# Self-Regulation in Childhood: A Developmental Perspective

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## Introduction

The National Research Council and the Institute of Medicine of the National Academies released an important report in the year 2000 called *From Neurons to Neighborhoods* (Shonkoff & Phillips, 2000). The report, which, to this date, serves as a main guideline to early childhood researchers and practitioners, had emphasized ten core concepts which are crucial to our understanding of the process of human development. One of these concepts is *self-regulation*—which stands at the center of the current chapter. In explaining why they see self-regulation as a factor standing at the core of human development, Shonkoff and Philips stated that: "The growth of self-regulation is a cornerstone of early childhood development that cuts across all domains of behavior. Regulation is a fundamental property of all living organisms. It includes physiological and behavioral regulations that sustain life… Regulatory processes modulate a wide variety of functions to keep them within adaptive ranges. The simultaneous operation of these multiple systems at different levels of organization is an essential feature of human development" (Shonkoff & Phillips, 2000, p. 26).

Notwithstanding the significance of Shonkoff and Philips's conclusion, it is important to note that the definitions of what is considered as self-regulatory capacities are not as clear as may be expected from such a core concept. Moreover, these definitions are likely to change across childhood as a function of age and development. Consequently, it is an important aim of this chapter to review the concept of self-regulation from a developmental perspective in order to further our understanding of the similarities and differences between self-regulatory capacities as a function of age and developmental milestones. The chapter is divided into four main sections. In the first section, we look at the different definitions of self-regulation as they appear in the literature and suggest an informative definition of that construct. The second discusses the development of self-regulation from infancy to middle childhood. The third section presents different methods of assessing self-regulation (again, as a function of age and development), and the fourth discusses the links between self-regulation and psychopathology and their implications to field practitioners, focusing mainly on clinical and educational implications. We summarize the chapter with a set of conclusions and recommendations for future research in the field.

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## Defining "Self-Regulation"

In a highly cited article, Kopp (1982) defines self-regulation as "the ability to comply with a request, to initiate and cease activities according to situational demands, to modulate the intensity, frequency, and duration of verbal and motor acts in social and educational settings, to postpone acting upon a desired object or goal, and to generate socially approved behavior in the absence of external monitors" (Kopp, 1982, pp. 199–200). Similarly to Shonkoff and Phillips (2000), Kopp emphasizes the simultaneous operation of various regulatory capacities and, as such, while recognizing the multiplicity and complexity of self-regulation, seems to discuss it essentially as one entity. More recently, however, researchers and theoreticians have argued that discussing self-regulation as one core concept could be misleading and thus it is more useful to make more specific and clear distinctions between separate regulatory capacities that may be related but are still distinct (Eisenberg, Hofer, Sulik, & Spinrad, 2014; Ursache, Blair, & Raver, 2012). For example, Eisenberg and colleagues suggest that it is useful to differentiate between internally motivated and externally enforced regulation processes and between more or less volitional regulatory processes (Eisenberg, Duckworth, et al., 2014; Eisenberg, Hofer, et al., 2014), whereas Ursache and colleagues highlight the distinction between emotion-related self-regulation and cognitive-related self-regulation capacities (Ursache et al., 2012). For these researchers, discussing different regulatory capacities, such as the maintenance of body temperature, the expression of feelings, and the capacity to pay attention, from the perspective of one core concept, necessarily assumes a connecting link that does not always exist.

On the other hand, it was also convincingly claimed that too many distinctions between different regulatory capabilities could be confusing, as different research traditions may refer to what seems to be identical (or, at least, very similar) processes in different names (Bridgett, Oddi, Laake, Murdock, & Bachmann, 2013; Liew, 2012; Zhou, Chen, & Main, 2012). For example, there is an unclear distinction in the literature between *effortful control* and *inhibitory control*. The former is mainly used in the context of research traditions focusing on temperament and, as such, is defined as the regulatory component of temperament (Rothbart & Bates, 2006). The latter, on the other hand, is typically used by researchers focusing on cognitive development and is referred to as one of the central executive functions controlled by the prefrontal cortex (Liew, 2012; Zhou et al., 2012). However, although these two constructs are mostly discussed as independent constructs (but, in some cases, inhibitory control is discussed as part of effortful control), their description seems to be very similar and focuses on the ability to use a less desired but more appropriate response over a more desired but less appropriate response (Bridgett et al., 2013).

Thus, it is important to suggest a clear definition of self-regulation that can help in what was recently described as a lack of clarity of this construct and its subcomponents (McClelland & Cameron, 2012). In the current chapter, we borrow from different prominent theoreticians and researchers (e.g., Bandura, 1991; Block & Block, 1979; Bridgett, Burt, Edwards, & Deater-Deckard, 2015; Eisenberg, Duckworth, et al., 2014; Eisenberg, Hofer, et al., 2014; Kopp, 1982; Ursache et al., 2012) and suggest the following definition: self-regulation includes a broad set of *self-initiated* behaviors that aim to regulate and modulate emotional, cognitive, and behavioral arousal through *conscious*, *deliberate*, *flexible*, and *effortful* inhibitory actions. There are a number of important features to this definition. First, it refers to self-regulation as a *set* of distinct behaviors rather than one core construct. Second, it highlights the cognizant aspect of regulation (i.e., that the person must be aware of what she is doing). Third, it emphasizes that self-regulation necessarily includes an important ability of restricting and limiting actions taken by the individual. Based on this definition, we look next at the developmental milestones related to these capacities.

## Self-Regulation in Childhood: Main Developmental Milestones

When can we expect to see the first signs of deliberate and effortful inhibitory actions and how do these abilities develop across childhood? In this section we try to answer these questions starting with infancy, continuing in early childhood, and concluding in middle childhood.

## Self-Regulation in Infancy and Toddlerhood (Ages 0–3)

While there are signs of self-regulation activities even before birth (Florez, 2011), most developmental theories concur that voluntary control over behavior only appears in the latter part of the first year of life and, even by then, it is mostly expressed in the form of the infant's compliance to the caregiver's requests (e.g., Rothbart, Sheese, Rueda, & Posner, 2011; Ruff & Rothbart, 1996). Thus, in the early years, self-regulation is regarded many times as "guided self-regulation" or "mutual regulation" because of the general conception that infants and toddlers can only regulate themselves through the guidance and specific instructions of their caregivers (Sroufe, 1995) or through co-constructions of these capacities (Beebe & Lachmann, 1998). As such, our definition of self-regulation as a set of conscious, deliberate, flexible, and effortful self-initiated behaviors does not adequately represent children regulatory capacities in the first 3 years of life.

Still, infants as young as 2 months old (and, as mentioned, even before birth) regularly engage in some form of self-regulatory activities. Their abilities are usually manifested in the form of neurophysiological modulation which, as mentioned, is highly unlikely to involve conscious intention or awareness to the meaning of a given situation. But even without the conscious aspect, these more primitive behaviors (which are usually reflex movements organized in patterns of functional behavior) aim to achieve the goal of regulating and controlling arousal states (Gartstein, Bridgett, Young, Panksepp, & Power, 2013). In these first months, the caregiver's ability to help the infant regulate her emotions and arousal state is crucial for her development. The caregiver will typically assist the infant through interaction and routine, and the infant will use her limited capabilities to adjust to the caregiver's directions. At around 3–4 months of age, infants gain more sensorimotor modulation and can activate a motor act and change the act if needed. During this period, infants add to their previous passive repertoire of self-soothing behaviors more active behaviors such as direct approach to caregivers and attainment of more control of their visuospatial orientation (Rothbart, Ziaie, & O'boyle, 1992). At 6 months, they start redirecting their visual attention more toward inanimate aspects in the environment than toward their mothers (Rothbart et al., 1992). Then, toward the end of the first year of life, infants show even more increase in inhibitory capacities, self-soothing, and social communications, which signifies an important developmental period of self-regulation (Rothbart et al., 1992). During that period, infants not only show an ability to respond to the caregiver's control effort but also develop an ability to plan an act toward a desired regulatory goal (e.g., crawling to the other side of the room to pick up the pacifier and put it in their mouth). Notably, that already in the first year of life, there are pronounced gender differences in self-regulation capabilities, with girls generally showing higher capabilities of self-control and lower levels of anger and frustration than boys (Kochanska, Coy, & Murray, 2001; Weinberg, Tronick, Cohn, & Olson, 1999). These differences continue to be evident throughout childhood (Raffaelli, Crockett, & Shen, 2005).

