (2002). Parenting and the development of children's self-regulation. *Handbook of Parenting*, *5*, 89–110.
- Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology*, *39*(3), 281–291. <https://doi.org/10.1017/S0048577201393198>.
- Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: A meta-analysis. *Psychological Bulletin*, *136*(4), 495–525. <https://doi.org/10.1037/a0019486>.
- Hamoudi, A., Murray, D. W., Sorenson, L., & Fontaine, A. (2015). *Self-regulation and toxic stress: A review of ecological, biological, and developmental studies of self-regulation and stress* (OPRE

- report no. 2015-30). Washington, DC: Office of Planning, Research and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services.
- Han, Z. R., & Shaffer, A. (2013). The relation of parental emotion dysregulation to children's psychopathology symptoms: The moderating role of child emotion dysregulation. *Child Psychiatry and Human Development*, 44(5), 591–601. <https://doi.org/10.1007/s10578-012-0353-7>.
- Heatherington, T. F., & Wagner, D. D. (2011). Cognitive neuroscience of self-regulation failure. *Trends in Cognitive Sciences*, 15(3), 132–139. <https://doi.org/10.1016/j.tics.2010.12.005>.
- Higgins, E. T. (1989). Continuities and discontinuities in self-regulatory and self-evaluative processes: A developmental theory relating self and affect. *Journal of Personality*, 57(2), 407–444. <https://doi.org/10.1111/j.1467-6494.1989.tb00488.x>.
- Hofmann, W., Finkel, E. J., & Fitzsimons, G. M. (2015). Close relationships and self-regulation: How relationship satisfaction facilitates momentary goal pursuit. *Journal of Personality and Social Psychology*, 109(3), 434–452. <https://doi.org/10.1037/pspi0000020>.
- Holt-Lunstad, J., Robles, T. F., & Sbarra, D. A. (2017). Advancing social connection as a public health priority in the United States. *The American Psychologist*, 72(6), 517–530. <https://doi.org/10.1037/amp0000103>.
- Hoyle, R. H., & Gallagher, P. (2015). The interplay of personality and self-regulation. In M. Mikulincer, P. R. Shaver, M. L. Cooper, & R. J. Larsen (Eds.), *APA handbook of personality and social psychology* (Vol. 4, pp. 189–207)., Personality processes and individual differences Washington: American Psychological Association. <https://doi.org/10.1037/14343-009>.
- Jacobshagen, N., Rigotti, T., Semmer, N. K., & Mohr, G. (2009). Irritation at school: Reasons to initiate strain management earlier. *International Journal of Stress Management*, 16(3), 195–214. <https://doi.org/10.1037/a0016595>.
- Jennings, K., Sandberg, I., Kelley, S., Valdes, L., Yaggi, K., Abrew, A., et al. (2008). Understanding of self and maternal warmth predict later self-regulation in toddlers. *International Journal of Behavioral Development*, 32, 108–118. <https://doi.org/10.1177/0165025407087209>.
- Jha, A. P., Stanley, E. A., Kiyonaga, A., Wong, L., & Gelfand, L. (2010). Examining the protective effects of mindfulness training on working memory capacity and affective experience. *Emotion*, 10(1), 54–64. <https://doi.org/10.1037/a0018438>.
- Jones, D. E., & Foster, E. M. (2009). Service use patterns for adolescents with ADHD and comorbid conduct disorder. *Journal of Behavioral Health Services and Research*, 36(4), 436–449. <https://doi.org/10.1007/s11414-008-9133-3>.
- Kabat-Zinn, J. (1999). Indra's Net at Work: The mainstreaming of dharma practice in society. In G. Claxton, S. Batchelor, & G. Watson (Eds.), *The psychology of awakening: Buddhism, science and our day to day lives* (pp. 226–249). London: Rider. <https://doi.org/10.1007/s1267>.
- Kannass, K., Oakes, L., & Shaddy, J. (2006). A longitudinal investigation of the development of attention and distractibility. *Journal of Cognition and Development*, 7, 381–409. https://doi.org/10.1207/s15327647jcd0703_8.
