CHAPTER 14

Development and Self-Regulation

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> "When you rule your mind you rule your world."
>
> —Shanklin, 1929, p. 22

Self-regulation has received heightened attention as a key mechanism that predicts a variety of outcomes including school readiness (Blair & Razza, 2007; McClelland et al., 2007; Morrison, Ponitz, & McClelland, 2010), academic achievement during childhood and adolescence (Cameron Ponitz, McClelland, Matthews, & Morrison, 2009; Duckworth, Tsukayama, & May, 2010; Li-Grining, Votruba-Drzal, Maldonado-Carreño, & Haas, 2010; McClelland, Acock, & Morrison, 2006), and long-term

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health and educational outcomes (McClelland, Acock, Piccinin, Rhea, & Stallings, 2013; Moffitt et al., 2011). Although researchers have studied self-regulation from a diverse set of perspectives, the literature clearly suggests that self-regulation has important implications for individual health and well-being starting early in life (Geldhof, Little, & Colombo, 2010; McClelland, Cameron Ponitz, Messersmith, & Tominey, 2010). In the fields of child psychology and developmental science, an emphasis on Relational-Developmental-Systems (RDS; Overton, 2013; Overton & Lerner, 2012) illuminates how self-regulation may impact individual development.

This chapter reflects the RDS theoretical orientation and explores major issues in the study of self-regulation in childhood and adolescence. The chapter starts by situating the study of self-regulation within a RDS context and discussing conceptual issues, such as relative plasticity, that guide researchers' understanding of the development of self-regulation. Next, the chapter defines self-regulation and reviews research on important correlates of self-regulation including academic achievement, motor processes, intelligence, and risk factors. It then discusses cross-cultural variation in these skills, and person-context relations. The chapter concludes by discussing self-regulation from the perspective of RDS and next steps for the field of self-regulation including studying self-regulation in context, improving intervention efforts, and advancing analytical and measurement methods.

HOW RELATIONAL-DEVELOPMENTAL-SYSTEMS INFORMS RESEARCHERS' UNDERSTANDING OF SELF-REGULATION

Relational-Developmental-Systems (RDS) rejects the mechanistic notion that a person's development can be separated into additive components such as genes or elements of the context in which a person lives (Lerner, 2006; Overton, 2006, 2011, Chapter 2, this *Handbook*, this volume). All development represents a bidirectional (←→) and dynamic process of person–context relationships and these are mutually regulating. Self-regulated action represents the processes through which a person regulates his or her environment, whereas the context provides conditions that similarly regulate the person's development. Due to their coregulatory nature, these bidirectional relations have been called developmental regulations (Brandtstädter, 2006). Developmental regulations occur in multilevel contexts and involve mutually coacting relations among genetic, epigenetic, cellular, neural, behavioral, and contextual levels of influence (Gottlieb, Wahlsten, & Lickliter, 2006; Lickliter & Honeycutt, Chapter 5, this *Handbook*, this volume). Related to this is the concept of *probabilistic epigenesis*, which holds that individual development is a result of dynamic and continuous bidirectional coactions between such different levels of influence. A set genotype can result in a probabilistically distributed array of phenotypes due to contextual processes that can occur at multiple levels of the developing person ←→ context system. Similarly, theories have emphasized the probabilistic and indeterminate nature of self-regulation, which has especially important implications for the understanding of how self-regulation develops in childhood and adolescence (Blair & Raver, 2012b; McClelland et al., 2010).

The RDS perspective arises from a relational metatheory that follows in a long line of integrative epistemologies such as Kant's efforts to reconcile rationalism and empiricism and Hegel's dialectical synthesis of the knower and the known (Overton, 2013). Relational perspectives emphasize cohesive integration (i.e., *holism*) as a fundamental guiding principle. Holism stands in direct contrast to atomistic approaches that imply an immutable reality composed of elements that preserve their identity regardless of context (Overton, 2006, Chapter 2, this *Handbook*, this volume). Under holism, the whole exists as an organized and self-organizing system of parts, each defined by its relations to other parts and to the whole itself (Overton, 2006). Key empirical issues for developmental scientists interested in describing, explaining, and promoting positive human development are therefore composed of five interrelated questions, which can be directly applied to the study of self-regulation:

1. What is the nature of self-regulation?
2. How is self-regulation expressed differently in different people?
3. How is self-regulation implicated in positive human development?
4. Self-regulation supports positive human development in relation to what contextual/ecological conditions?
5. At what points during ontogenetic, generational, and historical time does self-regulation support positive development?

Considering these five related questions has direct implications for empirical research on the development of self-regulation across the life span.

Core Issues Related to the Development of Self-Regulation

RDS consider living organisms to be *active agents*, "that is, as relational, spontaneously active, complex adaptive systems, that are self-creating (i.e., enactive; autopoetic), self-organizing (i.e., process according to which higher level system organization arises solely from the coaction of lower-level components of the system), and self-regulating" (Overton, 2013, p. 53). The core concepts of RDS and related perspectives (e.g., dialectical systems, Kuczynski & De Mol, Chapter 9, this *Handbook*, this volume; dynamic systems, Witherington, Chapter 3, this *Handbook*, this volume) inform how self-regulation and its development are presented in this chapter. The fundamental RDS concepts that frame the understanding of self-regulation development include *relative plasticity, multifinality, equifinality*, and *canalization*.

Relative Plasticity

Relative plasticity reflects a person's capacity for change. Intervention research (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Raver et al., 2011) and theoretical perspectives (Bateson, Chapter 6, this *Handbook*, this volume; Bateson & Gluckman, 2011; Lerner, 2006) suggest that self-regulation shows plasticity throughout the life span. The relative plasticity of self-regulation is affected by biological, behavioral, and contextual factors, such as when temperamental predispositions and aspects of the context influence a child's ability to regulate his or her thoughts, feelings, and behavior. These self-regulated actions can alternatively increase or constrain the child's potential for change over the life span, depending on the degree to which his or her self-regulated actions align with the strengths and resources found in his or her context (Lerner, 2006). For example, a child who has a difficult temperament but who has sensitive parents who modify their parenting to fit with her temperamental style may exhibit greater plasticity in the development of her self-regulation compared to a child whose difficult temperament fit poorly with her parents' parenting style.

The RDS view of development reflects conceptual and theoretical shifts away from problem-focused views of development toward views that focus on optimizing development and the possibility of change throughout a person's life. On the one hand, this suggests that there are many opportunities for children to develop strong self-regulation skills. In fact, researchers have identified windows of opportunity during early childhood and adolescence that represent sensitive periods for the development of self-regulation (Diamond, 2002; Zelazo, Carlson, & Kesek, 2008). On the other hand, the notions of relative plasticity and sensitive periods imply that the potential for change is not limitless and that the degree of plasticity may vary across the life span (McClelland et al., 2010). Although a child may have the potential to strengthen his or her self-regulation skills throughout childhood and adolescence, contextual factors such as parenting style and quality of the home and school environments can also limit plasticity. For example, children who grow up in the context of sociodemographic risk are more likely to face difficulties developing the regulation skills that would enable them to function adaptively in broader society. Such limited skills may in turn exacerbate developmental constraints related to the increased stress, chaos, and instability often found in these children's contexts (Blair, Granger, et al., 2011; Blair & Raver, 2012a; Sektnan, McClelland, Acock, & Morrison, 2010). However, contextual factors such as safe neighborhoods, high-quality schools, and strong teachers can also provide important buffers against the constraints inherent in adverse environments, which would work to strengthen plasticity in a child.

In addition to contextual factors, person characteristics such as temperamental reactivity and emotionality can work to strengthen or constrain the child's capacity for self-regulation (Lengua, 2002; Rimm-Kaufman & Kagan, 2005). Together, contextual and person factors that lead to developmental constraints or opportunities can limit or strengthen the potential for the development of adaptive self-regulation as children grow. Further, early experiences establish the foundation for later experiences (Entwisle, Alexander, & Olson, 2005; Heckhausen & Schulz, 1999), implying that the ability to regulate one's behavior may continue into later periods of the life span (McClelland et al., 2010). In sum, the plasticity of self-regulation is a positive feature of human development, but it is not without limits. Plasticity varies across development, and the potential for plasticity is a function of the many contextual and individual factors that coact to affect development (Heckhausen & Schulz, 1999; Lerner, 2006).

Multifinality and Equifinality

Along with relative plasticity, the concepts of multifinality and equifinality (Cicchetti & Rogosch, 1996; Overton, 2010) inform the field's understanding of the development of self-regulation. Here, *multifinality* describes

developmental processes that share a similar starting point (e.g., similar backgrounds, attending the same schools), but reach diverse outcomes. According to multifinality, the same set of self-regulatory skills may result in different outcomes for different people who develop in different contexts. Inversely, *equifinality* suggests there are multiple ways of attaining any given outcome, especially when that outcome requires aligning a person's unique strengths with the unique opportunities afforded by his or her context.

To illustrate multifinality and equifinality, imagine two children, Sophia and Lucy, who are best friends in preschool. Sophia and Lucy both come from families with highly educated parents who live in the same neighborhood. Yet despite these similarities, the two friends experience quite different pathways of development. Sophia has a fairly easy and nonreactive temperament, does well in school and goes to college. She eventually becomes a successful doctor who is passionate about her work. In contrast, Lucy has a more reactive temperament, dislikes school, and gets by with Cs. Although her parents send her to a local college, she does not find anything that interests her. She ends up with a low-wage job at a factory where she remains for many years. When the factory relocates overseas, Lucy decides to go back to school and earn a master's degree. She becomes a career counselor and goes to work at her old high school, which she finds very satisfying. Sophia and Lucy experience similar environmental conditions in early childhood but different paths early in adulthood (multifinality). Later, however, both obtain satisfying careers, suggesting equifinal outcomes that emerge from very different experiences in early adulthood. Thus, by taking a life-span perspective, seemingly incompatible concepts such as multifinality and equifinality may prove useful.

Self-regulation research, in fact, supports both multifinality and equifinality. For example, in one cross-sectional study of twins (Deater-Deckard, Petrill, Thompson, & DeThorne, 2005), characteristics of the family and early environment predicted children's task persistence in early childhood (an aspect of self-regulation). For older twins, however, child factors such as an intelligence measure and observer ratings of problem behaviors were relatively stronger predictors of task persistence compared to characteristics of the family and early environment (Deater-Deckard et al., 2005). In other words, results with older children suggested a greater influence of individual characteristics and mulifinality in outcomes compared to younger children.

In a study supporting equifinality, children who were rated as having strong attention when they were 5 or 6 years old were more likely to graduate from high school regardless of their socioeconomic background, compared to children who were viewed as having attention problems (Vitaro, Brendgen, Larose, & Tremblay, 2005). Another study found that children who were rated as having strong attention and persistence at the age of 4 had nearly 50% greater odds of completing college by the age of 25, after controlling for a host of background variables (McClelland et al., 2013). This research suggests that self-regulation may be a key developmental factor that helps children reach similarly positive outcomes even if they come from diverse backgrounds (equifinality). Taken together, these studies suggest that self-regulation shows multifinality and equifinality, depending on person and contextual factors.

Canalization

Equifinality and multifinality are closely related to the concept of experiential canalization (Blair & Raver, 2012b; Gottlieb et al., 2006). *Experiential canalization* refers to the coaction of biology and experience, which together influence behavior over time, and thus shape development. Taken in terms of Waddington's epigenetic landscape (Waddington, 1942; see Bateson, Chapter 6, this *Handbook*, this volume), the coaction of biology and experience therefore influences the channels dictating which developmental outcomes are most likely to occur. This can be seen early in life, when dynamic and bidirectional coactions with different aspects of children's environments (e.g., parents, siblings, peers, school and social contexts) lead them to develop differing self-regulatory skills, even when their temperamental characteristics are similar at birth. For example, a temperamentally reactive child may experience more difficulty regulating himself early in life but may develop strong self-regulation because his parents teach and model strategies to manage his reactivity. This child may continue to be generally more reactive as he grows older, which can develop into an asset that enables higher levels of enthusiasm and engagement.

Together, the core issues of relative plasticity, equifinality, multifinality, and experiential canalization suggest that the development of self-regulation fits well within a Relational-Developmental-Systems framework (Lerner, 2006; Overton, 2010). The next section discusses the action theoretical perspective, which falls under the larger umbrella of RDS, and focuses directly on self-regulation.

How Action Theory Models Inform Approaches to Self-Regulation

Action Theory is one of the most prominent approaches currently subsumed under the RDS perspective. Action Theory targets active agents and how they affect their contexts in ways that meaningfully regulate their own development. Action theoretical models thus represent a class of RDS theories that focus on self-regulated action and its role in developmental regulations.

Action and Agency

Action theories all approach action from the perspective of personal agency (Sokol, Hammond, Kuebli, & Sweetman, Chapter 8, this *Handbook*, this volume). For example, Brandtstädter (1998, 2006) defines "actions" as necessarily related to intentional states such as goals, and under at least partial personal control. Because self-regulation encompasses both conscious and nonconscious phenomena (see Baumeister & Vohs, 2004), action theories are primarily concerned with what Gestsdóttir and Lerner (2008) call intentional self-regulation. An admittedly arbitrary demarcation, intentional self-regulation requires a degree of conscious intention that more automatic forms of self-regulation do not (Gestsdóttir & Lerner, 2008; see, however, Overton, 2013, for the role of conscious, but non-self-conscious acts and intention in action theories). For example, organismic self-regulation represents largely physiological processes that lie outside of one's conscious control (e.g., hypothalamic control of body temperature). Automatized aspects of self-regulation similarly include actions and action-related processes that occur subconsciously through internalization (see Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001). In contrast to these less-conscious forms of self-regulation, intentional self-regulation represents explicitly conscious actions such as resisting the temptation to eat a fattening dessert by reminding oneself of the importance of maintaining a healthy weight.

By emphasizing intentional self-regulation, action theories highlight the person's active control over developmental regulations. Action theories therefore speak directly to the now-common notion that people actively produce their own development through intentional person ←→ context relations (e.g., Lerner, 1982). Action theories thus emphasize personal control over development while acknowledging that self-regulated actions occur within a fully relational integrated person-context system.

Action Is Broadly Defined

As noted by Brandtstädter (1998, 2006) action-theoretical approaches are largely concerned with the role that conscious actions play in developmental regulations, but consider a heterogeneous array of action components. For example, Baltes and colleagues' Selection, Optimization, and Compensation model (e.g., Baltes & Baltes, 1990; Freund & Baltes, 2000) delineates between actions that have different functions. Their model separates goal selection from actions that optimize already-selected goals, and differentiates selection and optimization processes from the compensatory behaviors that allow people to implement a dynamically changing set of means to bypass obstacles and reach their goals. The SOC model therefore hypothesizes that qualitatively distinguishable, yet simultaneously related, self-regulatory processes have an impact on behavior during different stages of the goal pursuit. For instance, imagine Brian, an adolescent who has just transitioned to high school. During middle school Brian participated in a number of different sports, but he finds that these same sports require a greater time investment in high school. Because his after-school time is limited, Brian must therefore choose which sport(s) he will continue playing and which he will discontinue. The ability to weigh the pros and cons of each sport and to make a decision to pursue some, but not all, of his athletic goals requires Selection skills as hypothesized by the SOC model. The skills required for goal selection differ from the self-regulatory skills that allow Brian to optimize his athletic performance (e.g., following a daily training regimen), and these optimization skills differ still from the self-regulatory strengths that Brian will rely on when something does not go according to plan. For instance, regular practice failed to improve Brian's batting skills and he compensated for this failure by consulting an outside hitting coach.