During the second year of life, infants start to show more direct signs of voluntary control and an ability to monitor their behavior in some ways. During this phase, children are aware of social and task demands of the caregiver and can react accordingly by "initiate, maintain, modulate or cease physical acts, communication and emotional signals" (Kopp, 1982, p. 204). Finally, the shift to internal monitoring, which more adequately fits our initial definition of self-regulation, starts to be manifested more clearly during the third year of life, when young toddlers begin to acquire the ability to postpone an act if requested

and to behave according to external standards without external monitoring (Kochanska, Murray, & Harlan, 2000; Posner & Rothbart, 1998). This phase depends on the emergence of representational thinking and evocative memory which allow the child to understand social standards and to link her behavior to her caregivers' expectations regarding acceptable and nonacceptable behaviors. Importantly, throughout these first years of life, children do far better in "don't" situations (i.e., when they are instructed by an adult not to engage in a pleasant task) than in "do" situations (i.e., when they are instructed by an adult to engage in an unpleasant task) (Kochanska et al., 2001). From a developmental perspective, this difference between "do" and "don't" situations suggests that the ability to suppress a response develops earlier than the ability to execute an undesired activity. It is plausible that this developmental difference occurs because of social demands (i.e., that parents start asking children to suppress a response before they ask them to initiate an undesired activity) or because the latter requires more complicated coordination between various behavioral elements than the former (Kochanska et al., 2001).

It is evident from the above review that voluntary self-regulation is an extremely hard task for children in the first 3 years of life. On the other hand, we also know that voluntary self-regulation capabilities are instrumental for children's learning and development (Ursache et al., 2012). Taken these two facts together, what does it say about children's ability to learn and develop during these early years? Does it mean that because they cannot regulate efficiently, they are also not efficient learners? An interesting and provocative perspective that may shed a somewhat different light on children's limited self-regulatory capacities in the first 3 years of life is suggested by Thompson-Schill, Ramscar, and Chrysikou (2009) in an article titled "Cognition without control." These authors claim that during the first 3 years of life, children exhibit what could be described as severely impaired behavioral and cognitive control which is remarkably similar to patients with neurological prefrontal cortex (PFC) damage. They argue that this erratic behavior occurs because the PFC, which is the part of the brain that is in charge of our ability to regulate our thoughts and behaviors, is the last part in the human brain to achieve synaptic maturation. In contrast to other mammals, this process reaches its pick only around the end of the fourth year of life (Huttenlocher & Dabholkar, 1997). Thompson-Schill and colleagues suggest that these early years differ significantly from later years in being a developmental period in which self-regulation may not be as important to learning as it is in later periods.

Their suggestion is fueled by the fact that during these years children gain multitude of life skills and world knowledge that are essential for their development even though they cannot control and regulate their thoughts and behaviors as efficiently as in later years. Moreover, they suggest that the absence of sufficient regulatory capacities during the early years not only does not interfere with learning but also serves as an advantage for specific developmental tasks such as language development and probability matching. Thompson-Schill and colleagues summarize by saying that, based on the Darwinian principle of "trade-offs", the advantages of PFC immaturity during the first 3 years of life outstrip the disadvantages (Thompson-Schill et al., 2009).

From our perspective, their take on cognitive development in the first 3 years of life is important for the acknowledgment that self-regulation, while extremely important for the acquisition of adequate social, emotional, and cognitive skills, has also some costs and can put significant limitations on our learning. Importantly, it also puts in different light Shonkoff and Philips's determination that regulatory processes modulate a wide variety of functions to *keep them within adaptive ranges* (Shonkoff & Phillips, 2000) as in infancy and toddlerhood, it seems that adaptability is more related to the absence of self-regulatory capabilities than to its existence.

## Self-Regulation in Early Childhood (Ages 3–7)

The early childhood years (from preschool to the first years of elementary school) mark an important developmental period in which children make large and significant gains in their abilities to self-regulate (Bronson, 2000). What was previously highlighted by "cognition without control" is changing into more controlled behaviors and thought processes that could change based on the specific context (i.e., are flexible), that are more conscious and deliberate, and that are more multidimensional (Bronson, 2000; Whitebread & Basilio, 2012) than in the first 3 years of life. In the next few pages, we focus on the development of self-regulation during the early childhood years from two perspectives: the cognitive perspective and the socioemotional perspective.

### Self-Regulation in Early Childhood: The Cognitive Perspective

Cognitively, children after the age of 3 can engage in a much wider range of cognitive tasks than before. Their perspectives on events and objects in the world are getting to be more multidimensional, they are more able to control their attention and resist distractions in their environment, they are getting to be more advanced and complex problem solvers, and they start to see the world from a more "objective" perspective. Because of these more advanced abilities, they begin to be more selective and choose tasks while taking into account their own level of skills (Whitebread & Basilio, 2012). This means that they are showing the first signs of what is referred to in later developmental period as metacognitive thinking (Flavell, 1979).

The main construct discussed by scientists researching self-regulatory capacities in early childhood from a cognitive perspective is "executive functions" (EF). The term "executive functions" is an umbrella term describing the ability to monitor and regulate different types of cognition and behavior to achieve specific internal goals (Xu et al., 2013). It usually includes three main brain functions that are strongly related yet considered to be independent: *working memory*, which refers to our ability to recall and operate distinct pieces of information over a very short period of time; *cognitive flexibility*, which describes our ability to shift attention between competing tasks in the most efficient way; and *inhibitory control*, which, within a specific context, enables us to select a less desired but more appropriate response over a more desired but less appropriate response (Diamond, Barnett, Thomas, & Munro, 2007; Miyake et al., 2000). Researchers discuss executive functions in relation to self-regulation because the main role of these executive skills is to monitor and control behavior in a flexible and adaptive manner, especially in novel situations (Bryce, Szűcs, Soltész, & Whitebread, 2011).

During the fourth year of life, we see a significant developmental leap in children's efficient use of their working memory, in their ability to shift between tasks (cognitive flexibility), and in their ability to inhibit desired responses in accordance to environmental demands. From around age 4 onward, there is a linear increase in working memory capacity that continues throughout childhood (Gathercole, Brown, & Pickering, 2003). During the early parts of this stage (ages 3–5), children use simple tactics for remembering but do not use mental strategies and do not typically show a clear ability to differentiate between what is considered as memory and what is considered as comprehension. Thus, in order to remember objects and events, they tend to verbally name or visually inspect items and use memory strategies intermittently or inconsistently even if they are aware of how they can improve recall (Henry & Norman, 1996). However, when they enter elementary school (ages 6–7), they begin to understand the advantages of memorizing and start to use more advanced techniques such as constant rehearsal and the use of categorization (Justice, 1985). These increased capacities allow them to more fully understand social rules and apply breaks or let go, as needed and commended by their environment.