- Karreman, A., van Tuijl, C., van Aken, M. A. G., & Deković, M. (2006). Parenting and self-regulation in preschoolers: A meta-analysis. *Infant and Child Development*, 15(6), 561–579. <https://doi.org/10.1002/icd.478>.
- Kellam, S. G., Koretz, D., & Mościcki, E. K. (1999). Core elements of developmentally based prevention research. *American Journal of Community Psychology*, 27(4), 463–482. <https://doi.org/10.1023/A:1022129127298>.
- Kelley, A. E., Schochet, T., & Landry, C. F. (2004). Risk taking and novelty seeking in adolescence: Introduction to part I. *Annals of the New York Academy of Sciences*, 1021, 27–32. <https://doi.org/10.1196/annals.1308.003>.
- Kelley, W. M., Wagner, D. D., & Heatherington, T. F. (2015). In search of a human self-regulation system. *Annual Review of Neuroscience*, 38, 389–411. <https://doi.org/10.1146/annurev-neuro-071013-014243>.
- Kopp, C. B. (2009). Emotion-focused coping in young children: Self and self-regulatory processes. *New Directions for Child and Adolescent Development*, 2009(124), 33–46. <https://doi.org/10.1002/cd.241>.
- Kuvaas, N. J., Dvorak, R. D., Pearson, M. R., Lamis, D. A., & Sargent, E. M. (2014). Self-regulation and alcohol use involvement: A latent class analysis. *Addictive Behaviors*, 39(1), 146–152. <https://doi.org/10.1016/j.addbeh.2013.09.020>.

- Landry, S. H., Smith, K. E., Swank, P. R., & Miller-Loncar, C. L. (2000). Early maternal and child influences on children's later independent cognitive and social functioning. *Child Development, 71*(2), 358–375. <https://doi.org/10.1111/1467-8624.00150>.
- Lenroot, R. K., Schmitt, J. E., Ordaz, S. J., Wallace, G. L., Neale, M. C., Lerch, J. P., et al. (2009). Differences in genetic and environmental influences on the human cerebral cortex associated with development during childhood and adolescence. *Human Brain Mapping, 30*(1), 163–174. <https://doi.org/10.1002/hbm.20494>.
- Lerner, R. M. (1986). *Concepts and theories of human development* (2nd ed.). New York: Random House.
- Lerner, R. M. (1991). Changing organism-context relations as the basic process of development: A developmental contextual perspective. *Developmental Psychology, 27*, 27–32. <https://doi.org/10.1037/0012-1649.27.1.27>.
- Lerner, R. M. (1992). *Final solutions: Biology, prejudice, and genocide*. University Park: Pennsylvania State University Press.
- Luciana, M. (2010). Adolescent brain development: Current themes and future directions. Introduction to the special issue. *Brain and Cognition, 72*(1), 1–5. <https://doi.org/10.1016/j.bandc.2009.11.002>.
- Lupien, S. J., McEwen, B. S., Gunnar, M. R., & Heim, C. (2009). Effects of stress throughout the lifespan on the brain, behaviour and cognition. *Nature Reviews Neuroscience, 10*(6), 434–445. <https://doi.org/10.1038/nrn2639>.
- Mani, A., Mullainathan, S., Shafir, E., & Zhao, J. (2013). Poverty impedes cognitive function. *Science, 341*(6149), 976–980. <https://doi.org/10.1126/science.1238041>.
- Matte-Gagné, C., & Bernier, A. (2011). Prospective relations between maternal autonomy support and child executive functioning: Investigating the mediating role of child language ability. *Journal of Experimental Child Psychology, 110*(4), 611–625. <https://doi.org/10.1016/j.jecp.2011.06.006>.
- McCoy, D. C., & Raver, C. C. (2014). Household instability and self-regulation among poor children. *Journal of Children & Poverty, 20*(2), 131–152. <https://doi.org/10.1080/10796126.2014.976185>.