Brandtstädter and Renner's (1990) dual process model alternatively delineates between assimilative actions that directly influence the external context through, for example, requesting that another student stop talking so one can work, and accommodative actions such as deciding to do one's work at home, which directly influence a person's own cognitive processes. Although both models are distinctly action theoretical, they approach self-regulated action from different angles and are somewhat complementary. Aspects of goal selection can alternatively be considered as assimilative (e.g., selecting the goal to acquire a new resource) or accommodative (e.g., restructuring

one's goal hierarchy in response to some external demand), for instance.

The above models differentiate different types of self-regulated actions based on qualitative characteristics, but action theoretical models encompass a much broader swath of research than this example may imply. For example, Brandtstädter (1998, 2006; Geldhof et al., 2010) describes four general categories of action theory. Structural theories focus on the structural analysis of actions and cognitive operations, such as Piaget's emphasis on the development of cognition's foundational components (e.g., transitivity, conservation; Piaget, 1970). Motivational theories instead highlight factors that motivate action such as expectancies for and the estimated value of success (see Eccles, 1983), control-systems theories draw from cybernetic and systems-theoretical models (e.g., Norman & Shallice, 1986), and social-constructivist theories emphasize cultural symbols, such as the meaning of specific words and hand gestures, and the roles these symbols play in the development of actions (e.g., Vygotsky, 1978).

ACTION AND DEVELOPMENT OCCUR IN A RELATIONAL INTEGRATED PERSON-CONTEXT SYSTEM

RDS in general, and action theories in specific, emphasize cohesive integration at all levels of science. Of particular interest to research on self-regulation, this integration suggests that researchers can only approach developmental regulations as occurring through the gyrations of a unified person-context system. Many authors have heuristically described this unity of person and context by emphasizing the completeness and bidirectionality of person-context coactions. This chapter adopts the completeness of this integration, and underscores that the person can only be truly defined as a subset of the larger contextual whole; the context exists as a set of multiple coacting parts, some of which exist as developing persons. When it comes to measurement, it may be virtually impossible to assess every factor that contributes to developing self-regulation. Yet using the RDS lens means acknowledging the relational and holistic nature of the person ←→ context system in the design and selection of measures, and in the interpretation of results.

This dynamic picture of individual development characterizes the present discussion of self-regulation across the life span and specifically, across childhood and adolescence. For example, Emily is an active, happy baby, with a relatively easy temperament. She adjusts easily to routines and calms down once upset. She can self-soothe (i.e., self-regulate) by sucking on her pacifier when she gets scared or distressed. One of her parents also has an easy temperament and may have passed this to Emily in part by responding calmly to Emily even when Emily is very upset. Emily's parents are consistently warm and responsive, which creates a good fit between her temperament and her parent's parenting style. This creates a positive set of coactions between Emily and her parents that sets the stage for strong regulatory skills throughout Emily's life.

In contrast, imagine Noelle, a baby who is often fussy and has a more difficult temperament. Noelle has difficulty adapting to routines and novelty easily distresses her. She also has trouble calming down when she is upset. Research suggests that the development of Noelle's self-regulation skills will be facilitated by parenting that fits well with her temperamental style. In other words, Noelle's self-regulation is likely to be strengthened if her parents are patient, warm, and responsive, and also model adaptive and positive self-regulation skills. However, if Noelle has parents who have difficult temperaments themselves or who live in chronic poverty, Noelle may be less likely to receive the quality of parenting needed for her to develop strong self-regulation skills (Blair & Raver, 2012a; Evans & Rosenbaum, 2008; Wanless, McClelland, Tominey, & Acock, 2011). Moreover, without additional support, Noelle may have difficulty with self-regulation as she moves through childhood and adolescence.

The complete fusion of person and context has two immediately salient implications for self-regulation research. First, the fusion of person and context suggests that self-regulation cannot exist as a person-level characteristic. Instead, self-regulation can be demonstrated by direct and indirect processes by which the person affects his or her surrounding context. For example, a child can directly resist the temptation to hit another child and also use self-talk and calming strategies to indirectly control the surrounding environment (e.g., helping to maintain a peaceful classroom climate by avoiding aggression). Any aspect of self-regulation can therefore only be measured—and indeed exist—as a specific component of the relational person ←→ context system. From this view, global measures of self-regulation thus can be considered heuristic proxies that estimate generalities that exist across many contexts.

As such, summary measures of self-regulation prove especially useful when predicting similarly domain-general measures of positive development that aggregate information about multiple contexts (see Geldhof et al.,

2010; McClelland et al., 2010). Lerner and colleagues, for example, have consistently shown positive relations between a domain-general measure of self-regulation and a similarly broad measure of positive youth development (e.g., Bowers et al., 2010; Lerner et al., 2005). Here, the domain-general measure of self-regulation measured goal-directed behaviors without referencing any specific context (e.g., "I make every effort to achieve a given goal"), whereas the domain-general measure of positive development aggregated information about multiple contexts such as academic and social skills (e.g., being good at school work, having a lot of friends), as well as connection to participants' families, peers, and social institutions (e.g., feeling important and useful in a family, having adults in the community listen).

Because domain-general measures either aggregate information across contexts or ask for information without specifying a specific context, such measures necessarily gloss over the highly idiographic nature of real-world self-regulated behaviors. Observing self-regulation means observing people with unique sets of self-regulatory strengths coacting with their equally unique contexts. Examining the relations among self-regulation and context-specific outcomes may accordingly require more nuanced measurement tools as well as more idiographic study designs (Molenaar & Nesselroade, Chapter 17, this *Handbook*, this volume; Nesselroade & Molenaar, 2010). For example, studies have suggested that domain-specific indices of positive development, such as academic competence, may be more strongly related to same-domain indices of self-regulation, such as the ability to select academic goals that align with one's personal strengths and skill level, than to domain-general indices of self-regulation such as inhibitory control (e.g., Geldhof, Little, & Hawley, 2012).

The utility of the domain-general/domain-specific distinction, however, is under debate for measurement as well as theoretical conceptualizations of self-regulation (Garon, Bryson, & Smith, 2008; Lewis & Todd, 2007; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Wiebe et al., 2011). This shift parallels neurological evidence that move theories away from the notion of specific brain locations that are linked to specific skills, and toward the idea that networks of brain areas are activated in any given task, albeit with the origin of activation fixed for a given task (Dehaene, 2011). Further, more complex and less automated tasks activate a greater number of neurological areas, especially in the prefrontal cortex (Colom, Jung, & Haier, 2006; Floyer-Lea & Matthews, 2004). The issues of measurement are discussed later in the chapter, focusing first on conceptual and definitional issues related to self-regulation.

Nonrelational Systems Theories and Perspectives of Self-Regulation

The relational developmental systems perspective offers a broad theoretical framework that integrates disparate approaches to human development. Doing so requires that relational models account for the unity of outwardly contradictory constructs and ideas (i.e., the identity of opposites; Overton, 2010), while simultaneously acknowledging their very real and practically meaningful uniqueness (i.e., the opposites of identity; Overton, 2010). However, fully relational approaches can result in highly complex theories, models, and analyses. Research goals certainly exist that do not necessarily require a high degree of complexity for parsimoniously examining inter- and intraindividual differences in self-regulation. In fact, a great deal of the self-regulation literature does not explicitly acknowledge the fusion of person and context.

For example, other perspectives place more emphasis on the relative stability and genetic contributions of the executive function components of self-regulation (Miyake & Friedman, 2012; Miyake et al., 2000). According to the unity/diversity framework of executive function proposed by Miyake and colleagues (Miyake & Friedman, 2012; Miyake et al., 2000), self-regulation reflects both common and separate underlying cognitive processes. Moreover, this framework argues for substantial genetic contributions to and relative stability in children's self-regulation. In contrast, others such as Blair and Raver (2012a, 2012b) use Gottlieb's (Gottlieb, 2007; Gottlieb et al., 2006) psychobiological theory and concept of experiential canalization concept to describe self-regulation as the complex and dynamic interplay among multiple levels of influence. This view also acknowledges the malleability of self-regulation in young children. Similarly, a relational perspective is used to frame and integrate the discussion of self-regulation in this chapter. However, it is important to note the diversity of theoretical perspectives inherent in self-regulation research and that not all research in this area stems from this view.

DEFINITIONS OF SELF-REGULATION AND RELATED CONSTRUCTS

The theoretical *concept* of self-regulation refers to taking in information, weighing choices and consequences, and

making adaptive choice(s) to attain a particular goal. Beyond this broad definition, which is generally agreed on, there are debates about the scientific *constructs* that represent self-regulation. These include the nature and type of information that is relevant in the decision process, the process(es) by which a person weighs choices and consequences including the role of emotion, what constitutes "adaptive," what is meant by "goal," and what to call these different components.

What Is Being Measured?

There is considerable debate concerning the definition of the construct of self-regulation and the terminology used when discussing its associations with developmental outcomes. This is partly due to the importance of self-regulation for a diverse number of fields, all of which use different methods to examine phenomena related to self-regulation in childhood and adolescence. Table 14.1 shows some examples of how different fields adopt different terms to describe the complex construct of self-regulation and its subcomponents. For example, executive function (EF) originated in clinical and neuropsychology and includes the components of attentional switching and working memory; and developmental psychologists have studied delay of gratification in normative samples of children (Duckworth & Kern, 2011; Mischel et al., 2011). *Effortful control* was coined by personality scholars to describe the early-life precursor to the conscientiousness trait of the Big Five model of personality in adulthood (Rothbart, 2007).

Construct differences have diminished as methodological approaches incorporate measures from multiple disciplines (Wolfe & Bell, 2007). This also highlights the utility of using domain-general and domain-specific measures of self-regulation, depending on the research question. In an attempt to clarify constructs and measures, researchers sometimes use different levels of analysis (e.g., neurological activation, physiological responses, observed behavior, or self-report). Low to moderate correlations, however, are typically observed for self-regulation tasks across raters, settings, and demand characteristics of tasks (Duckworth & Kern, 2011). For example, in a meta-analysis of 282 samples including more than 30,000 participants, Duckworth and Kern (2011) examined correlations among diverse measures of self-regulation and self-control. Studies assessing executive function, delay of gratification tasks, and observer and self-report measures were included. Given that all studies purported to measure self-regulation or its analogues, the authors found fairly low effect sizes of associations, averaging 0.27, but with substantial variability. Somewhat encouragingly, the source of the information (e.g., published article, chapter, dissertation, or e-mail to authors) did not suggest a publication bias where stronger effect sizes appeared in the published literature more often than did weaker effect sizes. The year of study was also not a predictor, which suggested that convergent validity in the measurement of self-control has been consistent for the past 45 years. These results therefore indicate that self-regulation measures are substantially distinct from one another and this has been the case for most of the time the construct has been studied.

Research has also supported the notion that common measures of self-regulation likely suffer from substantial levels of measurement error. For example, one study found

TABLE 14.1 Examples of Variation in Terminology in the Study of Self-Regulation

Field	Terms	Component(s)	Time Span
Clinical psychology	Signal detection	Perceptual sensitivity	<Seconds
		Drift rate	<Seconds
		Reaction time	<Seconds
Neuropsychology	Executive function	Attention/ switching	<Seconds
		Working memory	<Seconds
		Inhibitory control	<Seconds
Cognitive psychology	Fluid cognition	Perceptual speed	<Seconds
		Processing speed	<Seconds
		Manual dexterity	<Seconds
Developmental psychology	Delay of gratification	Thought suppression	<Seconds <Minutes
	Behavioral self-regulation	Attention/ switching	<Seconds
		Working memory	<Seconds
		Inhibitory control	<Seconds
		Distraction	<Seconds
		Impulse control	<Minutes
Personality psychology	Temperament	Conscientiousness	<Minutes
		Effortful control	<Minutes
		Grit/self-control	<Weeks/years
Educational psychology	Engagement	Time-on-task	<Hours
		Flow	<Hours
		Persistence	<Minutes
Life-span psychology	Goal-attainment	Selection, optimization, and compensation	<Weeks/years
		Primary versus secondary control	<Weeks/years

that one-fifth of the variance in teachers' ratings of 3- to 5-year-olds' self-regulation (defined as social competence and problem behaviors) was due to nonchild characteristics such as teachers' ethnicity, their self-reported self-efficacy for teaching, and whether their preschool classroom was located in a school or in an early childcare center (Mashburn, Hamre, Downer, & Pianta, 2006). In another study, Crane and colleagues found that teacher and parent ratings were more disparate for children of low and high directly assessed language and cognitive ability level, compared to children of average ability (Crane, Mincic, & Winsler, 2011). When children had low abilities, parents rated their children's social competence (initiative, self-control, and behavior problems) better than did their teachers. In contrast, when children had high abilities, teacher ratings were higher than parent ratings of social competence (Crane et al., 2011).

Finally, a study of 4- to 6-year-olds showed that the amount of assessor variance in child assessments administered by independent assessors was negligible but that the assessor variance for teacher assessors was substantial (Waterman, McDermott, Fantuzzo, & Gadsden, 2012). This suggests that large amounts of variability in teacher-administered measures were not related to children's own performance but rather to the teachers who administered the assessments. These studies illuminate potential sources of "error variance" in children's scores on an observer-reported measure. They also illustrate how a child's self-regulation is not necessarily inherent to the child but is a function of many other variables including the adult giving the rating and aspects of the social context.

Sources of variance are especially important to consider when studying self-regulation. However, the low to moderate effect sizes observed in Duckworth and Kern's (2011) meta-analysis suggest that self-regulation may encompass multiple oblique factors rather than standing alone as a unitary construct. Even if a generous amount of measurement error is allowed in the operationalizations of self-regulation considered (i.e., $\alpha = .60$), the average interitem correlation in the above meta-analysis adjusts to $.27/(\sqrt{.6}\sqrt{.6}) = .45$. A disattenuated correlation of .45 suggests that the items share approximately 20% of their total variance and does not indicate unidimensionality.

Duckworth and Kern (2011) suggest approaches to dealing with this issue such as using multiple methods, both domain-general and domain-specific, to assess self-regulation or relying on observer-report when only a single measure of self-control can be collected. For example, the 10-item classroom self-regulation subscale from the Child Behavior Rating Scale (Bronson, 1994) is related to both directly assessed self-regulation and academic achievement (e.g., Cameron Ponitz, McClelland et al., 2009; Wanless, McClelland, Acock, et al., 2011), and was adopted by the state of Oregon as part of their kindergarten assessment battery. When multiple measures are possible, Duckworth and Kern also advise using aggregate or latent scores of these measures to result in a single score with stronger reliability (Willoughby, Blair, Wirth, & Greenberg, 2012). Such analytic workarounds treat the lack of measure convergence as "error variance," that is, idiosyncrasies in children's responses that are unique to the person being tested as well as aspects of the setting (Duckworth & Kern, 2011). Examples might include the child's mood on the day of testing, whether the task was interrupted, whether the child was motivated by the particular rewards offered for doing the task, and who assigned the rating.

The diversity of self-regulation theories and the corresponding operationalizations suggest that the study of self-regulation lacks a cohesive framework. Nevertheless, such diversity is also a strength. This diversity provides a richness and depth of information regarding the development of self-regulation across childhood and adolescence. For example, infancy researchers often examine temperamental aspects of self-regulation, including activation and inhibition levels, and refer to the influence of effortful control and surgency for children's ability to self-regulate (Wolfe & Bell, 2007). Researchers who study self-regulation in early childhood are more likely to refer to a child's impulse control depending on specific task demands, such as teachers asking a child to wait while her peers line up at the classroom door (Smith-Donald, Raver, Hayes, & Richardson, 2007).

Several key aspects of self-regulation have proven especially useful to the study of children and adolescents. The purpose of the ensuing section, however, is not to provide an encyclopedic review of all self-regulation research. Instead, it shows how research from different perspectives can converge on an understanding of self-regulated action. It specifically considers the case of intentional self-regulation, which describes the person's deliberate regulation of his or her own attention, emotion, or behavior. Emotional and behavioral aspects of regulation are also included in the discussion (McClelland et al., 2010).