Also at around age 4, there is an increase in children's ability to use rules more flexibly and to change and shift between rules based on their understanding of environmental demands.

Zelazo (2006) has shown a rapid change in children's cognitive flexibility from age 3 to age 5. Using the dimensional change card sort (DCCS)—a card sorting task in which children are asked to switch their card sorting strategy (first by one dimension, e.g., color, than by another, e.g., shape, and, finally, either by color or by shape, depending on whether the card has a drawn border or not)—Zelazo has found that whereas 3-year-olds could not even make the initial switch (i.e., from color to shape), 4-year-olds had no problem doing it, but found it difficult to make a conditioned decision (i.e., to decide whether to sort by color or shape based on the existence of a border), whereas, by age 5, most children were also able to perform the conditioned switch with relative ease (Zelazo, 2006). Zelazo's important findings converge with Deák's (2003) conclusion that the most rapid change in children's ability to think more flexibly and switch between tasks based on environmental demands occurs between the ages of 3 and 6 years. Similar findings to Zelazo's, albeit with different measures, were found in a number of more recent studies (e.g., Deák & Narasimham, 2014; Deák & Wiseheart, 2015).

Finally, and strongly related to the other two executive functions discussed above, children from age 3 onward also show dramatic development in their inhibitory control (IC). As mentioned, inhibitory control refers to the ability to suppress or promote responses based on their appropriateness to the environment (Bryce et al., 2011) and, more specifically, to stop an ongoing thought or behavior in a sudden and complete manner (Williams, Ponesse, Schachar, Logan, & Tannock, 1999). Until the preschool years, this type of restrictive behavior is virtually impossible for toddlers. Only at around age 3, children begin to use restrictive judgments in selecting responses, with this ability rapidly developing until the early school years (Gagne & Hill Goldsmith, 2011; Liu, Zhu, Ziegler, & Shi, 2015). In a comprehensive study assessing various EFs of children, Carlson (2005) has shown a linear increase in children's IC from age 3 to 6 using both "cold" (i.e., the more traditional measures of PFC functions, e.g., a "Simon says" game or a "Stroop test") and "hot" (i.e., flexible control of appetitive reward systems which is more similar to the definition of effortful control, e.g., snack or gift delay) measures. For example, whereas only half of the young 3-year-olds passed the "cold" "bear/dragon" test (Reed, Pien, & Rothbart, 1984), all of the 5-year-olds passed this test successfully. Similarly with the "hot" measures, whereas 42% of the young 3-year-olds passed the "gift delay" test (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996), three quarters of the 5-year-olds were able to pass this task successfully (Carlson, 2005).

This last point brings us to the fine line between the cognitive and emotional aspects of self-regulation. As Carlson and others have shown, there are clear associations between the emotional and cognitive aspects of regulation; however, there seem to be more variance in emotionally-related self-regulation abilities, compared to the more "pure" (or "cold") cognitive regulation abilities. In the next section, we therefore review these emotional aspects of self-regulation, as exhibited in early childhood.

## Self-Regulation in Early Childhood: The Socioemotional Perspective

The two constructs most frequently used by researchers focusing on the socioemotional aspects of self-regulation are emotional self-regulation (or just, emotion regulation) and effortful control. From a socioemotional perspective, children entering their fourth year can more easily control their emotions, are more capable to use language to regulate their behavior, are more able to adjust their behavior based on their perceptions of others' behavior and state of mind, and, in general, seem to behave in ways that are based on an effort to adjust and adapt to the social demands of their environment (Bronson, 2000).

In the literature, emotional self-regulation typically refers to one's ability to respond to environmental demands with a range of emotions (both positive and negative) in a controlled manner (Panfile & Laible, 2012). Whereas emotional self-regulation continues to develop throughout the life-span, the period between ages 3 and 6 seems to be especially important for

the development of children's understanding of their own and others' emotional responses and self-control (Cole, Dennis, Smith-Simon, & Cohen, 2009). For example, it has been suggested that lip compression represents a conscious effort to suppress high levels of (negative or positive) emotional arousal (Bridges & Grolnick, 1995). Whereas lip compression and other self-soothing strategies are visible already in infancy, there is a dramatic increase in children's ability to control their emotions and understand the emotions of others after age 3.

Like in the other self-regulation capabilities discussed thus far, the fourth year of life seems to bring about an especially important developmental change in effortful control. As mentioned earlier, there are major similarities in the definition of inhibitory control and effortful control. Like IC, EC is defined as the ability to suppress a dominant response to perform a subdominant response (Rothbart & Rueda, 2005). Perhaps the best way to discriminate between the two is the way mentioned earlier of differences between "cold" (i.e., cognitive, PFC related) and "hot" (i.e., emotional, temperamentally related) inhibitory actions (Carlson, 2005). Kochanska and her colleagues were instrumental in defining the specific effortful control skills as well as designing appropriate measures to assess those (as will be discussed in Chapter "Challenging Behavior"; e.g., Kochanska et al., 1996, 2000). The five main effortful control skills identified by Kochanska and colleagues were *delay of gratification* (measured with tasks showing a candy or a gift for which the child has to wait for before receiving it), *slowing motor activity* (measured with tasks such as drawing a line very slowly), *suppressing or initiating a response based on changing signals* (measured by "go/no-go games"), *effortful attention* (measured via shape recognition tasks), and *lowering the voice* (measured by tasks of changing the level of voice pitch, i.e., asking the child to whisper). We will return to these constructs in Chapter "Challenging Behavior" when discussing the tasks designed to measure them and will see that some of these tasks may actually measure "cold" rather than "hot" traits, but, for the sake of this section, what is important to note is that in all of these tasks, 3–6-year-old children show linear and constant development, suggesting that there is an underline construct connecting all of them.

### Self-Regulation in Early Childhood: A Summary

The literature clearly shows that the early childhood years are a defining period for the development of self-regulation capabilities. From age 3 to the early elementary years, children progress in what seems to be a constant and linear line in their working memory capacities, cognitive flexibility, inhibitory control, emotional self-regulation, and effortful control. Still, even though children's development during these years is impressive, they are far from being skillful in exhibiting self-control and regulation. These capacities continue to develop through the middle childhood years, a period discussed in our next section.

## Self-Regulation in Middle Childhood (Ages 7–12)

Although self-regulation develops most rapidly at younger ages (Carlson & Moses, 2001), it continues to develop throughout the life-span (Best & Miller, 2010; Cicchetti & Tucker, 1994; Raffaelli et al., 2005). From both a cognitive and a socio-emotional perspective, middle childhood is a particularly demanding period of development, in which children are requested to manage multiple tasks at their homes, schools, and social lives. Moreover, many times they receive conflicting messages from parents, teachers, and peers, which add another layer of complexity to their ability to coordinate and facilitate their mental processes and behaviors. Thus, the task to self-regulate becomes more complicated and demands more advanced cognitive and emotional capabilities during this stage. Therefore, self-regulatory capacities at the middle childhood ages improve both qualitatively, in terms of the type of capabilities being mastered, and quantitatively, in terms of the degree to which self-regulatory capabilities are being mastered. Similarly to the previous section discussing self-regulation in early childhood,

we turn to discuss the development of self-regulation in middle childhood separately from a cognitive and socioemotional perspectives.