- McCoy, D. C., Roy, A. L., & Raver, C. C. (2016). Neighborhood crime as a predictor of individual differences in emotional processing and regulation. *Developmental Science, 19*(1), 164–174. <https://doi.org/10.1111/desc.12287>.
- McEvoy, A., & Welker, R. (2000). Antisocial behavior, academic failure, and school climate a critical review. *Journal of Emotional and Behavioral Disorders, 8*(3), 130–140. <https://doi.org/10.1177/10634266000800301>.
- McEwen, B. S. (2007). Physiology and neurobiology of stress and adaptation: Central role of the brain. *Physiological Reviews, 87*(3), 873–904. <https://doi.org/10.1152/physrev.00041.2006>.
- McEwen, B. S., & Wingfield, J. C. (2003). The concept of allostasis in biology and biomedicine. *Hormones and Behavior, 43*(1), 2–15. [https://doi.org/10.1016/S0018-506X\(02\)00024-7](https://doi.org/10.1016/S0018-506X(02)00024-7).
- McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. *The American Psychologist, 53*(2), 185–204. <https://doi.org/10.1037/0003-066X.53.2.185>.
- McRae, K., Gross, J. J., Weber, J., Robertson, E. R., Sokol-Hessner, P., Ray, R. D., et al. (2012). The development of emotion regulation: An fMRI study of cognitive reappraisal in children, adolescents and young adults. *Social Cognitive and Affective Neuroscience, 7*(1), 11–22. <https://doi.org/10.1093/scan/nsr093>.
- Metcalfe, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychological Review, 106*(1), 3–19. <https://doi.org/10.1037/0033-295X.106.1.3>.
- Metzler, M., Merrick, M. T., Klevens, J., Ports, K. A., & Ford, D. C. (2017). Adverse childhood experiences and life opportunities: Shifting the narrative. *Children and Youth Services Review, 72*, 141–149. <https://doi.org/10.1016/j.childyouth.2016.10.021>.
- Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychological Bulletin, 133*(1), 25–45. <https://doi.org/10.1037/0033-2909.133.1.25>.
- Mischel, W., Ayduk, O., Berman, M. G., Casey, B. J., Gotlib, I. H., Jonides, J., et al. (2011). “Willpower” over the life span: Decomposing self-regulation. *Social Cognitive and Affective Neuroscience, 6*(2), 252–256. <https://doi.org/10.1093/scan/nsq081>.
- Mischel, W., Shoda, Y., & Rodriguez, M. I. (1989). Delay of gratification in children. *Science, 244*(4907), 933–938. <https://doi.org/10.1126/science.2658056>.
- Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science: A Journal of the American Psychological Society, 21*(1), 8–14. <https://doi.org/10.1177/0963721411429458>.

- Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., et al. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences of the United States of America*, 108(7), 2693–2698. <https://doi.org/10.1073/pnas.1010076108>.
- Moilanen, K. L. (2015). Short- and long-term self-regulation and sexual risk-taking behaviors in unmarried heterosexual young adults. *Journal of Sex Research*, 52(7), 758–769. <https://doi.org/10.1080/00224499.2014.959881>.
- Mullainathan, S. (2013). *Scarcity: Why having too little means so much*. New York: Times Books, Henry Holt and Company.
- Mullainathan, S., & Shafir, E. (2013). *Scarcity. Why having too little means so much*. London: Allen Lane.
- Murray, D. W., Rosanbalm, K., & Christopoulos, C. (2016). *Self-regulation and toxic stress report 3: A comprehensive review of self-regulation interventions from birth through young adulthood* (OPRE report no. 2016-34). Washington, D.C.: Office of Planning, Research and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services.
- Murray, D. W., Rosanbalm, K., Christopoulos, C., & Hamoudi, A. (2015). *Self-regulation and toxic stress: Foundations for understanding self-regulation from an applied developmental perspective* (OPRE Report # 2015-21). Washington, D.C.: Office of Planning, Research and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services.