Executive Function

Cognitive researchers often examine the underlying components of executive function (EF), which is a complex

construct thought to underlie self-regulated action (Best & Miller, 2010). Executive function subsumes several disparate processes, suggesting that cognitive aspects of self-regulation can themselves be decomposed in numerous ways. The following cognitive processes are thought to be especially relevant to executive function and, in turn, self-regulated action: (a) attentional shifting, also referred to as cognitive flexibility and control, (b) inhibitory control, and (c) working memory (Best & Miller, 2010; Garon et al., 2008; McClelland & Cameron, 2012; Willoughby et al., 2012; Zelazo et al., 2008; Zelazo & Müller, 2002).

Attentional Flexibility and Control

Attentional flexibility and control are implicated in the infant's transition from simple arousal to fully endogenous attention in the first few years of life (e.g., Colombo, 2001), and the subsequent development of attentional capacities (e.g., Posner & Rothbart, 1998; Rothbart & Bates, 2006; Rothbart, Sheese, & Posner, 2007). Attention plays a major role in self-regulation as a gestalt phenomenon (e.g., Norman and Shallice's Supervisory Attention System; Norman & Shallice, 1986), and aspects of attention are especially intertwined with emotion regulation in infants and children (Sheese, Rothbart, Posner, White, & Fraundorf, 2008).

Attentional flexibility refers to the ability to voluntarily focus on a task and shift attention when needed (Rothbart & Posner, 2005). Attentional control and flexibility help children selectively emphasize goal-relevant environmental inputs, implicating attention in most developmental regulations. Furthermore, the role of attention in self-directed intentionality and responsiveness especially implicates attentional control as mediating agent-driven coactions between persons and their contexts. Attentional control thus serves as a key lynchpin of self-regulation throughout the life span.

Inhibitory Control

Attentional flexibility and control are strongly related to *inhibitory control*, which includes interference control of thoughts, attention, and memories; and response inhibition of behaviors (Diamond, 2013). Inhibitory control refers to the ability to inhibit a prepotent response and activate another, usually more adaptive, response (Diamond & Kirkham, 2005; Rothbart & Bates, 2006; Zelazo, Müller, Frye, & Marcovitch, 2003). Research suggests that children begin to display inhibitory control by approximately Age 3 (e.g., Posner & Rothbart, 1998), a period that also corresponds with the development of endogenous attention. Inhibitory control develops throughout childhood (e.g., Jones, Rothbart, & Posner, 2003), increasing throughout adolescence and into early adulthood (e.g., Hooper, Luciana, Conklin, & Yarger, 2004).

In terms of RDS, inhibitory control enables children to proactively optimize coactions with their contexts. Inhibitory control allows individuals to time their actions in ways that maximize adaptive development and allows them to inhibit immediately gratifying actions that may nevertheless lead to negative distal outcomes. Moreover, inhibitory control implies an increased level of personal effort and future-orientation and accordingly enables individuals to be more active producers of their own development. Inhibition also plays a major role in other conceptualizations of self-regulation such as effortful control and delay of gratification.

Working Memory

Working memory is another aspect of executive function and is closely related to inhibitory control (Best & Miller, 2010). Working memory includes actively working on and processing information and is demonstrated by a child who can remember and follow instructions in a multistep activity (Gathercole, Pickering, Ambridge, & Wearing, 2004; Kail, 2003). Working memory relates to academic success in young children (Gathercole & Pickering, 2000; Kail, 2003), and develops rapidly in childhood and adolescence with a substantial increase in capacity seen during these periods of the life span (Gathercole et al., 2004). Moreover, working memory constitutes a skill set that is related to intentional self-regulation. It enables children and adolescents to hold information in mind while they work and consider the best solution or strategy.

Complex and Combined EF Components

Research has differentiated responses that require inhibition only (children must stop or control motor activity) from relatively more complex responses that require inhibition of a dominant response *plus* activation of another, nondominant response (Blair, 2003; Dick & Overton, 2010; Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Müller, Baker, & Yeung, 2013; Sokol, Müller, Carpendale, Young, & Iarocci, 2010). For example, measurement research has examined conflict inhibition tasks such as the Head-Toes-Knees-Shoulders (HTKS) that requires stopping a response and initiating a new response, while also tapping working memory and attentional flexibility (McClelland & Cameron, 2012). In the task, children are asked to remember up to four paired rules for behavior

(e.g., "Touch your head" or "Touch your toes") and then asked to do the opposite in response to the given command. The task also increases in complexity as children progress through the items, requiring children to utilize working memory and attentional flexibility to remember new rules and switch attention from the old rule. The task has demonstrated strong interrater reliability, construct, and predictive validity in diverse samples in the United States, Asia, and Europe (Cameron Ponitz, McClelland, et al., 2009; McClelland et al., 2007; von Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011; Wanless, McClelland, et al., 2013). Future work must disentangle which cognitive components contribute most strongly across different ages and the different complexity levels of the task. For example, early in the task, when there are only two rules, inhibitory control may be most relevant; but later in the task, working memory and attentional flexibility may become more important because there are four rules to remember and the rules switch.

There is empirical evidence that the degree that each EF component relates to children's overall self-regulation skills may vary with age and skill level. In one study, Willoughby, Wirth, and Blair (2011) studied more than 1,000 children involved in the Family Life Project who were given measures of working memory, inhibitory control, and attention shifting. All tasks showed variability regardless of whether the child was from a low-income background or not. However, the attention-shifting task was better at distinguishing EF skills for low-ability children, the inhibitory control measure was best for children of average self-regulation ability, and the working memory task was the best for high-ability children. These results are interesting given developmental differences in how the underlying EF skills are thought to develop. Although all aspects of EF improve in the early childhood years, the developmental trajectories of skill components may be somewhat different. For example, research suggests that there is relatively more rapid development in inhibitory control in early childhood, which may influence the later development of attentional shifting and working memory (Best & Miller, 2010).

Further, EF appears more unitary for younger children but emerges as distinct components for older individuals (Best & Miller, 2010; Miyake et al., 2000). This finding is reflected in the unity/diversity framework by Miyake and colleagues (Miyake & Friedman, 2012; Miyake et al., 2000), which describes how components of EF show both unity (e.g., they correlate with each other and may tap common underlying processes), and diversity (e.g., they also are separable). This framework also aligns with the developmental trajectory of EF. For example, the latent, relatively stable nature of distinct EF components has been established for adult subjects across cultures (Best & Miller, 2010; Miyake et al., 2000), but is less differentiated in young children (Hughes, Ensor, Wilson, & Graham, 2010; Wiebe et al., 2011). The younger the children in the sample, the more likely that factor analyses will reveal one or two factors. Some research suggests that findings may be somewhat dependent on relatively subtle variations in tasks and performance indicators (Miller, Giesbrecht, Müller, McInerney, & Kerns, in press). A developed "EF Scale" for children aged 2 to 6 years begins with an inhibitory control demand only, then adds a switch demand, then adds increasing working memory demands (Carlson & Harrod, 2013). Children's performance increases gradually with age, aligning with the developmental progression of EF skills (Best & Miller, 2010).

Effortful Control

Rothbart and Bates (1998) defined effortful control as "the ability to inhibit a dominant response to perform a subdominant response" (p. 137). Although this definition is difficult to distinguish from inhibitory control, effortful control is instead considered an aspect of children's temperament that develops in tandem with the development of endogenous attention. Research on infant temperament has not found a complete analogue to effortful control, for example, with factor analyses instead uncovering a factor called *Orienting/Regulation* (e.g., Gartstein & Rothbart, 2003). Orienting/regulation contains many "regulatory" components similar to effortful control (e.g., orienting, soothability), but lacks a truly effortful component.

RDS emphasizes person and contextual relative plasticity as well as stability, which is compatible with the temperamental view of effortful control. Although temperament exhibits stability, it is also malleable especially early in life, and the two approaches are highly compatible in many respects. Temperament represents aspects of the individual (e.g., organismic prenatal epigenesis) that influence actions and behaviors in ways that produce cross-context cohesion. That is, temperamental characteristics such as effortful control align with RDS by representing a relatively stable characteristic of individuals that are otherwise highly malleable. Rather than an either/or distinction, the contribution of temperament to self-regulation is a good example of the tradition of the RDS perspective: Temperament is *both* individual (organismic) in origin,

and is malleable depending on contributions from the external environment. Similarly, effortful control has links to both temperament and to context.

Delay of Gratification

Delay of gratification is a separate approach to self-regulation with close ties to both inhibition and endogenous attention. Mischel and colleagues (e.g., Mischel & Ebbesen, 1970) originally studied delay of gratification using their now-famous marshmallow task with children. In this task, a child must choose between eating one marshmallow now or waiting for an unspecified period of time and being rewarded with two marshmallows. The time that a child delays his or her immediate gratification (eating the marshmallow) to obtain the larger future reward (two marshmallows) is taken as an index of that child's ability to self-regulate. Subsequent research has adapted this task for adults by varying the value of the rewards—sometimes making them hypothetical—and by extending the delay time to a month or longer (e.g., Duckworth & Seligman, 2005; Forstmeier, Drobetz, & Maercker, 2011).

Mischel's research links the ability to delay gratification to endogenous attention and effortful inhibition through what he and his colleagues have called the *Cognitive-Affective Processing System* (e.g., Mischel & Ayduk, 2002). This work has shown that children who distract their attention away from visually salient rewards are able to delay gratification longer than children who do not self-distract (Mischel, Ebbesen, & Zeiss, 1972). Similarly, children who direct their attention to the nonmotivating features of a reward are able to delay for longer periods of time than children who do not (who presumably focus on motivating aspects of the reward such as a marshmallow's sweet taste; Moore, Mischel, & Zeiss, 1976).

Self-Control

Experts do not consistently distinguish between the concepts of self-regulation and self-control, with many authors using the terms interchangeably. Some authors, however, consider self-regulation and self-control as distinct processes. For example, Kopp (1982) describes self-control as including the ability to behave according to a caregiver's requests and to adhere to social expectations in the absence of external monitors. She distinguishes this from self-regulation, which specifies a degree of flexibility not present in self-control. The flexibility of self-regulation allows children to meet the changing demands of a dynamic context, such that the distinction between self-control and self-regulation is, "a difference in degree, not in kind," (Kopp, 1982, p. 207). Self-regulation is, in other words, an internalization of self-control that allows for flexible adaptation to contextual demands. Under this definition, self-control allows for agent-driven coactions between persons and their contexts, but only to a limited degree. Control over developmental regulations increases exponentially with the onset of self-regulation. This control permits much greater flexibility and, therefore, the compensatory enactment of alternative, yet equifinal, means of goal attainment.

Kopp's distinction between self-regulation and self-control is not completely agreed on. Other researchers, for example, tend to differentiate between self-regulation and self-control on the basis of proactivity and the role of metacognitive processes. For example, McCullough and Willoughby (2009) specify self-regulation as the process by which a person uses information about his or her current state to change that state. In contrast, self-control represents a more reactive response to immediately salient urges. Similarly, Kuhl (2000) describes self-regulation as a largely implicit process that facilitates chosen actions. He defines self-control as conscious processes that inhibit alternative action tendencies that might "jeopardize the enactment of a difficult intention" (p. 115). The distinction between self-regulation and self-control therefore may vary from researcher to researcher and is somewhat arbitrary. For practical reasons, the two terms can be seen as functionally interchangeable, with both representing the multidimensional concept of self-regulation described in this chapter.

Engagement

Engagement overlaps with the conceptualization and measurement of self-regulation, and is often used by education and personality researchers especially with regard to the persistence of behavior (Boekaerts, 2006; Eccles et al., 1993; Fredricks, Blumenfeld, & Paris, 2004; Pintrich, 2000; Trommsdorff & Cole, 2011; Zimmerman, 1989). Engagement can be defined as conscious involvement in school and related activities, and includes three theoretical components: (1) *cognitive engagement* includes a child's willingness to dedicate effort to learning; (2) *emotional engagement* refers to a child's feelings about school and school-related activities; and (3) *behavioral engagement* includes the degree to which a child actively participates

in school and learning activities, such as class work and homework (Fredricks et al., 2004). Similar to EF components, Fredricks et al. (2004) note that the components of engagement are not always distinguishable empirically. What is clear, however, is that children's motivation, interest, value, and self-efficacy (e.g., feeling that "I can do this") are important predictors of how they regulate their behavior in school (Marinak & Gambrell, 2010). Many young children have high levels of motivation but as they grow older, and especially in middle elementary school, declines in motivation and increases in problem behavior are more common, especially for boys (Marinak & Gambrell, 2010; Wigfield, Battle, Keller, & Eccles, 2002). Children's engagement in school depends on their own characteristics and attitudes about school, which depend in turn on their interactions with teachers and peers (Patrick, Ryan, & Kaplan, 2007). For example, adolescents' behavior and ability to self-regulate may be influenced by the fact that they may physically look like adults but base their decisions on neurological and hormonal processes that deemphasize negative long-term consequences and emphasize situation-specific, socially relevant goals such as fame, shame avoidance, and immediate gratification (Steinberg, 2004).

Emotion Regulation

Because of its importance across the life span, the study of emotion regulation constitutes an area of research unto itself. Emotion regulation refers to children's ability to appropriately regulate their emotions (e.g., fear, anxiety, joy) as well as the behaviors influenced by such emotional reactions (Bridges, Denham, & Ganiban, 2004). Further, emotion regulation is thought to develop as a function of multiple dynamic processes that occur at all levels of the relational person ←→ context system, from the neuronal to the societal (Sokol et al., 2010). For example, work in neuroscience suggests a gene known as MAOA can change the presence of a regulating neurotransmitter, called MAO-A (Buckholtz & Meyer-Lindenberg, 2008). In male children (and rats) who are behaviorally aggressive, the MAOA gene is essentially "turned off" and results in MAO-A neurotransmitter imbalances that are thought to contribute to the aggression (Buckholtz & Meyer-Lindenberg, 2008). Rat studies indicate that pharmaceuticals can attenuate the negative neurotransmitter effects, but only within a specific developmental window. These lines of work have growing significance for the use of pharmacological treatments for children with problems regulating anger, anxiety, and other emotions, as well as for youth who encounter the justice system because of these problems.

Calkins (2010) describes emotion regulation as a process that becomes more automatic and improves with practice, which enables the child to manage increasingly complex and stressful environments. Emotion regulation emerges within early social relationships and takes different forms at various points in development (Calkins, 2010). In infancy, early regulatory tasks are tied to regulating children's attention and affective, temperament-based reactions to stimuli and information in the environment. These actions most clearly relate to emotion regulation in early childhood when children must exert considerable effort to regulate their overt behaviors (Eisenberg, Smith, Sadovsky, & Spinrad, 2004). Different types of emotion regulatory strategies have been proposed to help young children effectively manage their affect and emotions (Stansbury & Zimmermann, 1999). These include *instrumental* strategies, which are involved with trying to change a situation (such as trying to get a parent's attention); *comforting* strategies, which include or calming oneself by sucking on a pacifier without changing the situation; *distracting* strategies such as redirecting attention by looking away; and *cognitive* strategies, which include negotiating or reframing the situation into a better perspective. Cognitive strategies are considered the most difficult, especially for young children, who are limited in their metacognitive abilities.