## Self-Regulation in Middle Childhood: The Cognitive Perspective

Self-regulation capabilities during the middle childhood years are dependent upon the development of advanced cognitive strategies that help children better control their arousal level (Heckhausen & Dweck, 1998; Zimmerman, 2000). Importantly, children at these ages face much more challenging environmental demands than in the early childhood years, both academically and interpersonally. Therefore, their capacities to self-regulate their behaviors and cognitions are a hallmark of adaptive adjustment. Advancements in cognitive processing capabilities that are typically discussed in the literature in relation to self-regulation in middle childhood are the more efficient use of memory and better inhibitory control abilities.

In terms of children's use of memory, research shows a generally linear increase in children's working memory capacity and efficient use from the preschool age to early adolescence (Conklin, Luciana, Hooper, & Yarger, 2007; Gathercole, Pickering, Ambridge, & Wearing, 2004; Luciana, Conklin, Hooper, & Yarger, 2005; Xu, Farver, & Zhang, 2009). However, it was suggested that the developmental course of working memory depends on the complexity of the task, namely, its executive demands. Indeed, several studies showed that less demanding tasks are being fully mastered earlier in the preschool age and more complicated tasks continue to mature until early adolescence (Conklin et al., 2007; Luciana et al., 2005). These findings suggest that middle childhood is a stage characterized with the refinement of working memory capacities. The more nuanced capabilities developed during this phase allow children to not only store more information in their memory but also to be much better than in the early childhood years in retrieving this information in the right context. During these years, they become more proficient in using advanced memory strategies like relying on heuristics (like an educated guess or a rule of thumb), shortcuts, and grouping. These advanced capabilities replace the former methods of mostly memorizing and thus afford higher capacities and more efficient retrieving, thus assisting in goal-directed behaviors.

Inhibitory control is also an important facet of self-regulation that continues to develop through middle childhood (Romine & Reynolds, 2005) and particularly for tasks that combine inhibition and working memory (Carlson, 2005; Gerstadt, Hong, & Diamond, 1994). However, unlike the improvements evident in preschool children, improvements in inhibitory control during the middle school years are unlikely to be fundamental qualitative changes in cognition but instead seem to involve quantitative improvements in accuracy, perhaps due to an increasing efficiency to override proponent responses. Accordingly, Best and Miller (2010) suggested that inhibition tasks have varying sensitivities, with some being sensitive to the conceptual gains in early childhood and others being sensitive to the refinements in strength of the relevant cognitive skills or the generality of application in later childhood.

These advanced cognitive capabilities lay the infrastructure for the child's functioning in several contexts. Specifically, they are essential to school functioning, which imposes growing demands on children in the middle childhood years compared to the early childhood years. Self-regulation in academic settings has been defined as the "active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment" (Pintrich, 2000, p. 453). Models of self-regulation conceptualize the self-regulating student as a motivated proactive agent and depict the self-regulatory process as progressing along phases that include assessment of task conditions and relevant personal resources, goal setting and selection of strategies to pursue these goals, application of the strategies and metacognitive monitoring of this application, and evaluation of the products and metacognitive control of the continued use of these strategies (i.e., whether to maintain the strategies or change

them). These phases are thought to operate cyclically, with the evaluation phase leading back to the planning phase of goal setting and selection of strategies and so on (Winne & Hadwin, 1998; Zimmerman, 2000).

Thus, self-regulation in middle childhood goes beyond holding data in short-term memory and inhibiting unwanted responses. It is an active process that allows children at that stage to plan goal-directed actions, reconceptualize the situation, redefine their goals, or change their strategy in order to achieve that goal.

### Self-Regulation in Middle Childhood: The Socioemotional Perspective

Although the capacity for effortful control develops most rapidly in early childhood (Posner & Rothbart, 2000), there are some evidence showing that children further develop their regulatory skills in middle childhood (Eisenberg & Morris, 2002). In addition, as children grow up, they develop much more sophisticated ways to self-regulate their emotional experiences. Thus, while younger children rely mostly on attentional resources and self-soothing to self-regulate, school-aged children can rely on diverse internal mental and cognitive mechanisms to regulate their emotional experiences (Eisenberg, Duckworth et al., 2014; Eisenberg, Hofer, et al., 2014). In other words, in addition to the quantitative improvement of their inhibitory control capacities, children improve the quality of dealing with emotional experiences.

An example to a more sophisticated strategy of emotion regulation, which was explored extensively in adult population, is reappraisal. Reappraisal is considered an adaptive form of emotion regulation, which involves the capacity to cognitively reappraise events by interpreting them in ways that change the emotional responses to them (Gross & Thompson, 2007). So far, only a few studies have explored the use of reappraisal in middle childhood. For instance, McRae et al. (2012) have demonstrated that 10–13-year-old children use reappraisal to effectively deal with unpleasant emotions. However, much more research is needed in order to understand the developmental pathways that enable both younger and same age children to use more or less adaptive forms of emotion regulation and the normative development of the capacities for such forms of emotion regulation.

## The Assessment of Self-Regulation in Childhood

In the childhood years, self-regulatory capabilities are usually measured through direct assessments and/or behavioral ratings completed by adults (typically parents and teachers). Within this methodological framework, the following selective review highlights some frequently used measures in that field. We start by reviewing measures of executive functions and follow by reviewing measures of emotional self-regulation and effortful control.

### Measures of Executive Functions in Childhood

As shown by Carlson's comprehensive review (Carlson, 2005), there are numerous measures of executive functions in childhood. These measures focus mainly on the three main executive functions described earlier, working memory, cognitive flexibility, and inhibitory control. These measures are discussed next.

#### Working Memory

Most measures of working memory are characterized by having both a processing and a storage component (Waters & Caplan, 2003). Performance on these measures is usually expressed as a continuous score of memory span. Depending on their developmental stage, children are asked to recall sequences of objects/numbers/letters (Gathercole et al., 2004). An excellent example of the ways by which working memory is measured in children is the comprehensive *Working Memory Test Battery for Children* (WMTB-C; Pickering & Gathercole, 2001). This measure is designed for children and young adults (ages 4–22) and includes nine subtests: four tests examining verbal storage (digit recall, word list recall, non-word list recall, and

Word List Matching task), two tests focusing on visual recall (blocks recall and mazes memory), and three tests examining more complex recall patterns (backward digit recall, listening recall, and counting recall). All of these tests can be used with children from age 6, and five of these tests (digit recall, backward digit recall, word list recall, nonword list recall, and block recall) can be used with children as young as 4 (Gathercole et al., 2004).

A related yet methodologically different example of direct assessment measure of working memory in children is the *Automated Working Memory Assessment* (AWMA; Alloway, Gathercole, & Pickering, 2006)—a computer-based measure of working memory for children age 4 and up. Like the WMTB-C, it is responsive to the definition of working memory as a system comprising multiple components whose coordinated activity provides the capacity for the temporary storage and manipulation of information in a variety of domains (Baddeley, 2000). As such, it includes tests corresponding to each of these domains: word recall, listening recall, dot matrix, and a measure of visuospatial working memory called Mister X. Other examples of working memory assessments in childhood include the *backward digit span* (Davis & Pratt, 1996), which serves as the basis to some of the measures mentioned above, and *count and label* (Gordon & Olson, 1998) in which children are asked to both count and label correctly a set of objects.

Although parent and teacher ratings that directly tap working memory are not common, one way to assess working memory through such ratings is by asking about behavior problems that were previously found to be strongly related to working memory deficiencies. For example, the Working Memory Rating Scale (WMRS; Alloway & Gathercole, 2008) is a 20-item, four-point rating scale (from 0, not typical, to 3, very typical) of problem behaviors that are known to differentiate children based on their working memory abilities. The authors of this measure report that it is particularly valuable for teachers who do not wish to use more formal assessments of working memory, but do want to provide a more systematic evaluation of the potential working memory problems than can be provided by information observation alone (Alloway & Gathercole, 2008).