- O’Connell, M. E., Boat T., & Warner, K. E. (Eds) (2009) National Research Council (US) and Institute of Medicine (US) committee on the prevention of mental disorders and substance abuse among children, youth, and young adults: Research advances and promising interventions. In *Preventing mental, emotional, and behavioral disorders among young people: Progress and possibilities*. Washington (DC): National Academies Press (US). <https://doi.org/10.17226/12480>
- Ogders, C. L., & Jaffee, S. R. (2013). Routine versus catastrophic influences on the developing child. *Annual Review of Public Health*, 34, 29–48. <https://doi.org/10.1146/annurev-publhealth-031912-114447>.
- Oettingen, G., Pak, H., & Schnetter, K. (2001). Self-regulation of goal setting: Turning free fantasies about the future into binding goals. *Journal of Personality and Social Psychology*, 80(5), 736–753. <https://doi.org/10.1037/0022-3514.80.5.736>.
- Paus, T. (2005). Mapping brain maturation and cognitive development during adolescence. *Trends in Cognitive Sciences*, 9(2), 60–68. <https://doi.org/10.1016/j.tics.2004.12.008>.
- Piquero, A. R., Jennings, W. G., & Farrington, D. P. (2010). On the malleability of self-control: Theoretical and policy implications regarding a general theory of crime. *Justice Quarterly*, 27(6), 803–834. <https://doi.org/10.1080/07418820903379628>.
- Posner, M. I., & Rothbart, M. K. (2007). Research on attention networks as a model for the integration of psychological science. *Annual Review of Psychology*, 58, 1–23. <https://doi.org/10.1146/annurev.psych.58.110405.085516>.
- Raffaelli, M., Crockett, L. J., & Shen, Y.-L. (2005). Developmental stability and change in self-regulation from childhood to adolescence. *The Journal of Genetic Psychology*, 166(1), 54–75. <https://doi.org/10.3200/GNTP.166.1.54-76>.
- Raver, C. C., Carter, J. S., McCoy, D. C., Roy, A., Ursache, A., & Friedman, A. (2012). Testing models of children’s self-regulation within educational contexts: Implications for measurement. *Advances in Child Development and Behavior*, 42, 245–270. <https://doi.org/10.1016/B978-0-12-394388-8-0.00007-1>.
- Raver, C. C., Jones, S. M., Li-Grining, C., Zhai, F., Bub, K., & Pressler, E. (2011). CSRP’s Impact on low-income preschoolers’ preacademic skills: Self-regulation as a mediating mechanism. *Child Development*, 82(1), 362–378. <https://doi.org/10.1111/j.1467-8624.2010.01561.x>.
- Raver, C. C., McCoy, D. C., Lowenstein, A. E., & Pess, R. (2013). Predicting individual differences in low-income children’s executive control from early to middle childhood. *Developmental Science*, 16(3), 394–408. <https://doi.org/10.1111/desc.12027>.
- Rhodes, J. D., Colder, C. R., Trucco, E. M., Speidel, C., Hawk, L. W., Lengua, L. J., et al. (2013). The interaction between self-regulation and motivation prospectively predicting problem behavior in adolescence. *Journal of Clinical Child and Adolescent Psychology*, 42(5), 681–692. <https://doi.org/10.1080/15374416.2013.773515>.
- Romeo, R. D. (2010). Adolescence: A central event in shaping stress reactivity. *Developmental Psychobiology*, 52(3), 244–253. <https://doi.org/10.1002/dev.20437>.
- Romer, D., Duckworth, A. L., Sznitman, S., & Park, S. (2010). Can adolescents learn self-control? Delay of gratification in the development of control over risk taking. *Prevention Science: The Official*

- Journal of the Society for Prevention Research*, 11(3), 319–330. <https://doi.org/10.1007/s11121-010-0171-8>.
- Rueda, M. R., Posner, M. I., & Rothbart, M. K. (2004). Attentional control and self-regulation. In R. F. Baumeister & K. D. Vohs (Eds.), *Handbook of self-regulation: Research, theory, and applications*. New York: Guilford Press.