The use of these strategies also reflects the RDS perspective because the person ←→ context is viewed relationally. Consequently children employ different self-regulatory strategies depending on the relational coactions of child and context characteristics (Zimmermann & Stansbury, 2003). This can be seen in a study where shy children, when approached by a stranger in a laboratory, were more likely to use instrumental strategies compared to bold children, who relied more on comforting and distraction strategies (Zimmermann & Stansbury, 2003). In another stranger situation in the same study, children with stronger attentional focusing (an aspect of self-regulation) were more likely to use comforting strategies compared to those with weaker attention skills. Other research corroborates that children who use planful strategies to focus their attention away from a stressful situation tend to have fewer externalizing and other behavior problems later in the school trajectory (Morris, Silk, Steinberg, Terranova, & Kithakye, 2010). In sum, different strategy choices reflect the relational coacting factors of person and context, and attention plays a key role.

Despite the frequent separation of behavioral and emotion regulation in research, the two have strong conceptual and empirical ties. As noted, attention moderates the association between negative emotionality and later outcomes, although often in complex ways (e.g., Belsky, Friedman, & Hsieh, 2001). The empirical overlap found with respect to these constructs may partially reflect the differences in how the constructs have been operationalized by researchers from a diverse set of perspectives (McClelland et al., 2010). For example, the role of attention in regulating negative reactivity is of particular theoretical interest and some, but not all, evidence suggests that strong attention can make up for negative emotionality. Such inconsistencies in findings may reflect variations in measurement, sample, and outcome studied.

As one example, using the relatively advantaged sample of children from the NICHD Early Child Care Research Network (NICHD ECCRN), Belsky et al. (2001) attributed a complex pattern of research findings to the study's observed, laboratory-style measures of infant attention and negativity. These authors found that, for low-attention infants, negative emotionality displayed in a strange situation context at 15 months predicted negative social outcomes when the children were between 3 and 5 years old (Belsky et al., 2001). Emotionality and social competence were not related for infants with strong attention. Conversely, and contrary to hypotheses, greater observed negative emotionality at Age 15 months predicted *better* school readiness (assessed with simple academic concepts such as colors, numbers, and shapes) only for *high*-attention infants; emotionality did not predict school readiness for low-attention infants. Moreover, early attention did not moderate the association between negative emotionality and later problem behaviors. The authors attributed the complex pattern of findings in part to the laboratory measures. For attention, they noted that the play task did not explicitly challenge or frustrate the child in a way that would require emotion regulation. For negativity, they posited that infants' Strange Situation behavior may have been better described as fearfulness rather than anger, and might have been an indicator of infants' more watchful approach to the world (which would presumably help them learn academic concepts later on).

A later longitudinal analysis with children from the same study (Kim & Deater-Deckard, 2010) used different measures of attention, emotionality, and behavior outcomes. For children who had poor attentional focusing measured with teacher- and parent-report, parent-rated anger was more strongly associated with parent-rated externalizing problems. In contrast, anger and externalizing problems were more weakly related for children with strong attention. Of note, these relatively more straightforward and theoretically consistent results emerged when using observer-report data only. These results from two studies utilizing the same sample illustrate how measurement discrepancies may be implicated in conflicting results for the same underlying constructs of attention, emotion, and behavior.

Sample discrepancies may also contribute to inconsistent conclusions. Whereas the NICHD ECCRN sample is considered relatively advantaged, and strong attention appeared protective for children with high levels of emotionality, analyses of low-income children revealed the opposite pattern. In a study of low-income children transitioning to formal schooling (Marcynyszyn, 2007), strong parent-rated attention at 3 years predicted later achievement only for children ages 5 to 6 years who were *low* in parent-rated negative emotionality. Finally, a third study with rural, low- to mid-SES children in early elementary school (Wilson, Petaja, & Mancil, 2011) found that strong attention was only significantly related to children's school achievement for students who did not struggle with aggression. Instead, aggressive children were more likely to have attention problems, which predicted lower reports of children's school achievement.

In sum, although attention, proneness to negative emotions—such as frustration—and regulatory failures are related, how they relate, and for whom, is not yet clear. More comprehensive consideration of measurement and sample contributions to results may be helpful. For example, a meta-analysis of the associations among attention, emotionality, and behavioral and academic outcomes in early childhood is needed. For low-income children in home environments with numerous financial, health, or interpersonal stressors, research indicates that the child's neural development and subsequent behavioral patterns of difficulty may reflect their need to constantly respond to intense negative and stressful stimuli (Blair & Raver, 2012a). Negative environments are thought to overuse the developing brain's "fight or flight" responses and may result in withdrawal or reactive behaviors that can contribute to deficits in processing social information. Thus, children in stressful environments may develop qualitatively different ways of coping with the world and regulating themselves within those contexts.

Given the impossibility of randomly assigning children to stressful environmental conditions, the work in this area is necessarily correlational. Burke, Hellman, Scott, Weems,

and Carrion (2011) demonstrated that children who had been exposed to four or more developmental traumas such as emotional or physical abuse or parental incarceration are 17 times more likely than children who experienced no traumas to have learning and behavior difficulty. The consequences of early adversity are thought to have cascading effects after children enter school. Masten et al. (2005) found that children with externalizing problems in childhood had significantly worse academic outcomes by adolescence, which was then related to significantly more internalizing problems in early adulthood.

In an effort to understand the processes that can lead to this developmental cascade, Ladd, Birch, and Buhs (1999) found that children's early behavioral style (e.g., prosocial styles that include cooperative play, or antisocial styles that include aggressiveness) contributed to their peer acceptance or rejection at 5 to 6 years. Acceptance versus rejection was related to the level and quality of classroom participation, which predicted academic achievement. This study raises a key question about the factors that contribute to whether a child establishes a prosocial, problem-solving approach to the world or an antisocial, aggressive, and hostile approach. For example, to decide how to react to a peer who just took his toy, a young boy might need to inhibit yelling or hitting. He may then need to decide to offer to play, tell the teacher, or find a new toy. These self-regulating choices in turn require language facility and planning what to say in the midst of an emotional stressor. Thus, successful self-regulation relates to other processes and skills when influencing children's development.

Bringing Together the Separate Aspects of Self-Regulation

Self-regulation includes both top-down (e.g., executive functions) and bottom-up regulation of thoughts, feelings, and behavior (Blair & Raver, 2012b; Zelazo & Cunningham, 2007). For example, executive function includes attentional flexibility, working memory, and inhibitory control and is used to plan, organize, and problem-solve as well as to manage the regulation of emotions and behavior. This model of self-regulation includes relational bidirectionality between the top-down effortful regulation and the more automatic, bottom-up, aspects of regulation. According to this view, self-regulated behavior includes relations between executive functions associated with the prefrontal cortex (PFC) and emotional and stress responses associated with the limbic and brainstem areas of the brain (Blair & Raver, 2012b). This bidirectional coaction between the top-down and bottom-up aspects of self-regulation enables a child to manage his or her thoughts, feelings, and behavior, which lays the foundation for successful behavior in all areas of that child's life.

Children benefit when educational practices and policies reflect the scientific understanding of school readiness as indicative of the relationships, processes, and contexts within which the child is expected to function (Pianta, Cox, & Snow, 2007). A child's regulatory difficulties may signal a mismatch between environmental demands and available regulatory resources. In line with the RDS perspective, Ursache, Blair, and Raver (2012) frame children's self-regulation as emerging from executive, "top-down" control of "bottom-up" emotional reactivity. For some children, especially those operating within predictable, supportive environments, this emergence produces contextually relevant responses that are adaptive over the long term and that facilitate EF. In contrast, for other children, using EF to make choices may become "derailed" because they must constantly respond to stressful events and short-term consequences.

IMPORTANT CORRELATES OF SELF-REGULATION

Given the conceptualization of self-regulation as occurring within a relational developmental system, it is necessary to describe significant codeveloping skill sets and constructs. In the following section, the relations between self-regulation and several key related constructs are discussed. Given the consistency of such findings, they suggest areas where future research is likely to be especially fruitful.

Self-Regulation and Academic Achievement in Childhood and Adolescence

Although self-regulation and related constructs have been studied by researchers in a variety of fields, it is clear that components of self-regulation are critical for long-term social and academic success (McClelland et al., 2013; Moffitt et al., 2011). An emerging area considers how underlying EF processes are integrated and translated into children's self-regulated behavior especially in contexts such as school and classroom settings (McClelland & Cameron, 2011). Consistently strong relations have been found between children's self-regulation and their

academic achievement in early childhood (Blair & Razza, 2007; Cameron Ponitz, McClelland, et al., 2009; Duncan et al., 2007; McClelland et al., 2006; McClelland et al., 2007) throughout adolescence (Duckworth & Seligman, 2005; Duckworth et al., 2010), and into adulthood (McClelland et al., 2013; Moffitt et al., 2011).

Links among self-regulation, school readiness and academic achievement begin to emerge in early childhood. Many studies now document that self-regulation measures, either as a composite construct or through measures of attentional flexibility/control, inhibitory control, and working memory, are robustly associated with both short- and long-term social and academic success (Blair & Razza, 2007; Duncan et al., 2007; Gathercole & Pickering, 2000; Howse, Lange, Farran, & Boyles, 2003; Kail, 2003; NICHD Early Child Care Research Network, 2003; Trentacosta & Izard, 2007). Strong self-regulation and its underlying components indicate that children can manage their emotions, cognitions, and behavior so they can take advantage of instruction and learning activities in schools and classrooms.

Work by McClelland and colleagues (e.g., Cameron Ponitz, McClelland, et al., 2009; McClelland & Cameron, 2012; Wanless, McClelland, Acock, et al., 2011) has examined a direct assessment of self-regulation called Head-Toes-Knees-Shoulders (HTKS), which taps inhibitory control, attentional flexibility, and working memory. In these studies, children's performance on HTKS predicts emergent literacy, vocabulary, and math skills between the ages of 3 and 6 years (Cameron Ponitz, McClelland, et al., 2009; McClelland et al., 2007). These results have also been replicated in international studies with Asian (Wanless, McClelland, Acock, et al., 2011) and European (von Suchodoletz et al., 2013) samples. In one study, gains in self-regulation predicted gains in emergent literacy, vocabulary, and math skills over the school year in 4- to 5-year-olds after controlling for fall achievement scores and demographic variables (McClelland et al., 2007).

In a follow-up study, fall self-regulation scores in children ages 5 to 6 years predicted fall and spring academic achievement skills, although gains in self-regulation predicted gains only in early math skills (Cameron Ponitz, McClelland, et al., 2009). This suggests that self-regulation may be important for a range of developing academic skills prior to formal schooling, but domain-specific relations may emerge as children enter more structured academic settings (McClelland et al., 2007). This notion is supported by the strong relations that have been documented between self-regulation and early math skills by a number of researchers and studies (Blair & Razza, 2007; Bull, Espy, Wiebe, Sheffield, & Nelson, 2011; Bull & Scerif, 2001; Cameron Ponitz, McClelland, et al., 2009).

The associations between self-regulation and math appear particularly strong during early childhood and may reflect the importance of both inhibitory control and working memory in processing and completing math problems (Blair & Razza, 2007; Cameron Ponitz, McClelland, et al., 2009). Moreover, the term *math* is general and includes skills like number sense that are heavily language-based, and skills like approximation and comparison that are more spatially based (LeFevre et al., 2010). Little has been done to unpack the domains within mathematics and to link aspects of self-regulation to specific skills under the math umbrella. Some research however, is emerging. For example, in a sample of Chinese and American children aged 3 to 5 years, performance on the HTKS was related to counting aspects of math but not calculation in both cultures (Lan, Legare, Cameron Ponitz, Li, & Morrison, 2011). Individual EF components, however, showed cultural differences. Chinese children with better working memory and attentional control had higher achievement outcomes across the board (reading, counting, and calculation), whereas neither working memory nor inhibition were associated with reading for American children.

In another study, self-regulation measures were differentially related to counting and calculation (Miao, Diaz, & McClelland, 2013). Specifically, when children were assessed at school entry at 4 to 5 years, measures of inhibitory control (Day-Night task) and working memory (Woodcock-Johnson Auditory Working Memory test) predicted children's counting, whereas the relatively more complex HTKS predicted calculation skills. At the end of the school year, inhibitory control (on the Day-Night task) was associated with counting, working memory predicted calculation, and the HTKS predicted both counting and calculation. Over the school year, early performance on HTKS predicted calculation at the end of the year, with weaker relations for initial working memory predicting end-of-year calculation. These results suggest that different aspects of self-regulation show domain-specific relations to counting and calculation skills even before formal school entry.

Counting is considered a basic number core component, whereas calculation involves more complex mathematical operations (Cross, Woods, Schweingruber, & National Research Council, 2009). Number core and counting skills develop earlier than skills in more complex mathematical operations. Similarly, children's inhibitory control skills

may develop earlier than more complex self-regulatory abilities such as working memory and complex inhibition measures such as the HTKS (Diamond, 2002). These results suggest that whereas earlier developing components of self-regulation (e.g., inhibitory control) are associated with basic number core components such as counting, measures of more complex self-regulation components (e.g., working memory, attentional or cognitive flexibility) may be more aligned with complex mathematical operations such as calculation. At the same time, there are some intriguing cultural differences that warrant further investigation.

Together, this body of research suggests that self-regulation and the underlying executive function components form a foundation for learning early in life. The next sections build on this general finding by discussing specific processess through which self-regulation skills may relate to learning and achievement. In particular, the demands on children's self-regulation capacity are explored from a new vantage point: motor development, the demands that motor tasks place on the developing person, and implications for self-regulation.

Self-Regulation of Motor Processes and Relevance for Cognitive Development

Throughout development, children encounter increasingly complex tasks that require increasingly sophisticated cognitive processes to solve. Consider a child, Duncan, in a second grade classroom. Duncan's teacher has asked the students, one row at a time, to each fetch a small box of LEGOs from the coat room, bring it back to their desk, empty it out, and sort the LEGOs by color, 10 at a time. The final step involves writing down how many sets of 10 they find for each color. In order to do this, Duncan must:

> *Remember the teacher's directions*, push his chair back from the desk, ignore his friend in the next row who has just playfully punched him, walk to the coat room, find a LEGO box that no one else is using, ignore the loudspeaker announcement for the fourth-grade field trip, return to his desk, *remember the teacher's directions*, pull the chair up to be able to sit at the desk comfortably, *remember the teacher's directions,* use his hands and fingers to pick up only the LEGOs that are the correct color, count to ten while picking up the LEGOs, write down the number of sets in each color, and finally, wait for his teacher to come and check his work.

This vignette reveals just how complex and cognitively demanding an early learning environment can be. Duncan must use his behavioral and emotional regulation skills to ignore his friend and shut out the distractions of the loudspeaker announcement and the adult. He must also sort and count a set of interesting blocks that he might rather use to build a bridge than count, so in addition to using his counting skills, he must inhibit the urge to play with LEGOs and instead use conflict inhibition to activate different behaviors so he can complete the assignment. Finally, he must use fine, gross motor, and visuospatial skills to move about the classroom, pick up the LEGOs and place them with their set, arrange his paper on the desk, and write down his name and the number for each color.

Surprisingly little research in normative samples has examined self-regulation in relation to motor development. This is an interesting gap in the literature, given the strong neuroscience and clinical evidence that links the early development of motor processes to the development of EF and other abstract cognitive processes (Diamond, 2000; Paus, 2001). The work of scholars such as Adolph, Diamond, Keen, and their colleagues (Adolph, 2008; Diamond, 2002; Keen, Carrico, Sylvia, & Berthier, 2003) suggests that the neural networks that are built during infancy for crucial developmental milestones such as reaching and walking are later co-opted and used for complex cognitive processing.