## Cognitive Flexibility

Measures of cognitive flexibility typically assess children's ability to flexibly switch between competing tasks. Among these measures, the dimensional change card sort (DCCS; Zelazo, 2006) mentioned above is likely the most well known and widely used. The DCCS is an easily administered measure in which children are required to sort a series of bivalent test cards, first according to one dimension (e.g., color) and then according to another (e.g., shape). The child is then asked to sort the cards either by color or shape, depending on whether or not the card has a border. In recent years, more complex versions of this measure such as the Three Dimension-Changes Card Sorting Photoshop-modified (Deák & Wiseheart, 2015) were introduced. These new measures include more colors and shapes and thus can produce higher distinguishing capabilities.

Other cognitive flexibility measures from the same group of researchers (Deák, 2000; Deák & Narasimham, 2014; Deák & Wiseheart, 2015) include the Flexible Induction of Meaning-Objects (FIM-Ob) and the Flexible Induction of Meaning-Animates (FIM-An). These measures use novel objects (FIM-Ob) or novel animated creatures (FIM-An) as stimuli. In each of these measures, the child has to sort these novel objects/creatures a number of times based on different criteria. It is considered to be a strong measure of flexibility because on the later trials, the child must ignore matches that are perceived similarly, and, moreover, must ignore responses that were previously primed (Deák, 2000).

## Inhibitory Control

There are numerous measures that are used to assess inhibitory control in children from the preschool years. The common thread among these measures is their attempt to measure the child's ability to postpone a preferred response in favor of an undesired response. Carlson (2005) provides a comprehensive list of these measures and here we review only a selection. Another important point to be made: we discussed earlier

the unclear distinction between inhibitory control and effortful control. This vagueness is also vividly apparent when reviewing measures of inhibitory and effortful control. In order to somewhat clear this vagueness, we use in this chapter the distinction used by Carlson (2005) and others between "cool" and "hot" regulation that we believe could be very useful also when trying to distinguish IC and EC measures. Using this perspective, we treat measures of "cool" regulation skills (i.e., measures that seem to include less affective components) as inhibitory control measures, whereas we present measures of "hot" regulation skills (i.e., measures that clearly include affective components) as measures of effortful control.

The following is a selective review of IC measures that are frequently used with children age 4 and older. Some of these measures are Stroop-like assessments of children's ability to follow a direction that asks them to inhibit an automatic (i.e., dominant) response to a stimulus and to use an opposite (i.e., subdominant) response instead. For example, in the day/night assessment (Gerstadt et al., 1994), children are asked to say "night," when they see a card with a sun drawn on it, and to say "day," when they see a card with a moon. Similarly, in the grass/snow assessment (Carlson & Moses, 2001), children are asked to point to a white card when the experimenter says "grass" and to point to a green card when the experimenter says "snow." In other examples of such tests, children are asked to make a fist when the experimenter points her finger and to point their finger when the experimenter makes a fist (Hughes, 1998) or to tap once when the experimenter tap twice and vice versa (Blair, 2003).

Other inhibitory control measures assess children's ability to follow inhibiting directions for a long time and to keep turns. For example, in the whisper task (Kochanska et al., 1996), the experimenter asks the child to name different cartoon characters but to always do it in a very quiet voice. In the tower game (Kochanska et al., 1996), children are asked to build a tower with an experimenter but only do it on their turn. During this task, children are never reminded on the turn-taking rule and are scored for their ability to maintain the rule for the duration of the game. Similarly, in the pinball task (Reed et al., 1984), children are asked to wait for the experimenter's direction each time it is their turn to play the game. Other tasks imitate the well-known children game "Simon says" (Bear-Dragon; Reed et al., 1984; Simon Says, Strommen, 1973) in which the child is supposed to follow the direction of the experimenter, but only under certain conditions (e.g., when the experimenter says that Simon said to do it) but not under other conditions (e.g., when the experimenter tells the child to do the task without saying "Simon said to").

Finally, Rothbart and her colleagues have created a series of parent and teacher reports of children's temperament which include a significant number of items tapping inhibitory control. Whereas some of these items may tap effortful control (based on our distinction between measures of "cold" and "hot" regulation), we briefly present these questionnaires in this section. This set of questionnaires covers almost every period of development (infancy to adulthood). The questionnaires relevant to the current chapter are the Infant Behavior Questionnaire (IBQ; Rothbart, 1981; for infants ages 3–12 months); the Early Childhood Behavior Questionnaire (ECBQ; Putnam, Gartstein, & Rothbart, 2006; for toddlers ages 18–36 months); the Children's Behavior Questionnaire (CBQ: Rothbart, Ahadi, Hershey, & Fisher, 2001; for children ages 3–7 years); the Temperament in Middle Childhood Questionnaire (TMCQ; Simonds & Rothbart, 2004; for children 7–10 years old); and the Early Adolescent Temperament Questionnaire (EATQ-R; Capaldi & Rothbart, 1992; Ellis & Rothbart, 2001; for children ages 9–15 years). All of these questionnaires include items that ask parents or teachers to rate children's capacity to plan ahead, as well as their ability to suppress inappropriate response.

## Measures of Emotional Self-Regulation and Effortful Control in Childhood

The most well-known battery of effortful control measures is likely the one proposed by Kochanska

and her colleagues (e.g., Kochanska et al., 1996, 2001). As mentioned earlier, Kochanska's measures focus on five components of EC: (a) delaying (e.g., waiting with an instruction not to do anything for a pleasant event (receiving a candy or a gift) that will only occur if waiting), (b) slowing down gross and fine motor activity, (c) suppressing/initiating activity to a signal (e.g., games in which the child produces a response to one signal and inhibits it to another), (d) effortful attention (Stroop-like assessments, which requires ignoring a dominant perceptual feature of a stimulus in favor of a subdominant feature), and (e) lowering voice (whispering). As can be seen, based on our "hot" and "cold" definitions above, not all of these tests qualify as "real" EC measures, and some seem to tap the cognitive rather than the affective part of control. Thus, in the following short description of EC measures, we focus only on those that seem to trigger the arousal levels of specific affective systems.

Most of these measures seem to be related to the first of Kochanska's definition of EC, delaying, in which children are asked to delay their response to an attractive stimulus in order to receive a better reward later. For example, in the delay of gratification task (Mischel, Shoda, & Rodriguez, 1989), after children select their favorite treat out of two options, two bowls with their favorite treat are placed in front of them, one with a large number of treats and the other with a small number of treats. After making sure that the children prefer the bowl with the larger amount of treats, the children are then told that the experimenter needs to leave the room for a while but if they wait until she returns, they will receive the bowl with the large number of treats. Children are also given the option to call the experimenter back to the room but are being told that if they do that, they will receive the bowl with the smaller amount of treats. Mischel and his colleagues designed a number of delay of gratification tasks, perhaps the most well known is the Stanford Marshmallow test (Mischel, Ebbesen, & Raskoff Zeiss, 1972), which is an earlier and simpler version of the delay of gratification measure described above.

Other researchers designed innovative measures that add complexity to Mischel's delay of gratification tasks. For example, in the less is more task (Carlson, Davis, & Leach, 2005), Carlson and her colleagues added a layer of reverse reward contingency to the task. In this procedure, children are also asked to select between a larger and smaller selection of candies (put on trays) but, in addition, are told that the tray they will select will go to a naughty puppet, whereas they will receive the other tray. Carlson (2005) also combined the Saarni's disappointing gift task (Saarni, 1984) with Kochanska's gift delay task (Kochanska et al., 1996) to create an even more elaborated version of the delay of gratification task. In this combined version, children are asked to wait until an experimenter wraps a gift that she "forgot" to wrap before. This is done behind their back. Then, when they open the gift, it turns out to be a disappointing gift, and their affective responses are being measured.