- Ruff, H. A., & Capozzoli, M. C. (2003). Development of attention and distractibility in the first four years of life. *Developmental Psychology*, 39, 877–890. <https://doi.org/10.1037/0012-1649.39.5.877>.
- Ruff, H. A., & Rothbart, M. K. (1996). *Attention in early development: Themes and variations*. London: Oxford University Press.
- Samdal, O., Nutbeam, D., Wold, B., & Kannas, L. (1998). Achieving health and educational goals through schools—A study of the importance of the school climate and the students' satisfaction with school. *Health Education Research*, 13(3), 383–397. <https://doi.org/10.1093/her/13.3.383>.
- Sanders, M. R., & Mazzuchelli, T. G. (2013). The promotion of self-regulation through parenting interventions. *Clinical Child and Family Psychology Review*, 16(1), 1–17. <https://doi.org/10.1007/s10567-013-0129-z>.
- Sbarra, D. A., & Hazan, C. (2008). Coregulation, dysregulation, self-regulation: An integrative analysis and empirical agenda for understanding adult attachment, separation, loss, and recovery. *Personality and Social Psychology Review: An Official Journal of the Society for Personality and Social Psychology, Inc.*, 12(2), 141–167. <https://doi.org/10.1177/1088868308315702>.
- Schetter, C. (2017). Moving research on health and close relationships forward—a challenge and an obligation: Introduction to the special issue. *The American Psychologist*, 72(6), 511–516. <https://doi.org/10.1037/amp0000158>.
- Search Institute. (2014). *A research update from search institute: Developmental relationships*. Retrieved January 14, 2018, from <https://www.search-institute.org/research-update-search-institute-developmental-relationships/>.
- Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2002). *Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse*. New York: Guilford.
- Shonkoff, J. P. (2012). Leveraging the biology of adversity to address the roots of disparities in health and development. *Proceedings of the National Academy of Sciences of the United States of America*, 109(Suppl 2), 17302–17307. <https://doi.org/10.1073/pnas.1121259109>.
- Shonkoff, J. P. (2018). Making developmental science accessible, usable, and a catalyst for innovation. *Applied Developmental Science*, 1, 1. <https://doi.org/10.1080/10888691.2017.1421430>.
- Shonkoff, J. P., & Garner, A. S. (2012). The lifelong effects of early childhood adversity and toxic stress. *Pediatrics*, 129(1), e232–e246. <https://doi.org/10.1542/peds.2011-2663>.
- Silvers, J. A., McRae, K., Gabrieli, J. D. E., Gross, J. J., Remy, K. A., & Ochsner, K. N. (2012). Age-related differences in emotional reactivity, regulation, and rejection sensitivity in adolescence. *Emotion*, 12(6), 1235–1247. <https://doi.org/10.1037/a0028297>.
- Squeglia, L. M., Jacobus, J., & Tapert, S. F. (2009). The influence of substance use on adolescent brain development. *Clinical EEG and Neuroscience*, 40(1), 31–38.
- Steinberg, L. (2010). A dual systems model of adolescent risk-taking. *Developmental Psychobiology*, 52(3), 216–224. <https://doi.org/10.1002/dev.20445>.
- Steinberg, L. (2012). Should the science of adolescent brain development inform public policy? *Issues in Science and Technology*, 28(3), 67–78. <https://doi.org/10.1037/0003-066X.64.8.739>.
- Steinberg, L. (2014). *Adolescence* (10th ed.). New York: McGraw-Hill.
- Steinberg, L., Albert, D., Cauffman, E., Banich, M., Graham, S., & Woolard, J. (2008). Age differences in sensation seeking and impulsivity as indexed by behavior and self-report: Evidence for a dual systems model. *Developmental Psychology*, 44(6), 1764–1778. <https://doi.org/10.1037/a0012955>.
- Steinberg, L., Graham, S., O'Brien, L., Woolard, J., Cauffman, E., & Banich, M. (2009). Age differences in future orientation and delay discounting. *Child Development*, 80(1), 28–44. <https://doi.org/10.1111/j.1467-8624.2008.01244.x>.