Results from research using the dual task paradigm, an experimental paradigm that poses two types of demands, suggests that simultaneously exercising self-regulation and performing a motor task is quite difficult for infants. In one study, the increased motor demands of a task were negatively related to infants' ability to self-regulate by not reaching to a known incorrect choice (Boudreau & Bushnell, 2000). Additional research suggests that self-regulation and motor skills remain related through adulthood. For example, neurological studies where adults must learn a novel motor sequence until they master it show that activation patterns change in both quantitative and qualitative ways (Floyer-Lea & Matthews, 2004). Early in the learning trajectory, there is more activation overall, especially in the prefrontal cortex. After many practice trials, as automaticity and task performance increase, overall activation lessens in EF neural areas and shifts to subcortical areas traditionally associated with motor activity including the cerebellum and basal ganglia. This work suggests that responding to motor and EF demands in a novel learning context draws from an overlapping set of finite cognitive resources. Much of the evidence that links self-regulation with motor development and achievement in early childhood has been established in populations with disabilities. But growing evidence links fine motor skills in particular with school performance in normative

samples as well. This makes sense given the substantial motor requirements in school. In an observational study of early childhood classrooms, children spent from 30% to 60% of their time in fine motor activities (Marr, Cermak, Cohn, & Henderson, 2003).

Self-regulation in school settings may be especially difficult for young children because such environments often place simultaneous demands on their developing cognitive, attention, emotional, motor, and behavioral capacities. To complete many school-related and self-care tasks, children must coordinate complex visual and/or auditory input while ignoring distractions, represent and transform stimuli in working memory, and then plan and realize a series of precise motor movements (Korkman, Kirk, & Kemp, 2007a; Sortor & Kulp, 2003). These include visuomotor tasks that adults may take for granted, such as tying shoes, packing a backpack, arranging or sorting materials, cutting with scissors, and writing on a piece of paper (Cameron, Chen, et al., 2012). When children are faced with a task that requires processing in both self-regulation and visuomotor modalities, those who have difficulty in both domains may be more likely to struggle. But, evidence also suggests that self-regulation and visuomotor skills may relate with academic achievement in a complementary, compensatory, way, illuminating each as potential sources for intervention.

Strong motor skills may support children's ability to navigate complex classroom environments. In one study, early elementary students from two sites—one middle-SES and one low-income—whose teachers rated them higher on the "classroom fine motor" subscale of the Motor Skills Rating Scale (Cameron, Brock, et al., 2012) performed better on a range of tasks including attention and design copy visuomotor integration tasks, earned better ratings in achievement from teachers, and scored at higher levels on a direct measure of achievement (Cameron, Brock, et al., 2012). Large longitudinal studies also show that children who do well on a fine motor composite measured at the beginning of kindergarten (i.e., at approximately 5 years old) achieve at higher levels at the end of the school year (Son & Meisels, 2006). Moreover, Grissmer, Grimm, Aiyer, Murrah, Steele (2010) reported that kindergarteners with strong fine motor skills had higher third- and fifth-grade achievement (i.e., at 8 and 10 years old, respectively) in reading and mathematics, after controlling for teacher-rated attention and children's previous achievement.

Like self-regulation, fine motor measures draw on multiple component processes including visuospatial skills and sensorimotor processing. EF is also an essential contributor to fine motor competence (Korkman, Kirk, & Kemp, 2007b), so studies are needed that clarify how and whether they relate to other cognitive outcomes. Current work shows some intriguing trends as well as inconsistencies that may depend on sample or age differences. For example, one study examined middle-SES children who completed both a fine motor task and the HTKS before kindergarten (Cameron, Brock, et al., 2012). The fine motor skill composite and the HTKS self-regulation measure were correlated below .20 and made separate contributions to achievement in multiple domains. Self-regulation was more strongly related to mathematics than were fine motor skills, and fine motor skills were most related to skills that involved combining visual symbols (word-reading and comprehension) or manipulating the sounds in language.

In another study (Becker, Miao, Duncan, & McClelland, 2014), variation in both fine motor skills and self-regulation predicted variation in early literacy, but only performance on self-regulation tasks (the HTKS, the Auditory Working Memory task and the Day/Night Stroop task) predicted math and vocabulary skills. In a related longitudinal study (Becker, Duncan, Miao, & McClelland, 2012), both fine motor skills and self-regulation were associated with change in each measure between fall and spring of prekindergarten. Specifically, although strong levels of fine motor skills and self-regulation in the fall predicted greater improvement in math between fall and spring, self-regulation was a stronger predictor of math gains than was fine motor skills.

Other work has suggested that fine motor skills may confer an advantage when there are other challenges present (Liew, Chen, & Hughes, 2010). Thus, in addition to an additive model where fine motor and self-regulation contribute separately to outcomes, a compensatory model may also describe how these two predictors relate to other aspects of children's development (Barron & Harackiewicz, 2001). Compensatory associations were found in a study of low-income children ages 2 to 5 years (mean age 4.1 years) across the United States who were given the pencil-tap inhibitory control task as a self-regulation measure and a common visuomotor design copy measure, the test of Visuomotor Integration (VMI; Beery, Buktenica, & Beery, 2010). Compared to children with high levels of both skills, children who had initial strengths in either inhibitory control or in visuomotor integration achieved at similar levels in early teacher reports of their classroom behavior, expressive and receptive language, and

a measure of phonological processing (Cameron et al., 2014). Only children who were weak in both inhibitory control and visuomotor skills performed more poorly on the outcome measures. This compensatory pattern also applied for gains over the school year in print knowledge and to a weaker extent, phonological awareness. Finally, in a separate study of 5- to 6-year-old children from a high-poverty community, Byers (2013) found that the compensatory pattern between visuomotor integration and a composite measure of EF emerged for predicting gains in early math skills.

Together, this research suggests domain-specific relations between fine motor skills including visuomotor integration, self-regulation, and early academic outcomes for children. Fine motor skills seem important especially for early literacy development, whereas self-regulation has demonstrated stronger relations to early math and vocabulary skills. This must be considered in the context of longitudinal work, which demonstrates that early fine motor skill predicts math achievement in middle school (Grissmer et al., 2010; Murrah, 2010). In addition, fine motor and self-regulatory skills may interact, for some children in relation to some behavioral or academic outcomes.

Self-Regulation, General Intelligence, and the Importance of Automation

As Gestsdóttir and Lerner (2008) note, self-regulation is not necessarily fully conscious, such as when a young child notices that snack is ready but seemingly instinctively goes to wash his hands first. But automated actions are acquired through practice and deliberate modification of prepotent, already-established, or desired responses, such as reaching instinctively for the snack. In other words, self-regulation may be involved—or even required—to turn nonautomatic processes, such as tying a shoe or writing one's name, into automatic processes. This rationale has been supported by neurological activation studies of adults (Floyer-Lea & Matthews, 2004), but similar data are more difficult to collect with children. This represents a ripe area for further work to validate (or refute) a working theory among scholars who study children during the school years.

Applied to early development, the *cognitive load theory* holds that when a child automates a skill, this automation frees up cognitive resources for the next task (Diamond, 2002). As noted above, self-regulation has enormous implications for learning and development during childhood. A child who can tie his shoes without thinking about it can be more independent than a child who must fetch an adult to tie his shoes for him. Similarly, a child who has an organizational system for her homework, where she keeps a notebook with all her assignments and checks completed items off a list, is better equipped for school and its myriad organizational demands when compared to a child without such a system.

The role of self-regulation in automating nonautomatic responses, including the learning of new motor sequences, also overlaps with notions of general intelligence (Blair, 2006). As noted earlier, scholars distinguish between domain-general cognitive skills related to cognitive processing across tasks—which would include constructs like EF—and domain-specific skills such as spatial, linguistic, and quantitative abilities (Demetriou, Spanoudis, Mouyi, Ferrari, & Vuletic, 2010). In one study using this framework, the domain-general working memory and attention control components of self-regulation predicted growth in domain-specific emergent literacy and mathematics (Welsh, Nix, Blair, Bierman, & Nelson, 2010).

From an information-processing perspective, Demetriou, Mouyi, and Spanoudis (2010) described the nature of neurological architecture with three hierarchical, interrelated levels. One level includes specialized domain-specific areas dedicated to processing types of information such as verbal, quantitative, and spatial reasoning. Another includes core general capacities such as speed of processing and memory span that are implicated within and across domains. The third level is self-regulatory and monitors, evaluates, and integrates information from the other two levels. The authors found support for the notion that progress emerges within a level and is constrained by the resources and capacity at that level. When information at one level becomes sufficiently complex, the need for automaticity arises, such as in the shift from processing single letters and their sounds to reading whole words. Children have slower reaction times than adults, which may partially reflect that they have automated fewer cognitive processes (Demetriou et al., 2002; Kail, 2003).

Although research has established that self-regulation is related to cognitive processes that become more automatic over time (e,g., reading, counting), scholars have generally distinguished intelligence from self-regulation and other measures of EF. In American 16- to 18-year-olds, the working memory component of EF was more strongly related to both fluid and crystallized intelligence (*r*s above .60) as compared with inhibition or shifting, with correlations around .30 (Friedman et al., 2006). Other research

has found that although self-regulation and intelligence are related, they are not the same and demonstrate differing patterns of predictability especially to academic outcomes (Blair, 2006; McClelland et al., 2006; McClelland, Morrison, & Holmes, 2000). In another series of studies using a measure of grit, defined as intensely focusing on a single goal over the long-term, no correlation was found between grit and traditional measures of intelligence (Duckworth, Peterson, Matthews, & Kelly, 2007), though both uniquely contributed to outcomes such as educational attainment. Thus, research supports the notion that although aspects of self-regulation may overlap with indices of intelligence depending on how self-regulation is measured, they also contribute unique variance to outcomes.

Risk and Self-Regulation

Children's sociodemographic characteristics are a major predictor of variation of self-regulation skills and, accordingly, of related developmental outcomes. This section considers the possibility of differences regarding the relevance of self-regulation for other outcomes, issues that arise in measurement, and the way early experiences may support the development of self-regulation. Research suggests that adaptive self-regulation is associated with academic achievement across many cultures (von Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011), across varying levels of socioeconomic risk (McClelland & Wanless, 2012), and for both genders (Wanless, McClelland, et al., 2013). Although self-regulation positively relates to child academic outcomes for both girls and boys, a mixed picture of gender differences in self-regulation during early childhood is beginning to emerge. In the United States, girls consistently show higher self-regulation than boys based on direct assessments (Cameron Ponitz et al., 2008; Kochanska, Coy, & Murray, 2001; Matthews, Ponitz, & Morrison, 2009; Wanless, McClelland, et al., 2013) and teacher reports (McClelland et al., 2000; Ready, LoGerfo, Burkam, & Lee, 2005; Wanless, McClelland, et al., 2013). In Asian countries such as Taiwan, South Korea, and China, however, research has found no gender differences in directly assessed self-regulation, but teacher-reported self-regulation showed an advantage for girls in Taiwan and South Korea (Wanless, McClelland, et al., 2013). Finally, research in Europe has not documented gender differences in directly assessed or teacher-reported self-regulation in France or Germany. European girls have shown higher self-regulation, however, when directly assessed in Iceland and Norway, and when rated by teachers in Iceland (Gestsdóttir et al., 2014; Størkson, Ellingsen, Wanless, & McClelland, 2014). These mixed findings across cultures and across assessment tools suggest that gender may be considered a risk factor in some contexts, but not others. Understanding these differences may help support boys' development in those parts of the world where gender gaps in self-regulation are documented.

Differences in children's self-regulation can also be seen based on the degree and number of risk factors present (Evans & Rosenbaum, 2008; Galindo & Fuller, 2010; Raver, Blair, & Willoughby, 2012; Sektnan et al., 2010; Wanless, McClelland, Tominey, et al., 2011). For example, research has examined cumulative risk and the effects of being low-income and an English-language learner on children's self-regulation growth between the ages of 4 and 6 years (Wanless, McClelland, Tominey, et al., 2011). Children from low-income families began the study with lower self-regulation than their peers from middle-income families. Within the low-income group, English-speaking children exhibited a faster rate of self-regulation growth than English language learners. However, although low-income English-speaking children caught up to their more economically advantaged peers by the end of the study on self-regulation, low-income English-language learners did not. Taken together, these findings suggest culture plays a unique role in determining how being from a low-income environment relates to the emergence of self-regulation.

Toxic Stress

Low socioeconomic status is related to low self-regulation on a variety of measures (e.g. caregiver report, direct assessments) and may be indicative of children's responses to chronic stress and to being exposed to fewer optimal learning experiences (Blair & Diamond, 2008; Blair & Raver, 2012a). In one study, although poverty between birth and 13 years old was related to adult working memory, this relation was partially mediated by the degree of chronic stress the child had experienced (Evans & Schamberg, 2009). Specifically, children who lived in poverty tended to experience more stress over longer periods of time, and amount of stress (beyond poverty status) predicted lower levels of working memory in adulthood.

Conceptualizations of children's development provide a model through which early childhood adversity is related to weaker self-regulation in children through stress hormones and neural connectivity (Blair & Raver, 2012a). In this model, cumulative risk is related to increased levels of

stress hormones in ways that may benefit the person by increasing a child's vigilance and ability to quickly react to threatening situations, which would be helpful for children living in unsafe or unpredictable environments. However, this increased level of reactivity also comes with short- and long-term costs to children's health and adjustment, including EF and self-regulation deficits. Such associations also emerge in the context of the caregiving environment. For example, research from the Family Life Project has also indicated that positive parenting was modestly related to lower stress hormones in children through Age 4 (Blair, Raver, Granger, Mills-Koonce, & Hibel, 2011). Moreover, poverty was related to lower self-regulation in children through its association with lower parenting sensitivity and higher levels of cortisol in children (Blair, Granger, et al., 2011).

Another study utilized data from the NICHD Study of Early Child Care and Youth Development and investigated how self-regulation mediated relations between early risk (growing up in chronic poverty, being of minority status, having mothers who were depressed or parents with low parent education) and later academic success (Sektnan et al., 2010). As might be expected, results indicated that many of these risk factors had negative effects on children's reading, math, and vocabulary achievement in first grade. Moreover, children's self-regulation in preschool and kindergarten were significant mediators between family risk factors and first grade achievement. Low maternal education and chronic levels of high maternal depressive symptoms were associated with lower first-grade achievement through lower self-regulation skills at 54 and 66 months. This is particularly concerning because research suggests that growing up in the context of risk can set the stage for a negative cycle. Specifically, children experiencing multiple risk factors (poverty, minority status, maternal depression) may enter school around 5 years old with poorer self-regulation, have more difficulty in the classroom and on academic tasks, have teachers and other children who find them challenging, and as a result, may disengage from school and learning (Blair & Diamond, 2008; Ladd et al., 1999).

Self-Regulation as a Protective Factor

Research also suggests that self-regulation is an important compensatory factor for children growing up in the context of risk. For example, the results from one study (Sektnan et al., 2010), indicate that regardless of the presence of a risk factor, children with stronger self-regulation, defined as one standard deviation above the sample average self-regulation score, had stronger achievement than children with self-regulation that was one standard deviation below the average score. Moreover, for children with the same number of risk factors, those with strong self-regulation did better academically than children with low self-regulation. Another study found similar results with a sample of homeless children (Obradović, 2010). Self-regulation, indexed by measures of effortful control, was the most significant predictor of teacher ratings of academic competence, peer competence, and internalizing and externalizing symptoms and of resilient status of homeless children, relative to IQ, parenting quality, and the presence of cumulative risks. Together, this research suggests that even when children are exposed to considerable risks, those with stronger self-regulation have better school outcomes than those with weaker self-regulation.

Clarifying how poverty, attention, and negative emotional tendencies interrelate to produce regulatory outcomes in early childhood is critical. At least in the United States, school in the modern era presents numerous attentional, behavioral, and emotional demands for children, many of whom arrive at school ill-equipped to cope with such demands. This can be seen in the national average of 5% of preschoolers expelled from their classrooms each year, the highest rate for any age group between 4 and 18 years old (Gilliam, 2005), and the estimated 30% to 50% of children whom their teachers rate as having difficulties regulating their behavior in the classroom (Rimm-Kaufman, Pianta, & Cox, 2000). Rather than blaming children for regulatory failure, another interpretation of this "crisis" of poor adaptation to school is that many children come from home environments that have a particular set of expectations that vary across families (e.g., to be quiet, or to be inquisitive) and may or may not align with expectations in classrooms (Wachs, Gurkas, & Kontos, 2004).