## Self-Regulation and Psychopathology: Implications to Field Practitioners

Failures of self-regulation contribute to children's maladjustment and are manifested in various forms of children's psychopathology. Particularly, children's difficulties at self-regulation are evident in a wide range of maladjusted patterns of behaviors, including both externalizing and internalizing spectrums (Neuhaus & Beauchaine, 2013; Nigg, 2000). On the other hand, research has clearly demonstrated that optimal self-regulatory capacities contribute to children's adaptive social and academic adjustment (Eisenberg, Duckworth et al., 2014; Eisenberg, Hofer, et al., 2014; Liew, 2012). Therefore, informing practitioners and socialization agents how to foster optimal self-regulatory capacities should be a primary goal of self-regulation research. The present section will first discuss how self-regulatory capacities are involved in children's maladjustment and then discuss implications for practitioners.

## Self-Regulation and Externalizing Problems

Lower levels of self-regulation capabilities have been consistently linked to higher levels of externalizing problems, manifested in aggression, impulsivity, and inattention. This association is evident in the toddler and preschool years as well as in later childhood and adolescence (for a review, see Eisenberg, Spinrad, & Eggum, 2010). However, closer inspection at different externalizing symptoms and different self-regulatory capacities reveals a more complicated picture.

Notably, failures of self-regulation are evident in attention deficit hyperactivity disorder (ADHD). ADHD has long been associated with impaired abilities for response suppression, manifested in ADHD children's difficulties at executing goal-directed behaviors (Nigg, 2000). Thus, large body of evidence has demonstrated that children who exhibit ADHD symptoms perform worse than controls on tasks measuring response suppression such as the stop-signal task (Logan, 1994) and the go/no-go task (Miller, Schäffer, & Hackley, 1991). Willcutt, Doyle, Nigg, Faraone, and Pennington (2005) reviewed studies and noted a composite effect size for ADHD versus control of $d$ = 0.61 (a medium effect size). Similarly, Schoemaker, Mulder, Deković, and Matthys (2013) reviewed 18 studies that explored the relations between executive functions and ADHD symptoms among preschoolers and found a medium correlation effect size (ESzr = 0.21) for overall executive functions, as measured by teachers' and parents' questionnaires. More specifically, small effect sizes were found for working memory (ESzr = 0.17) and for cognitive flexibility (ESzr = 0.14), and medium effect size was found for inhibitory control (ESzr = 0.24). Therefore, these studies suggest that although children who exhibit ADHD symptoms manifest impaired cognitive self-regulation abilities, this link may be less robust than what was commonly argued.

Beyond cognitive control mechanisms, deficiencies in emotional self-regulation have also been associated with ADHD (Barkley, 1997; Nigg & Casey, 2005; Wender, 1995). Accordingly, researchers (e.g., Martel, 2009; Nigg, Goldsmith, & Sachek, 2004) have suggested that deficiencies in effortful control may account for the inattentive symptoms of ADHD. Following these claims, a growing body of research has explored the links between effortful control and ADHD symptoms. Although preliminary, this research has consistently demonstrated that children with ADHD score lower than controls on measures of effortful control (De Pauw & Mervielde, 2010; Foley, McClowry, & Castellanos, 2008; Martel, Gremillion, & Roberts, 2012; Martel & Nigg, 2006). Similarly, studies that explored individual differences in effortful control and ADHD symptoms found negative relations between the constructs, both among preschool children (Papageorgiou et al., 2014) and among college students (Graziano et al., 2015).

Another line of research has followed Shiner and Caspi's (2003) suggestion that temperament and personality traits can and should be integrated in children due to similarities between the two domains. Specifically, these researchers claimed that there is a certain degree of overlap between effortful control and the trait "conscientiousness," defined as "the propensity to follow socially prescribed norms for impulse control, to be goal directed, to plan, and to be able to delay gratification and to follow norms and rules" (Roberts, Jackson, Fayard, Edmonds, & Meints, 2009, p. 369; see also Eisenberg, Duckworth, Spinrad, & Valiente, 2014). Accordingly, several studies have demonstrated that children who exhibit ADHD symptoms score lower than controls on measures tapping conscientiousness (Martel, 2016; Martel, Nigg, & von Eye, 2009; Ullsperger, Nigg, & Nikolas, 2016).

Taken together, these results suggest that emotional self-regulatory capacities play a role in ADHD symptomatology. However, more research is needed to establish this assumption. Specifically, longitudinal studies are required to examine developmental trajectories and causal pathways. In addition, more direct scrutiny should explore the differentiation between measures supposedly tapping the same constructs (i.e., effortful control, inhibitory control, and conscientiousness) and their relation to ADHD.

Deficiencies in self-regulatory capacities are also evident in disruptive behavior disorders (DBD), such as oppositional defiant disorder and conduct disorder. In the past two decades, a growing body of research has explored the relations between effortful control and externalizing problems and DBD (for a full review, see Eisenberg, Spinrad, & Eggum, 2010; Eisenberg, Spinrad, Eggum, Silva, et al., 2010). This research demonstrated that effortful control assessed at toddlerhood and early childhood negatively predicted externalizing symptoms both at preschool (Eisenberg et al., 2005; Murray & Kochanska, 2002; Olson, Sameroff, Kerr, Lopez, & Wellman, 2005; Valiente et al., 2013) and middle childhood (Choe, Olson, & Sameroff, 2014; Eisenberg et al., 2004). Also, Woltering, Lishak, Hodgson, Granic, and Zelazo (2016) found that 7–12-year-old children diagnosed with DBD scored lower than controls on measures of effortful control.

However, both Spinrad et al. (2007) and Eisenberg, Taylor, Widaman, and Spinrad (2015) found that effortful control did not negatively predict toddlers' externalizing problems over time when controlling for earlier levels of externalizing problems. Therefore, it is suggested that effortful control is linked to maladjustment only after it is fairly sophisticated and mature. Eisenberg et al. (2015) also found that high levels of children's externalizing problems at both 30 and 42 months negatively predicted effortful control a year later. Thus, it is likely that, at these ages, high levels of externalizing problems impair the development of effortful control by affecting children's social environment, including aspects of parenting.

While the research exploring the relations between effortful control and DBD has been intensively explored over the years, the relations between executive functions, and specifically inhibitory control, and DBD have only lately gained researchers' attention. This late inspection might have been the result of the historical view that ascribed the impairments in executive functions, often found in children with DBD, to comorbid ADHD in these children (Pennington & Ozonoff, 1996). However, in recent years, a growing body of research has addressed this lacuna and showed links between executive functions and DBD, above and beyond the presence of comorbid ADHD. Indeed, Schoemaker et al.' (2013) meta-analysis mentioned above reviewed nine studies that explored the relations between DBD and executive functions and found similar effect sizes as in studies that explored ADHD and executive functions (ESzr = 0.19, 0.15, 0.22, and 0.13 for overall executive functions, working memory, inhibitory control, and flexibility, respectively).