- Steinberg, L., & Monahan, K. C. (2007). Age differences in resistance to peer influence. *Developmental Psychology*, 43(6), 1531–1543. <https://doi.org/10.1037/0012-1649.43.6.1531>.
- Stifter, C. A., & Braungart, J. M. (1995). The regulation of negative reactivity in infancy: Function and development. *Developmental Psychology*, 31, 448–455. <https://doi.org/10.1037/0012-1649.31.3.448>.
- Stifter, C. A., & Spinrad, T. L. (2002). The effect of excessive crying on the development of emotion regulation. *Infancy*, 3(2), 133–152. https://doi.org/10.1207/S15327078IN0302_2.

- Tan, C. C., & Chow, C. M. (2014). Stress and emotional eating: The mediating role of eating dysregulation. *Personality and Individual Differences*, *66*, 1–4. <https://doi.org/10.1016/j.paid.2014.02.033>.
- Wang, M. T., & Holcombe, R. (2010). Adolescents' perceptions of school environment, engagement, and academic achievement in middle school. *American Educational Research Journal*, *47*(3), 633–662. <https://doi.org/10.3102/0002831209361209>.
- Woltering, S., & Lewis, M. D. (2009). Developmental pathways of emotion regulation in childhood: A neuropsychological perspective. *Mind, Brain, and Education*, *3*(3), 160–169. <https://doi.org/10.1111/j.1751-228X.2009.01066.x>.
- Wong, C. A., Eccles, J. S., & Sameroff, A. (2003). The influence of ethnic discrimination and ethnic identification on African American adolescents' school and socioemotional adjustment. *Journal of Personality*, *71*(6), 1197–1232. <https://doi.org/10.1111/1467-6494.7106012>.
- Xu, X., Demos, K. E., Leahey, T. M., Hart, C. N., Trautvetter, J., Coward, P., et al. (2014). Failure to replicate depletion of self-control. *PLoS ONE*, *9*(10), e109950. <https://doi.org/10.1371/journal.pone.0109950>.
- Zalewski, M., Lengua, L. J., Wilson, A. C., Trancik, A., & Bazinet, A. (2011). Emotion regulation profiles, temperament, and adjustment problems in preadolescents. *Child Development*, *82*, 951–966. <https://doi.org/10.1111/j.1467-8624.2011.01575.x>.
- Zeigler, D. W., Wang, C. C., Yoast, R. A., Dickinson, B. D., McCaffree, M. A., Robinowitz, C. B., et al. (2005). The neurocognitive effects of alcohol on adolescents and college students. *Preventive Medicine*, *40*(1), 23–32. <https://doi.org/10.1016/j.ypmed.2004.04.044>.
- Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool executive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives*, *6*(4), 354–360. <https://doi.org/10.1111/j.1750-8606.2012.00246.x>.
- Zelazo, P. D., & Cunningham, W. (2007). Executive function: Mechanisms underlying emotion regulation. In J. Gross (Ed.), *Handbook of emotion regulation* (pp. 135–158). New York: Guilford.
- Zelazo, P. D., Müller, U., Frye, D., Marcovitch, S., Argitis, G., Boseovski, J., et al. (2003). The development of executive function in early childhood. *Monographs of the Society for Research in Child Development*, *68*(3), vii-137.
- Zhou, Q., Chen, S. H., & Main, A. (2012). Commonalities and differences in the research on children's effortful control and executive function: A call for an integrated model of self-regulation. *Child Development Perspectives*, *6*(2), 112–121. <https://doi.org/10.1111/j.1750-8606.2011.00176.x>.
- Zhou, G., Wang, D., Knoll, N., & Schwarzer, R. (2016). Planning mediates between self-efficacy and physical activity among motivated young adults. *Journal of Physical Activity & Health*, *13*(1), 87–93. <https://doi.org/10.1123/jpah.2014-0555>.

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