Cross-Cultural Variation in Self-Regulation

Self-regulation research increasingly includes international perspectives that describe average differences between cultures as well as variability within cultures. This advancement is critical to understanding the richness of the concept of self-regulation because self-regulation may be defined, fostered, and related to later outcomes in culturally specific ways. Although there is often considerable cultural variation within a country, research on self-regulation is included that uses country of origin as a proxy for culture.

Average differences in self-regulation between cultures are informative because they may direct attention toward culturally driven practices that may support or hinder self-regulatory development. Comparisons between Asian and European/North American cultures have been particularly popular in past research. For example, in comparing infants in the United States, Spain, and China, Chinese infants were rated by their mothers as having significantly longer attention spans than either American or Spanish infants (Gartstein et al., 2006). Similarly, a Chinese advantage was also present at the entry to formal schooling, based on a directly assessed working memory task (Geary, Bow-Thomas, Fan, & Siegler, 1993). Cultural differences in the amount of self-regulatory support for children, however, may lead to culturally specific judgments about children's levels of self-regulation. Research in classrooms in the United States and China, for example, has shown that although there were more behavioral problems in U.S. classrooms, there was also more unstructured time than in Chinese classrooms. This contextual factor was culturally situated and may have elicited certain behaviors (Tobin, Wu, & Davidson, 1989). In other words, U.S. children's observed skill level may have been undermined by a lack of structure in their classrooms.

Moreover, seminal research by Stigler, Stevenson, and colleagues (Stevenson et al., 1990; Stevenson, Lee, & Stigler, 1986) described children's approaches to a difficult task. Whereas U.S. children gave up after seconds, Japanese children persisted as long as the researchers allowed, up to one hour. In contrast, Chinese children showed more adaptive self-regulation skills compared to children from the United States and New Zealand, but this same advantage was not evident for Japanese children (Jose & Bellamy, 2012). This work begins to tease apart Asian cultural practices, and suggests that although Asian cultural practices may prioritize self-regulation in broad terms, Chinese parenting and teaching practices, specifically, may uniquely support self-regulation development.

Cross-cultural research also demonstrates that although the components of self-regulation may be similar across cultures, cultural variations among these components may emerge. In a study using direct assessments of components of self-regulation, for example, correlations between working memory and attention were virtually equal in the United States and China, but correlations between inhibitory control and attention were much stronger in China than in the United States (Lan et al., 2011). These cultural nuances regarding subcomponents of self-regulation were also present in Carlson and Meltzoff's (2008) study of bilingual children. Bilingual children showed a self-regulation advantage over monolingual children in terms of attentional shifting, but not inhibitory control (Carlson & Meltzoff, 2008). Although the bilingual and monolingual children were both from the same country (United States), the differentiation in self-regulation components underscores the importance of cultural practices, such as the extent to which children are expected to become bilingual, for promoting self-regulatory development. Learning two words for the same thing may exercise children's ability to notice and select between a seeming contradiction. For example, research finds a bilingual advantage in children's ability to process complex information in self-regulation and EF tasks, especially those requiring conflict resolution, switching, and updating (Bialystok, 2010; Bialystok, Craik, Green, & Gollan, 2009). Thus, although attentional flexibility, working memory, and inhibitory control are important elements of self-regulation across cultures, cross-cultural differences are also present.

By comparison, parent and teacher ratings of self-regulation are more consistent across cultures than are direct assessments. For example, cross-cultural studies have found the same factor structure for self-regulation when using parent reports of effortful control in the United States and China (Ahadi, Rothbart, & Ye, 1993). Additionally, teacher ratings of self-regulation have shown fairly similar overall internal consistencies across cultures (Gestsdóttir et al., 2014). Adults appear to show some agreement about what constitutes self-regulation. This same consistency is not evident, however, with adult ratings of children's levels of self-regulation. One study suggested that cultural factors such as adults' expectations for children's self-regulation may influence their ratings of children's skill levels. For example, when teachers in the United States and Taiwan rated their own students' skills, the Taiwanese children had lower scores than the U.S. children on politeness and extraversion (Jose, Huntsinger, Huntsinger, & Liaw, 2000). When the U.S. teachers watched videotapes on these Taiwanese children, however, they rated the Taiwanese children similarly to the U.S. children. These findings may suggest that the Taiwanese teachers had higher expectations for the children's abilities than the U.S. teachers had. Thus, despite similarities in the components of self-regulation across cultures, cultural differences in the expectations that adults have for children's skills may lead to culturally specific nuances in ratings of self-regulation.

Despite differences in self-regulation within and between cultures, one finding remains consistent. Self-regulation significantly relates to academic achievement concurrently, and in some cases, over time in multiple

cultures including the United States, China, Taiwan, South Korea, Japan, Australia, Germany, Iceland, and France (Blair & Razza, 2007; Gestsdóttir et al., 2014; Lan et al., 2011; Purdie & Hattie, 1996; von Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011; Zhou, Main, & Wang, 2010). Moreover, in many of these cultures, self-regulation positively predicts mathematics skills more strongly than other academic skills. These relations have also been found across multiple cultures when using a teacher-reported measure (Wanless, McClelland, Acock, et al., 2011). Other examples of research examining cross-contextual variation includes work by Ahadi and colleagues, who found that effortful control related differently to other aspects of temperament in Chinese and American samples (Ahadi et al., 1993). Similarly, Feldman, Masalha, and Alony (2006) examined differences in self-regulation among Israeli and Palestinian children. In this study, children from both cultures displayed equivalent scores on an overall self-regulation composite variable, but Israeli children scored higher on compliance while Palestinian children scored higher on inhibition. Further investigation into such differences can accordingly inform the many ways that people actively engage their contexts and direct the course of their own development.

Measures of Self-Regulation Across Cultures

Most self-regulation measures are parent-reported, teacher-reported, or direct assessments. Researchers are beginning to examine the cross-cultural utility of these types of measures in order to draw conclusions about universal versus culturally specific aspects of self-regulation. Similarities in the functioning of the measure across cultures seem more evident for direct measures than for adult-reported measures. For example, in one study of young children in the United States, Taiwan, South Korea, and China, the predictive validity of a direct self-regulation measure was more stable across cultures than was a teacher-rated measure (Wanless, McClelland, Acock, et al., 2011).

Although direct assessments may show promise for cross-cultural research, many of these assessments assume that children have a certain degree of independence. For example, researchers often ask children to remember and follow a rule that guides them to do the opposite of what the research assistant asks, which was earlier defined as conflict inhibition. The child's willingness to act independently and do the opposite of what an adult is asking, however, may vary depending on the value that the child's culture places on independence. In Hispanic cultures, for example, children are expected to show independence at a later age than their peers in the United States (Markus & Kitayama, 1991). It is possible that these children will not be comfortable with self-regulatory tasks that ask them to behave independently before they are old enough for it to be culturally appropriate for them to do so.

Conducting research across cultures requires the researcher to determine whether one measure can be used for all participants or whether culturally specific measures are needed to most accurately capture the construct. Studies that have used the same measure across cultures lead to conclusions about the differences between self-regulatory ability in each culture, and need to present evidence that the measure worked sufficiently well in each culture. This evidence usually consists of high internal reliability, predictive validity with expected outcomes such as math skills, testimony of face validity by experts in the culture, and significant relations with other measures of self-regulation such as a teacher report. Although evidence is compelling, the question remains whether, and to what extent, nuances in the validity of the measure and the amount of measurement error in each culture play a role in the substantive findings.

Van de Vijver and Leung (1997) suggest three types of equivalence to establish before making comparisons across cultures (see also Van de Vijver, Hofer, & Chasiotis, 2010). First, construct equivalence is when both cultures define the construct measured in the same way. One culture may view self-regulation as the ability to regulate oneself to achieve one's own goals for behavior (i.e., stopping from speaking before the teacher calls on you to achieve the goal of being a better student). Another culture, however, may view self-regulation as the ability to regulate oneself to be more aligned with the collective behaviors of a group (i.e., waiting to sit down at a table until there are enough chairs available for all of the people in the group). These differences in construct equivalence have implications for the validity of measures of self-regulation across cultures and may limit the utility of cross-cultural comparisons.

Second, measurement unit equivalence refers to the introduction of bias due to differences in administration protocols, in the characteristics of the children in each sample, or in the children's familiarity with the self-regulation tasks. For example, children may be more comfortable being tested in the hallway or on a computer in one culture than another and this difference may influence their self-regulation scores. Third, full score equivalence refers to item bias, usually resulting from linguistically accurate, yet not substantively accurate translation of measures. For the most part, self-regulation direct assessments are comprised of simple commands (i.e., "Touch your toes,

touch your head"; Cameron Ponitz et al., 2008) and are less at risk for item bias than more complex parent or teacher questionnaire items that ask the caregiver to make a judgment of many behaviors over time (i.e. "When drawing or coloring in a book, shows strong concentration," Putnam & Rothbart, 2006).

Consulting experts from the culture being studied may help to achieve comparability across self-regulation measures (Van de Vijver et al., 2010). Ideally, researchers would then pilot the measures in the culture, using a mixed methods approach. This may include (a) observing children during the assessment and comparing their comfort level with the procedures, (b) conducting focus groups with caregivers in the culture about their understanding of the construct and how they view the measure's likelihood of accurately capturing it, and (c) comparing children's observed self-regulation in their natural context with their scores on the self-regulation task to examine rank order. These steps would occur before full-scale data collection occurs, but examining cross-cultural comparability after data collection starts using statistical analyses such as factor analysis and item response theory is also useful (Van de Vijver et al., 2010).

Influences on Self-Regulation Across Cultures

Trommsdorff and Cole (2011) write that culture may influence self-regulation through parents' and teachers' goals and expectations for young people, the practices that result from these goals, and ultimately the neural and behavior changes children experience (Kitayama & Uskul, 2011). Caregiver expectations and social norms transmit to children through relationships and experiences, and in turn, children internalize expectations that they should have associated levels of self-regulation (Tomasello, 1999). Specific experiences in early childhood that are rooted in these different cultural beliefs are potential processes through which culture influences children's early self-regulatory development. Moreover, as children develop self-regulation they look for culturally specific clues to guide and scaffold their actions. For example, as toddlers and young children spend more time in social environments, they gather information about how and when it is acceptable or beneficial to behave in particular ways. These behaviors are dictated by the cultural milieu in which children are raised. For instance, cultural emphases on independence and interdependence help shape children's goals and their use of self-regulatory behaviors (Trommsdorff, 2009).

Depending on the context, children may be expected to use self-regulatory skills to help align their behaviors with those of their peers, or, alternatively, to establish independence from their peers. For example, a child in Asia may learn that when her grandparents are visiting they expect her not to speak at the dinner table unless someone else initiates a conversation with her. In this case, the child will learn that when grandparents are visiting, dinner is a time for more inhibition in order to meet grandparents' expectations (Hsieh, 2004). This cultural difference was seen in a study comparing parents of young children in the United States and Japan. Parents in Japan encouraged children to show empathy and to meet others' expectation, but U.S. parents were more comfortable with children's willfulness and attention to their own personal needs (Kazui, 1997; Rothbaum & Weisz, 1989). Being raised in each of these cultures would require children to self-regulate at different times and to different degrees to match the cultural expectations.

As another example, when children move into formal schooling, expectations may change and the demand for children to regulate their behaviors may be greater than in preschool or childcare. Although a move to formal schooling around 5 years old is somewhat common across cultures, it is not universal. In Finland, for example, children's early learning environments do not become more formal until they are around 7 years old. This delay does not appear to hinder the development of children's self-regulation, possibly because Finnish cultural values and associated caregiver practices emphasize the importance of children's self-sufficiency before formal schooling begins (Ojala, 2000). In other words, cultural expectations, such as Finnish parents' strong belief in the importance of children's self-sufficiency, may be reflected in parenting practices that promote self-regulation before formal schooling. In contrast, parents from Hispanic cultures focus on compliance and are more likely to expect school environments to instill self-regulatory skills (Brooks-Gunn & Markman, 2005; Wasserman, Rauh, Brunelli, Garcia-Castro, & Necos, 1990). Compliance may look similar to self-regulation because children are controlling their behavior, but they are doing it to meet an adult's requirement rather than to meet their own understanding of what behaviors to enact or inhibit. A child with high compliance but low self-regulation, for example, may struggle to develop and follow rules during sociodramatic play, but would be able to follow a teacher's command to stay in line when walking with classmates in the hallway. These children, however, may experience greater increases

in self-regulation after they enter formal school and are expected to develop these skills. In sum, cultural differences in children's self-regulation may reflect, in part, different cultural expectations and practices. These influences on children may occur at home and at school and have long-lasting impacts on children's outcomes.

There is broad variation in children's self-regulation within as well as between cultures (Eid & Diener, 2009; OECD, 2010a, 2010b; Rescorla et al., 2011; Winterhoff, 1997). One study examined means and standard deviations on the HTKS collected with 3- to 6-year-olds in the United States, Taiwan, South Korea, China, Germany, and Iceland (von Suchodoletz et al., 2013; Wanless, McClelland, Acock, et al., 2011). In general, the variation observed within cultures was substantively larger than between cultures. The variation in self-regulation scores in samples of children in South Korea and Germany, for example, was much larger than the variation between the two cultures. These samples both had a mean age of 5 years, and showed substantial variability in self-regulation despite assumed differences in each sample's cultural beliefs and practices. Although greater variation within cultures than between cultures is not evident in all cross-cultural research (Keller et al., 2004; Lan et al., 2011), this comparison draws attention to the fact that average cultural differences provide only one perspective, and should be interpreted in combination with additional information about variability.

Increasing the Focus on Person ←→ Context Relations

Cross-cultural research makes it clear that differing contexts have an impact on different levels of self-regulation and different rates of growth in self-regulation. Research in this area, however, is still developing. Three areas of research have emerged to inform the thinking about the dynamic relations between contextual factors and children's self-regulation. First, cross-cultural research has aptly taken advantage of natural variations in contexts across cultures to examine cultural-specific influences on self-regulation. This work currently centers on establishing the psychometric properties of self-regulation measures in different cultures, but future work may consider how differences in cultural beliefs and practices may support or hinder self-regulatory development. For example, socialization practices that encourage Chinese children to focus on the collective needs of the group may offer many opportunities for these children to practice regulating their own needs to align with the state of their peers. Evidence from studies that only measure the child's country of residence, however, and not the extent to which their context reflects collectivist practices, for example, are limited for informing practice. Ideally, cross-cultural research may uncover specific processess supporting self-regulation that may be adapted and incorporated into self-regulation interventions.

Second, research on children experiencing varying levels of sociodemographic risk, including toxic stress, also examines natural variation in contextual factors. Not only does this work highlight the ways that challenging circumstances can affect on self-regulation, it also uncovers the role of self-regulation as a protective factor. Specifically, self-regulation can universally support children's social and academic development regardless of the risk factors children are experiencing (McClelland & Wanless, 2012; Obradović, 2010; Sektnan et al., 2010). Together, studies of self-regulation and risk factors advance the understanding of person ←→ context relations and suggest that children in certain contexts should be the first in line to access self-regulation interventions. Finally, limited research has examined the variability of children's observed self-regulation as they encounter varying contexts throughout the day. Preliminary work in this area suggests that although children may have a core level of self-regulation skills, the ways that those skills manifest across situations is highly dependent on contextual factors such as the presence of certain activity-types, routines, materials, adults, and peers (Booren, Downer, & Vitiello, 2012; Pellegrini, 1984; Vitiello, Booren, Downer, & Williford, 2012). All three research foci provide different angles by which to examine person ←→ context relations and learn how to apply these findings to intervention efforts to support self-regulation development. Most studies in these areas, however, offer crude measures of the environment such as using country as a proxy for culture, or attendance at Head Start as a proxy for low-income status. Future research would benefit from a more fine-tuned assessment of contextual factors.