In recent years, researchers have further established this link between executive functions and different types of aggressive behavior (Buss, Kiel, Morales, & Robinson, 2014; Choe, Shaw, Brennan, Dishion, & Wilson, 2014; Euler, Sterzer, & Stadler, 2014; Granvald & Marciszko, 2016; Monette, Bigras, & Guay, 2015; Sulik, Blair, Mills-Koonce, Berry, & Greenberg, 2015; Suurland et al., 2016; Verlinden et al., 2014; Woltering et al., 2016). Overall, findings from these studies support the assumption that a strong link exits between executive functions and different types of aggression, both in children diagnosed with DBD (e.g., Euler et al., 2014), and in non-referred populations (e.g., Sulik et al., 2015).

## Self-Regulation and Internalizing Problems

In internalizing problems, deviant emotion-driven behaviors are targeted inward toward the individual (Colman, Wadsworth, Croudace, & Jones, 2007). This category encompasses a wide range of problems, such as anxiety, depression, withdrawal, and somatic complaints. At a first glance, the relations between self-regulation and internalizing problems may seem less clear and straightforward, as these have often been mentioned as problems characterized by overcontrol. However, Eisenberg and her colleagues have suggested that this overcontrol is reactive and therefore could be counteracted by effortful control (Eisenberg, Spinrad, & Morris, 2002).

Indeed, several internalizing problems are manifested by dysregulated emotion expression

and experience (e.g., rumination; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), as well as heightened emotional reactivity and impulsivity (Carver, Johnson, & Joormann, 2008; Yap, Allen, & Sheeber, 2007). However, the relations of self-regulatory capacities with internalizing problems have been less systematically explored than their relations with externalizing problems. In addition, most studies that examined this link focused on the concept of effortful control, and less on inhibitory control.

Studies that explored the relations between effortful control and internalizing symptoms exhibited mixed findings that tend to vary with age. Specifically, whereas several studies conducted in the toddlerhood and preschool years found negative relations between effortful control and internalizing symptoms (Carrasco, Holgado-Tello, Delgado, & González-Peña, 2016; Hopkins, Lavigne, Gouze, LeBailly, & Bryant, 2013; Lemery, Essex, & Smider, 2002), others found positive relationships (Murray & Kochanska, 2002) or mild/null relationships (Dennis, Brotman, Huang, & Gouley, 2007; Eisenberg, Spinrad, Eggum, Silva, et al., 2010; Ghassabian et al., 2014; Moran, Lengua, & Zalewski, 2013). In addition, in all cases where internalizing and externalizing symptoms were simultaneously measured, the internalizing symptoms' relationships with effortful control were weaker than they were with externalizing symptoms (e.g., Carrasco et al., 2016; Eisenberg, Spinrad, & Eggum, 2010; Eisenberg, Spinrad, Eggum, Silva, et al., 2010; Moran et al., 2013).

Interestingly, there was a stark division between the measurements used to assess effortful control in the studies that found negative relationships between effortful control and internalizing symptoms and those that did not. Thus, while the former relied solely on the CBQ (Putnam & Rothbart, 2006; Rothbart et al., 2001) to measure effortful control, the latter used the battery developed by Kochanska (1996, 2001) or similar observational methods. This distinction casts doubt on the assumption that early childhood internalizing problems are related to deficiencies in effortful control at these ages. Thus, the negative links found in the early years might as well be the result of a self-report bias or of construct validity bias, wherein items from both the CBQ and the measurements of internalizing symptoms tap similar constructs (Lemery et al., 2002; Lengua, West, & Sandler, 1998).

A different pattern of results emerged in middle childhood and adolescence, where fairly consistent negative relationships between effortful control and internalizing symptoms emerge (Hilt, Armstrong, & Essex, 2012; Hofer, Eisenberg, & Reiser, 2010; Muris, 2006; Muris, Meesters, & Blijlevens, 2007; Oldehinkel, Hartman, Ferdinand, Verhulst, & Ormel, 2007; Sportel, Nauta, de Hullu, & de Jong, 2013; Sportel, Nauta, de Hullu, de Jong, & Hartman, 2011). These negative relationships were found both in relation to depression (Sportel et al., 2013), to anxiety (Muris, 2006; Oldehinkel et al., 2007; Sportel et al., 2011; Vervoort et al., 2011), and to mixed measures of internalizing symptoms, which include withdrawal, anxiety/depression, and somatic symptoms (Dyson, Robertson, & Wong, 2015; Hofer et al., 2010; Muhtadie, Zhou, Eisenberg, & Wang, 2013). In addition, recently several studies have indicated that effortful control capacities served as a moderator between several risk factors and later internalization problems (e.g., Gulley, Hankin, & Young, 2016; Hilt et al., 2012; Muhtadie et al., 2013).

Thus, these results suggest that effortful control capacities developed early in life might protect children against internalizing symptoms in adolescence. However, as the research is still preliminary, more data is needed to determine the developmental trajectories that follow from early effortful control capacities to internalizing symptoms in adolescence. In addition, much less research has explored the relations between inhibitory control and internalizing symptoms, and recent evidence suggests that such an exploration is warranted. For instance, Ghassabian et al. (2014) relied on self-report measures of inhibitory control and showed positive relations between parents' reports of inhibitory control at age 4 and internalizing symptoms at age 6. As mentioned, more research is needed in order to establish these findings, and specifically, behavioral measures of inhibitory control are needed.

## Self-Regulation and Adaptive Adjustment

Beyond their role in the development and prevention of psychopathology, self-regulatory capacities contribute to children's adaptive adjustment (for a review, see Liew, 2012). Research has consistently demonstrated that children with good self-regulatory capacities do better than other children both socially and academically. For instance, several studies found positive relationships between effortful control and adaptive indicators of social adjustment among children, such as empathy (e.g., Eisenberg, Wentzel, & Harris, 1998; Panfile & Laible, 2012; Rothbart, Ahadi, & Hershey, 1994) and prosocial behavior (e.g., Diener & Kim, 2004; Eisenberg et al., 1997; Luengo Kanacri, Pastorelli, Eisenberg, Zuffianò, & Caprara, 2013).

In addition, researchers have demonstrated positive relationships between self-regularity capacities and academic skills and achievements both in the preschool years (e.g., Blair & Razza, 2007; McClelland et al., 2007) and in grade school (e.g., Liew, McTigue, Barrois, & Hughes, 2008; Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008; Valiente et al., 2013).

## Promoting Self-Regulatory Capacities

The evidence overviewed in the previous sections emphasized the importance of self-regulatory capacities to children's psychosocial and academic adjustment. In addition, a large body of evidence indicates that beyond heredity, socializers' practices affect the development of self-regulatory capacities (Eisenberg, Cumberland, & Spinrad, 1998). Together, this body of evidence underscores the importance of developing effective interventions to foster self-regulation. However, the research supporting the effectiveness of such attempts is still limited. Thus, whereas several attempts were focused on the improvement of children's executive functions, including inhibitory control (for a review, see Diamond & Lee, 2011), only a few have targeted effortful control.

Diamond (2012) described three types of interventions aimed at improving children's executive functions, namely, computerized training, school curricula, and physical exercise (including martial arts and meditation training). Computerized training tasks were originally designed to improve the working memory aspect of executive functions (for a review, see Shipstead, Redick, & Engle, 2012). The most researched approach for improving children's working memory is Cogmed computerized training. This training was found to be successful in several studies (e.g., Holmes, Gathercole, & Dunning, 2009; Holmes et al., 2010; Klingberg et al., 2005; Thorell, Lindqvist, Bergman Nutley, Bohlin, & Klingberg, 2009). However, other authors advised more caution in the interpretation of results (Shipstead, Hicks, & Engle, 2012). Specifically, these authors claimed that Cogmed improves performance on tasks that resemble Cogmed training, but probably does not transfer to untrained tasks. Several studies have also tried to implement Cogmed to also improve recipients' inhibitory control abilities, with partial success. Specifically, whereas gains in inhibitory control following Cogmed practice were observed in middle childhood (Karbach & Kray, 2009), none were observed in preschool children (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005; Thorell et al., 2009).