STUDYING SELF-REGULATION FROM THE PERSPECTIVE OF RDS

Yogi Berra said, "In theory, there is no difference between theory and practice. But in practice, there is." Thus, arming self-regulation researchers with RDS-informed hypotheses is only half the battle when conducting research framed by the RDS perspective. Although this perspective is an

important way forward for self-regulation research, it can also be challenging to translate theory into practice.

Implications of RDS for Analyzing Self-Regulation

Understanding development, especially the development of self-regulation, as it occurs in a transactional, multilevel, dynamic, and relationally integrated person ←→ context system requires equally complex analytic tools that are capable of detecting phenomena at both the macroscopic and microscopic levels. To date, "the relational developmental systems approach has lacked [such] a toolbox of nonlinear analytic methods and, as a consequence, has often been in the unfortunate position of attempting to express nonadditivity effects in an additive context," (Overton, 2011, p. 260). In the following sections, a few key implications of the RDS perspective for measuring self-regulation as it develops across the life span are highlighted (see also Geldhof et al., 2014, for a parallel discussion of measurement issues related to RDS in general).

Incorporating an Idiographic Perspective

Since Allport (1955) popularized Windelband's terms *idiographic* and *nomothetic* in psychology (see Holt, 1962; Marceil, 1977, for reviews), researchers and theorists have debated whether the province of psychology is to study common (i.e., nomothetic) characteristics shared by all people or the idiosyncratic (i.e., idiographic) characteristics that make each person unique. As Holt (1962) commented more than 50 years ago, the idiographic versus nomothetic debate is, "[o]ne of the hardiest perennial weeds in psychology's conceptual garden," (p. 376) and indeed it remains a source of considerable discussion (e.g., Lamiell, 2009).

Although a majority of existing self-regulation research has emphasized cross-person (i.e., cross sectional, between group, interindividual variation), nomothetic relations and developmental trajectories, contemporary "developmental science [and RDS as a part of this science] seeks to describe, explain, and optimize intraindividual changes and interindividual differences in intraindividual changes across the life span" (Lerner & Benson, 2013, p. 2). As a consequence, intentional self-regulation can be defined as an idiographic (intraindividual) process. Self-regulation involves specific persons coacting with their contexts in ways that bring about their personally desired states (i.e., goals). This suggests that as the child develops, his or her self-regulated actions become increasingly deliberate and fashioned in ways that align unique personal strengths with resources in their equally unique contexts. Self-regulation may, therefore, be optimally studied in highly nuanced ways. In addition, there is no guarantee that phenomena observed at the population (or sample) level necessarily hold for any specific person.

As Molenaar (e.g., 2004) notes, the asymptotic equivalence of inter- and intraindividual observations, known as the assumption of ergodicity, does not hold for most psychological processes (see Molenaar & Nesselroade, Chapter 17, this *Handbook*, this volume). Put more simply, ergodicity as a theoretical assumption posits that individuals are assumed to look like the group. In reality, however, the individual may not mirror the group. Statistical conclusions based on the average findings from a sample of individuals may not be directly relevant for any given person in the sample; similarly, the trajectory of development for a single person may be wholly distinct from the patterns observed using group-level data. Because self-regulated actions are highly idiographic, the implications of nonergodicity may be especially important to interpreting research on self-regulation.

The presence of nonergodicity does not mean nomothetic research on self-regulation is without merit. Every field needs a starting place. Group-level observations likely reflect person-level phenomena to some degree, and a fusion of idiographic and nomothetic observations (e.g., Molenaar & Nesselroade, 2012, Chapter 17, this *Handbook,* this volume; Nesselroade & Molenaar, 2010) will help researchers tease apart inter- and intraindividual processes. A fuller understanding of person- and group-level development can then be applied cohesively to maximize the effectiveness of developmental interventions and youth development programs.

Mixed-Methods Triangulation

The precise nature of self-regulation as defined by the RDS perspective will never fully be appreciated if it relies only on quantitative methods. Instead, the complexity implied by an RDS framework demands that researchers more thoroughly integrate their quantitative findings with qualitative research that describes development from the perspectives of the developing individuals and important figures in their lives like teachers, parents, and peers. Researchers must "attempt to map out, or explain more fully, the richness and complexity of human behavior by studying it from more than one standpoint" (Cohen & Manion, 2000, p. 254).

Fusing the understanding of inter- and intraindividual phenomena will require that researchers supplement their nomothetically derived research. Idiographic and semi-idiographic methods describe the experiences of individuals with single-subject designs or designs that deliberately emphasize classes of relatively homogenous participants. In other words, researchers must merge existing methods, which have arisen within disciplines and are often based on convenience samples, with methods similar to what Magnusson (1999) has called the *person-oriented perspective* (see von Eye, Bergman, & Hsieh, Chapter 21, this *Handbook*, this volume, for an extensive discussion of person-oriented techniques). Adopting a more person-oriented perspective will also help align empirical examinations of self-regulation with RDS, by both explicitly acknowledging the specificity and nuance of self-regulated actions and by treating the active agent or person as a holistic gestalt (see Lerner, 1982).

In some ways this is similar to the age-old debate that pits quantitative against qualitative approaches and at the same time transcends the debate. A mixed methods movement has gained momentum and is characterized by research teams with diverse backgrounds (Huston et al., 2005; Lowe, Weisner, Geis, & Huston, 2005, see also Tolan & Deutsch, Chapter 19, this *Handbook*, this volume). The goal of mixed methods work is to incorporate diverse perspectives to better understand general trends as well as the specific stories of development (Weisner, 2005). Mixed methods are needed to address why interventions that target self-regulation do not benefit all children in all contexts. For example, treatment effects for the New Hope project—which offered randomly assigned working families living in poverty a range of benefits such as earnings supplements, health insurance, and health care—quantitatively showed a stronger relation of boys' scholastic and behavioral outcomes than girls' outcomes (Huston et al., 2005). Using inductive analyses (here, ethnographic interviews) to understand the lack of statistical effects for girls, Gibson and Weisner (2002) learned that families may have allocated more resources to boys to prevent delinquent behavior. As this example demonstrates, qualitative research can be particularly useful for bring unexpected processess to light. This set of complex findings, where puzzling quantitative results are illuminated by focused qualitative work, warrants further person-oriented investigations of the development of self-regulatory strengths and deficits.

Truly idiographic designs require in-depth analysis of individual subjects, especially to determine which self-regulatory strengths each person displays and how people intentionally align these strengths with characteristics of their contexts. Any interindividual differences in these intraindividual processes will necessarily indicate nonergodicity and suggest areas where nomothetic theories require greater nuance and refinement. Idiographic findings can also be aggregated in ways that filter out idiographic specificity (e.g., Molenaar & Nesselroade, 2012; Nesselroade, Gerstorf, Hardy, & Ram, 2007), allowing for some nomothetic generalizations despite intraindividual variability.

Semi-idiographic (also known as person-oriented) methods will also allow self-regulation researchers to explore the differences and similarities of self-regulated action across different "types" of people. These methods may make use of cluster analysis (e.g., Bergman, Magnusson, & El-Khouri, 2003) and latent class analyses (e.g., Collins, 2001), for example, and are especially likely to be informed by exploratory methods such as qualitative interviews and focus groups. From the perspective of RDS, clusters uncovered by semi-idiographic methods represent heuristically defined groups of people who display similar strengths and weaknesses and exist in relatively similar contexts. The relative homogeneity of such groups increases the probability that violations of the ergodicity assumption will be trivial. Understanding processes at the level of such groups will facilitate the generalizability of group-level findings to individual group members, while potentially informing universal principles of how people intentionally regulate their own development.

The probability that these idiographic and semi-idiographic methods will reveal important interindividual differences suggests that researchers might increasingly begin to define self-regulation as a multidimensional, contextually dependent concept rather than as a unidimensional construct. The existence of different types of people with heterogeneous self-regulatory styles, strengths, and weaknesses makes it inappropriate to compare individuals on a unidimensional continuum of "better" versus "worse" self-regulation. Self-regulation instead emerges as an adaptive coaction between an individual and his or her specific context. It is, however, possible to argue that a group or individual displays deficits in specific components of regulation compared to other individuals, and that such deficits impair adaptive coactions with their contexts. Through idiographic and semi-idiographic analyses, discussion focuses on how people with various constellations of self-regulatory strengths and deficits experience different developmental regulations when set in different contexts.

Coupling nomothetic and idiographic information about self-regulation thus allows a closer coupling between RDS-derived theory and practice. For example, group-level data can provide information about the conditions that affect average performance on a self-regulation task. These group-level analyses can then be supplemented with single-subject interviews, which may help researchers understand which subsets of self-regulatory strategies individual participants implemented, and which factors promote the development of these strategies under which conditions. As one example, Kidd, Palmeri, and Aslin (in press), found that when children trusted the adult giving the instructions, they could wait on average 12 minutes in the marshmallow task, compared with children in a condition where the examiner first promised them a gift (crayons) that was not given. The children who had been disappointed by the examiner could wait only 3 minutes on average, which researchers attributed to a lack of trust in the adult responsible for giving them their marshmallow.

Analyzing Discrete Constructs Holistically

Regardless of whether researchers take nomothetic or idiographic methodological approaches to their work on self-regulation, many available statistical tools are overly simplistic. The most common models of developmental phenomena can be considered models of additively concatenated intervariable relations. Such models treat the developmental phenomena that were reviewed earlier in the chapter, (e.g., attention shifting and working memory) as separable components whose contributions to an outcome, such as classroom behavior, can be added together as one would add discrete quantities. One reflection of this assumption is the prevalence of hierarchical regression, which pits one or more predictors against each other in explaining variance in a measured outcome. Investigators may allow these components to interact by calculating an interaction term, but even such models tend to follow a linear function. Nonlinear terms, such as quadratic terms, are rarely considered, and nonlinear equations (e.g., the Gompertz function) are considered even less frequently, despite the fact that such relations likely exist (Grimm, Ram, & Hamagami, 2011; Ram & Grimm, Chapter 20, this *Handbook,* this volume). For example, poor self-regulation skills may lead a person to experience anxiety, but one might argue that overly high levels of self-regulation can lead to anxiety as well (Eisenberg & Fabes, 1992). Disrupting an overly internalized behavioral routine can cause dissonance, for example. As such, the relation between aspects of self-regulation and reports of anxiety may take the common inverse U-shape of a quadratic relationship.

Additive methods do not align with the holistic approach put forth by RDS, and developmental researchers must consider both benefits and drawbacks when implementing these techniques. Factor analysis, for example, can serve as a versatile tool, which allows researchers to aggregate directly assessed components or observer-reported indices of self-regulation into distinct latent factors. These factors may accurately and parsimoniously reflect the constructs that underlie the analyzed indicators and allow for more accurate tests of interconstruct relations. The underlying assumption that data can be linearly decomposed into discrete factors is atomistic, however, and can only serve as a first step in understanding self-regulation from the RDS perspective. By aggregating empirical data into distinct bins (i.e., factors), factor analysis necessarily attempts to "carve nature at its joints." This kind of heuristic atomism is necessary as a first step in understanding self-regulation, but it can only take researchers so far. As Overton (2010) notes, relational scientists must treat such categories as "groundings, not bedrocks of certainty," (p. 13; see also Overton, Chapter 2, this *Handbook*, this volume).

Mediation and moderation models also allow researchers to model their data as representing a relationally interconnected person-context system. Investigators who implement such models can even move beyond simple mediation and moderation effects to include complex combinations of each. For example, moderated mediation models allow researchers to investigate conditional indirect effects (Preacher, Rucker, & Hayes, 2007). Mediated moderation models likewise allow researchers to examine the processes through which interaction effects may occur (Baron & Kenny, 1986; Little, Card, Bovaird, Preacher, & Crandall, 2007).

Especially when framed in a multilevel framework, such models allow investigators to explicitly consider how the components of self-regulation dynamically coact in leading to specific behavioral outcomes (e.g., Preacher, Zhang, & Zyphur, 2011; Raudenbush & Bryk, 2002). Understanding these outcomes help us understand the implications of various self-regulatory strengths and weaknesses for person-context fit, and accordingly for positive development.

Nonlinear Development

Relative plasticity in the relational person-context system implies that developmental trajectories are mutable and can

be changed by multiple moderating influences. As such, acknowledging plasticity implies the need for investigators to implement longitudinal designs and analyses that explicitly account for nonlinearity to uncover meaningful information about the developmental implications of any complex phenomenon. Although methods for analyzing such nonlinearity have not fully penetrated the social sciences (and indeed many are still in their infancy), researchers who study self-regulation are not without options (see Molenaar & Newell, 2010; Ram & Grimm, Chapter 20, this *Handbook*, this volume; Witherington, Chapter 3, this *Handbook*, this volume, for extended discussions of nonlinear models). For example, the now-common growth curve model allows researchers to efficiently model development. While traditional growth curves specify linear change over time, quadratic, cubic, and even higher-order time effects can also be easily modeled. Furthermore, translating the standard multilevel growth curve into a structural equation modeling framework (i.e., latent growth curve models, see Bollen & Curran, 2006) allows researchers to test empirical hypotheses about the shape of a construct's developmental trajectory, as well as to examine relations among developmental trajectories and other variables. Such models specify growth parameters as latent constructs, which allows researchers to simultaneously model multiple growth trajectories, examine the correlations among these trajectories, and determine which person-level variables predict interindividual differences in these trajectories.

The common growth curve model is widely generalizable, but one distinct limitation is that it assumes development can be modeled as a linear function. That is, all parameters in the standard growth curve model (e.g., $b1$, $b2$) must be combined additively. Aspects of self-regulation do not likely develop in such a linear way, and alternative growth models may be more appropriate for examining the development and developmental implications of different aspects of self-regulated action. Complex coactive relations among the parts of larger relational person $\leftrightarrow$ context systems can also be analyzed using methods borrowed from systems science and dynamic systems theorists (see Witherington, Chapter 3, this *Handbook*, this volume). For example, the simulation-based methods of systems science allow users to simultaneously model a high number of multidirectional processes in ways that promote theory development, exploration, and synthesis (Urban, Osgood, & Mabry, 2011). These tools can be used to forecast the effects of various public policies, allowing researchers to more directly translate their theories into practice.

Self-regulation researchers can also draw on concepts and methods derived from dynamic systems theories. As discussed above, self-regulation is not a blanket trait that individuals bring equally to every situation. Self-regulation instead emerges as the real-time interaction between attributes of unique individuals and their dynamically changing contexts. Methods designed from the perspective of dynamic systems theories explicitly account for the real-time nature of such phenomena and allow for a more nuanced approach to action within the relational developmental system. Granic (2005; see also Witherington, Chapter 3, this *Handbook*, this volume) discusses various methods that allow researchers to derive and test hypotheses directly related to dynamic systems concepts, including attractor states, behavioral resilience to perturbations, and phase transitions. Plotting real-time data using state-space grids (Hollenstein, 2007) and analyzing the variability of actions are among some of these methods that may be especially relevant to self-regulation research.