School curricula were designed to more specifically address children's self-regulatory capacities of inhibitory control. For example, the Promoting Alternative Thinking Strategies (PATHS; Greenberg, Kusche, Cook, & Quamma, 1995) curriculum involves classroom lessons and students' practice of inhibitory control and emotion identification, on children's self-regulation. Riggs, Greenberg, Kusché, and Pentz (2006) found that students (second and third graders at pretest) participating in PATHS performed better than control children on measures of executive function (inhibitory control) and verbal fluency. However, these results were not replicated in other intervention studies that used the PATHS (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Domitrovich, Cortes, & Greenberg, 2007).

The *Tools of the Mind* (Tools; Bodrova & Leong, 2007) is an intervention program that focuses specifically on promoting young children's (aged 3–6) executive functions, including self-regulatory capacities. This program was inspired be Vygotsky (1978), who emphasized the importance of social pretend play for early development of executive functions. During pretend play, children must inhibit acting out of character, remember their own and others' roles, and flexibly adjust as their friends improvise. Such play exercises all three core EFs and is central to Tools. Diamond et al. (2007) demonstrated the effectiveness of the Tools curriculum to children's three aspects of executive function among young children. However, more research is needed to establish the effectiveness of Tools and similar programs in improving children's executive functions. These efforts should extend beyond specific populations and age levels and explore the mechanisms through which these programs exert their changes.

There are also several studies that explored the effectiveness of both habitual (also referred to in the literature as "chronic") and singular (also referred to in the literature as "acute") physical activity on children's executive functions (for a review, see Best, 2010). It was suggested that this effect was typical to forms of exercise that are cognitively engaging and that this cognitive engagement inherent in exercise may help explain how exercise impacts cognition (Sibley & Etnier, 2003; Tomporowski, Davis, Miller, & Naglieri, 2008).

Along the same lines, Diamond (2012) suggested that exercise alone may be less effective in improving children's executive functions than activities that involve both exercise and character development (e.g., traditional martial arts) or activities that involve both exercise and mindfulness (e.g., yoga). For example, Razza, Bergen-Cico, and Raymond (2015) showed that preschoolers (3- to 5-year-olds), who went through a daily mindful yoga practice for a year, performed better than control children on several indices of self-regulation (including effortful control). Similarly, Lakes and Hoyt (2004) randomly assigned children in kindergarten through fifth grade (5- to 11-year-olds) by homeroom class to take part in either traditional taekwondo or standard physical education. Students in the taekwondo group improved more than students in the standard physical education group in working memory and on several dimensions of inhibitory control.

Nevertheless, the claim that martial arts may promote children's executive functions was criticized by other authors (Mercer, 2011; Strayhorn & Strayhorn, 2011), doubting the scientific status of the evidence showing such links. Furthermore, beyond criticizing the quality of research, Strayhorn and Strayhorn (2011) espoused an educational and ethical stance and claimed that "in a world beset by violence, there is irony and pathos in hoping that our children will be improved by teaching punching, kicking, and tripping" (p. 310).

## Conclusions and Future Research Directions

There are a number of important conclusions that could be drawn from the current review:

**There is a lack of clarity in the definition of self-regulation and its subcomponents**. Like many others before us (e.g., Liew, 2012; McClelland & Cameron, 2012; Zhou et al., 2012), we identified some inconsistencies and overlaps in the various definitions of self-regulation and its subcomponents. This may be the result of self-regulation being the focus of two distinct research traditions, one that views self-regulation from a cognitive perspective and another focusing on the affective aspects of self-regulation. These two research traditions have identified constructs and developed measures independently, and this resulted in major overlaps. Perhaps one solution to this state of affairs is to reconstruct measures within each research tradition that are conscious of the definitions and measures created within the other tradition. For example, conceptualize effortful control measures as those tapping "hot" self-regulation and inhibitory control measures as those tapping "cold" self-regulation, as we tried to demonstrate

in the current chapter (see "Inhibitory Control" and "Measures of Emotional Self-Regulation and Effortful Control in Childhood" sections).

Moreover, we suggest that current definitions of self-regulation do not do full justice to the complex set of behaviors and mental representations that children may be using to gain control over their own and others' behaviors. Most definitions (as is the one we suggested at the beginning of this chapter) focus on self-soothing and attention control, yet children as young as 2 can use a chain of behaviors in response to actions and events in their environment that require regulating their arousal levels. For example, they may fail to self-regulate based on traditional definitions when they do not receive the toy they wanted (i.e., respond with a temper tantrum) but later may show prosocial behavior that hints on a connection they make to the previous act (e.g., give the toy they received after the tantrum to their sister to play with). We suggest that researchers should reconsider current definitions of self-regulation to include also the chain of reactions that may occur after the initial trigger.

A promising line of research that could provide insight into such complexities is the study of different emotion regulatory strategies (Gross, 1998), which has been mostly applied to adults' population. As several studies have demonstrated that children use emotion regulatory strategies such as reappraisal (e.g., McRae et al., 2012), we advise a more thorough scrutiny of the different tactics both young and older children use to regulate their emotions.

**Whereas the ability to self-regulate has clear developmental advantages, its limitations should also be considered.** Related to the last point we just made, the restrictive definitions of self-regulation may prevent us from focusing not only on the potential problems that are associated with dysregulation but also on the possible advantages that may exist in some unregulated behaviors.

We have discussed earlier that there are clear developmental benefits to the seeming inability to efficiently and independently regulate during the first 3 years of life. The knowledge that we pose today on the development of the PFC and the likely evolutionary trade-off occurring during these early years (i.e., cognition without control: young children cannot efficiently regulate but still learn multiple skills in the most efficient way; see "Self-Regulation in Infancy and Toddlerhood (Ages 0–3" section) should inform practitioners developing intervention programs for infants and toddlers perhaps not to put too much emphasis on teaching and enhancing regulation abilities during these years.

Moreover, this knowledge should also inform our thinking and research on self-regulation in later years. As mentioned earlier, traditional thinking on self-regulation is pretty much one directional in nature, i.e., self-regulation is almost always considered as advantageous for the development of children, whereas dysregulation is always considered a disadvantage. This line of thinking has led to the fact that there are no studies focusing on the possible advantages of dysregulation. For example, is it possible that children showing difficulties to self-regulate think more innovatively? Perhaps because they rarely fit the box, they are forced to think "outside the box"? We believe that future research should explore these possibilities by, for example, (a) designing studies focusing on measuring outcomes that are different from the usual school readiness and adjustment constructs that are typically measured in relation to self-regulation and (b) studying in depth children with self-regulation problems who are still successful in school and in other aspects of their lives. This type of research could certainly inform the practices of educators and clinicians committed to improve the developmental outcomes of children with self-regulation difficulties.

**The associations between self-regulation and psychopathology should be more specifically explored.** We have reviewed above the abundance of literature on the links between self-regulation and psychopathology with a majority of studies showing links between self-regulation failures and various adjustment problems. However, in order to advance the field, the developmental pathways by which early

self-regulation problems affect later externalizing and internalizing problems should be further explored. In addition, existing research on these links did not control sufficiently for the possible overlap between different developmental problems, for example, differentiating externalizing problems that are or are not the result of ADHD or differentiating anxiety and depression when examining the links between self-regulation and internalizing problems.

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