With regard to the study of self-regulation, there are also practical implications to consider. First, longitudinal models require multiple time points, with more being ideal, though they can accommodate some degree of missing data. So far, complex nonlinear models have been used with success on vertically equated achievement tests, but more dynamic and complex skills such as self-regulation may pose a steeper measurement challenge (Grimm et al., 2011). Namely, there are few self-regulation measures that can be vertically equated (Zelazo et al., 2013). A computerized measure that can be administered from 2 years to adulthood would be an ideal measure with which to apply nonlinear models. Progress is being made in this arena, however, and advances with the NIH Toolbox initiative have resulted in a series of cognitive measures (including measures of EF) that can be administered between Ages 3 and 85. Research demonstrates that the cognitive measures have strong psychometric properties, with evidence of increasing differentiation in cognitive abilities between Ages 3 and 15 (Zelazo et al., 2013). Future researchers may be able to utilize these measures in nonlinear models.

Second, multiple time points are more costly to collect. Third, these models require an advanced degree of expertise. Like most sophisticated analytic techniques, there is likely to be a lag between when they are developed and refined and when the average psychology or education department has resources to either train or hire someone with this knowledge. Fourth, the momentum of a field led by seasoned scholars who often rely on two time points

and multivariate regressions (including the authors of this chapter!) must shift to incorporate new analytic techniques, when appropriate.

Time as a Proxy for Development

Developmental researchers widely understand that change occurs over time, and that modeling complex, plastic developmental trajectories requires longitudinal data and analyses. Longitudinal data are only as good as the forethought put into longitudinal study design, however. On top of collecting data longitudinally, researchers must explicitly account for the many ways that "time" can manifest in a relational developmental system. As noted by several authors (e.g., Lerner, Schwartz, & Phelps, 2009; Little, Card, Preacher, & McConnell, 2009; Wohlwill, 1973), "time" can mean many different things in relation to many different phenomena. Further, each of these phenomena can evolve on a different time scale. Developmental change in some phenomena can be measured in terms of years, whereas other developmental phenomena can only be adequately captured at the scale of weeks or days. The effects of time also manifests in historical factors (e.g., the Great Depression) and episodic factors (e.g., September 11, 2001), and the same amount of chronological time can mean different things to different children (e.g., the onset of puberty varies across individuals). The RDS perspective acknowledges all of the above conceptualizations of time as co-occurring, and developmental researchers must pay close attention to how they conceptualize, measure, and analyze development as a function of time.

Acknowledging multiple metrics of time may be especially important for self-regulation researchers, given that self-regulated actions themselves occur over the span of seconds, whereas the long-term consequences of control by the active agent might be best analyzed over the course of several years. Young children's behavior on a real-time measure of self-regulation can predict developmental outcomes in adolescence and adulthood, for example (e.g., Ayduk et al., 2000; Mischel, Shoda, & Peake, 1988). Researchers must accordingly measure and analyze time in a metric that is meaningful to the phenomenon of interest and at a rate that allows for the accurate representation of that phenomenon's development. The importance of this consideration stands in stark contrast to the all-too-often annual data collection schedule followed by large longitudinal investigations, which reflects financial and personnel constraints. The next section discusses how integrative methodological approaches, which connect large-scale longitudinal and cross-sectional work to literature reviews to experimental designs, can be combined systematically to accomplish more than a single study can on its own.

Some research on the development of self-regulation is beginning to tackle these methodological challenges, illuminating the importance of assessing not only self-regulation levels, but also the pathway of self-regulation development (Kochanska et al., 2001; Kochanska, Murray, & Harlan, 2000; Li-Grining, 2007; McClelland et al., 2007). For example, a study by Wanless, Kim, Zhang, and Degol (2013), found two distinct self-regulation trajectories in a sample of almost 200 young Taiwanese children between 43 and 72 months of age. Although the two trajectories reflected similar behavioral regulation scores at the beginning and end, their pathways were strikingly different. These trajectories were related to children's vocabulary skills in kindergarten, with children who developed strong self-regulation skills early having the greatest vocabulary benefits (Wanless, Kim, et al., 2013). This research reflects efforts to study development over time, and moves the field toward understanding the complex emergence of these skills.

FUTURE DIRECTIONS FOR RESEARCH IN SELF-REGULATION

Future efforts to support children's adaptive self-regulation development must consider strategies that capture adequate variability in measured phenomena and account for child-environment interdependencies. The following section discusses how researchers can increase the focus on person ←→ context relations, and intervention efforts that have been shown to be effective in improving self-regulation in children. Finally, several strategies for integrating methods in the study of self-regulation are presented, including those that represent within-study techniques and between-study (or between-discipline) approaches. These all have costs and must be weighed against overall study aims. But up-front investment in planning activities, such as a systematic review of possible measures and pilot tests in the sample to be studied, can also save time and frustration later.

Studying Self-Regulation in Context

As noted earlier, context permeates the study of self-regulation and it is evident that a child's self-regulation depends on the context in which it is measured. In line

with RDS and closely related perspectives such as dialectical theory (Kuczynski & De Mol, Chapter 9, this *Handbook*, this volume; Sameroff, 2010), a person's self-regulation depends on dynamic coactions between his or her own characteristics and the nature of the environment. Myriad statistical interaction results provide examples of the codetermination of children's regulatory outcomes. For example, infants with depressed mothers tend to show poorly regulated attention and perform worse on cognitive measures (Murray, 1992). In contrast, young children whose families encourage them to ask questions and challenge authority tend to be more inquisitive and less controlled (Wachs et al., 2004). Further, the level of engagement and attention that observers report in young children's behavior depends on whether the children are interacting with teachers, peers, or tasks (Booren et al., 2012).

Another set of interaction findings highlights how similar environments can co-act with child characteristics. For example, one study found that urban first graders (i.e., 6- and 7-year-olds) with low self-regulation benefited more than children with strong self-regulation when their teachers spent more time planning small-group instruction and when their classrooms spent less time in transition (Connor et al., 2010). In another study, first grade boys in a rural setting made greater gains in mathematics when their classrooms were better organized, which is thought to support self-regulation (Cameron Ponitz, Rimm-Kaufman, Brock, & Nathanson, 2009). Together, these studies demonstrate that the regulatory behaviors and learning that children achieve depend in part on what is happening around them, and on characteristics of children themselves.

Improving Intervention Efforts

As demonstrated throughout this chapter, mounting evidence suggests that children's self-regulation is malleable and undergoes significant development during infancy, childhood, and adolescence (Diamond & Lee, 2011). Thus, efforts have focused on interventions to strengthen self-regulation in children, and on identifying the key processess underlying these interventions' effectiveness.

For example, a number of studies have supported the efficacy of the Preschool Promoting Alternative Thinking Strategies (PATHS) social-emotional intervention for strengthening emotional regulation and social competence in young children, where intervention participation was related to significant improvements in socio-emotional competence and self-regulation skills (Bierman et al., 2008; Domitrovich, Cortes, & Greenberg, 2007). Moderated effects were also found where intervention-group children with low self-regulation scores at the start of the year demonstrated greater improvement in social competence, lower aggression ratings, and stronger print knowledge than children in the control group who also had low self-regulation scores at the beginning of the year. In contrast, no significant intervention effects were found for social competence, aggression, or print knowledge for children with higher self-regulation at the start of the year. Bierman et al. (2008) identified pathways of influence where improvements in teacher-rated task orientation partially mediated intervention effects on emergent literacy and social-emotional skills.

Other research on a classroom-based self-regulation and social competence intervention called the Kids in Transition to School Program (KITS), suggests that the intervention was related to improvements in observer-reported social competence and emotion regulation (Pears, Fisher, Heywood, & Bronz, 2007). Interventions focusing on improving specific aspects of self-regulation through classroom games have also demonstrated some impacts. For example, one intervention with young children focused on the behavioral aspects of self-regulation, utilizing games designed to help children practice paying attention, remember instructions, and demonstrate self-control (Tominey & McClelland, 2011). Participation in the intervention was related to stronger self-regulation for children who started the year low in these skills. In addition, the intervention led to gains in emergent literacy skills over the school year for children in the intervention group compared to children in the control group. In a related study utilizing a larger sample of low-income children 3 to 5 years old, Schmitt, McClelland, Tominey, and Acock (in press) found that children in the intervention group demonstrated gains in two direct measures of self-regulation. Indirect effects were also found for children's spring achievement through their self-regulation scores. Finally, English-language learners who participated in the intervention showed greater gains in math compared to children in the control group, and to English speakers in the intervention.

Other research has focused on professional development for teachers in classroom interventions. The Chicago School Readiness Project (CSRP) is a comprehensive intervention aimed at improving self-regulation and socio-emotional skills in the prekindergarten year by helping teachers improve classroom management, deal with children's difficult behavior, and reduce their own stress (Raver et al., 2011). Children who participated in the intervention

showed improvements in self-regulation and academic achievement relative to the control group. Ursache et al. (2012) posit that such interventions minimize stressful and negative events within the classroom, which diminish the demands on children's emerging self-regulation and enable them to show more long-term adaptive behaviors.

There is also some evidence that participating in computer-based interventions may improve aspects of self-regulation. For example, one study found that children who received computer-based attention training demonstrated greater gains in executive attention and intelligence scores as compared to control children (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005). Another study targeted either working memory or inhibitory control in young children (Thorell, Lindqvist, Bergman Nutley, Bohlin, & Klingberg, 2009). Children in the working memory intervention group demonstrated improvements in working memory and attention compared to those in a control group. Children who were trained on inhibitory control also showed improvement in inhibitory control, but no transfer effects to working memory or attention tasks (Thorell et al., 2009). Although these results are somewhat encouraging, there has been less evidence of transfer or generalization of intervention effects to behavior or indicators such as academic achievement (Diamond & Lee, 2011; Melby-Lervåg & Hulme, 2013).

Partly because of these issues, work has focused on identifying the key components of effective interventions for improving children's self-regulation. In general, research has demonstrated that activities that help children practice skills like stopping, thinking, and *then* acting, help children develop self-regulation (Bodrova & Leong, 2006; Diamond & Lee, 2011; Tominey & McClelland, 2011). A review by Diamond and Lee (2011) found that effective interventions included activities and tasks that constantly challenged self-regulatory skills and increased in complexity. There is also some evidence that computer-based interventions and physically active interventions (such as martial arts) may be more effective for older children compared to younger children (Diamond & Lee, 2011). Another key component may be increasing children's ability to reflect on their thoughts, which has also been called mindfulness. Research has suggested that mindfulness training, which helps children reflect on experiences in the moment, may help facilitate self-regulation (Zelazo & Lyons, 2012). Specifically, mindfulness training may strengthen the cognitive (top-down) aspects of self-regulation while also decreasing negative emotional (bottom-up) aspects of self-regulation such as anxiety or stress (Zelazo & Lyons, 2012). Finally, an intervention that emphasized copying designs with creative materials in an after-school setting had positive effects on kindergarteners and first graders' executive function, visuospatial skills, classroom behavior, and first grade mathematics achievement (Grissmer et al., 2014).

Taken together, intervention research supports the malleability of self-regulation in childhood and provides accumulating evidence to suggest that these interventions are effective at improving self-regulation, especially in young children. More work is needed, however, on the long-term effects of such interventions. It is also unclear if interventions have varying effects for different groups of children and under which conditions these interventions are most effective. Future research needs to continue to probe these questions and examine complex mediated and moderated relations, consistent with the RDS view of development.

Improving Methodology

Moving the field of self-regulation forward requires that researchers integrate innovative within-study techniques with between-study (or between-discipline) approaches. Within-study approaches include broadening the ways that self-regulation is measured over time and across levels of analysis. Between-study (or between-discipline) approaches include identifying commonalities in findings across studies and disciplines that can pave the way for new questions to be raised and answered.

Within-Study Approaches

Within a single research study, strategies for improving methodology include (a) increasing measurement occasions or measuring the same skill more than once (Adolph & Berger, 2006); (b) diversifying measurement types or using multiple measures of a construct (Duckworth & Kern, 2011; Willoughby et al., 2012); (c) systematically measuring the component processes of interest in an effort to link theory and practice (Korkman, 1999); and (d) covering multiple units of analysis such as children, families, and classrooms to capture all the important elements that likely contribute to children's self-regulation (Blair & Raver, 2012a; McClelland et al., 2010).

First, increasing measurement occasions can help address the finding that the number of times a phenomenon is measured seems to affect its course of development (Adolph & Berger, 2006). This is especially relevant for EF, which, by definition, involves assessing a person's reaction to a novel set of demands.

Second, diversifying measurement types addresses the question of whether the same findings would have emerged if a different measure had been used (Duckworth & Kern, 2011; Willoughby et al., 2012). This is especially relevant for the study of self-regulation and EF given the huge variation in response modalities (e.g., fine motor movements such as pointing and mouse-clicking, gross motor movements such as touching one's head, oral responses, or observed classroom behavior).

A third strategy to improve methodology is to systematically measure the component processes of interest (Korkman, 1999). This strategy is sometimes referred as the component process approach and has been used most commonly in neurological work to link behavioral measures with underlying neural networks (Machamer, Darden, & Craver, 2000). The advantage of this approach is that it systematically identifies the individual components of behavioral measures along with their higher-order phenomena. It helps to address the "third variable problem" of processess and can be used to link specific measures to specific outcomes or to eliminate other measures that may appear to be contributing to an outcome but are actually linked because of some other process.

Finally, covering multiple units of analysis within studies is also critical (Blair & Raver, 2012a; McClelland et al., 2010). This is because acknowledging environmental contributions to self-regulation must be accompanied by methodological investments that include measurement across contexts such as talking to teachers and parents, observing classrooms, and examining out-of-school contexts. In addition, a literature that establishes the emotional and regulatory impacts on caregivers from dealing with many children who struggle with self-regulation has yet to be fully incorporated (Jennings & Greenberg, 2009).

Between-Study Approaches

A second set of strategies involves looking beyond individual research programs to identify key areas of convergence in findings and identify new research questions. Between-study approaches attempt to draw connections across disparate disciplines. They focus less on improving measurement at a microlevel and more on identifying big-picture points of convergence and divergence. These strategies may not be as intuitive to the current and historical scholarly paradigms that tend to assume a single lead researcher or small research team with training in the same area. Yet such between-study or between-discipline approaches may reveal commonalities that were previously unnoticed, provide ground for developing new theory or increasing precision of current theory, and point to new, untested hypotheses.

One such strategy is a systematic literature review across disciplines. For instance, the research reviewed in this chapter draws from studies of self-regulation across diverse disciplines, including psychology and its codisciplines, sociology, economics, public policy, and medicine (including psychiatry and occupational therapy). Keeping up with these diverse literatures can be time-consuming, and integrating findings from all these perspectives may be overwhelming for any single scholar. But a systematic literature review by a team can reveal connections, areas of overlap, and gaps.

Meta-analysis of a measure or construct is likely the most common between-study approach to convergence and involves analyzing the effect sizes from studies using the same set of constructs as a dependent variable. Meta-analyses of self-regulation or related skills have confirmed its importance for adaptive development (Duckworth & Kern, 2011). Meta-analysis of self-regulation may be somewhat impeded by the diversity of measures that differ in quantitative as well as qualitative ways across development. But after 20 years of research examining self-regulation and executive function, the field is ripe for more studies that tell us which measures of self-regulation predict which outcomes at which points in infancy, childhood, and adolescence.

Another strategy is to examine multiple data sets that contain similar measures. Such examination can lead to convergence, point to new research questions, and inform a program of research. It can be illuminating to start with a large longitudinal data set and then move to smaller-scale correlational and intervention studies to test hypotheses. For example, Duncan and colleagues (2007) found that early math achievement and attention, a teacher-report proxy for classroom self-regulation, was more important for later achievement than early reading achievement and social skills. Follow-up studies including Grissmer et al. (2010) and Murrah (2010) added two new constructs, fine motor skills and general knowledge, which were surprisingly strong predictors of later achievement as well. A subsequent study used a smaller convenience sample to confirm that both fine motor skills, particularly design copying items, were the most important contributors to achievement in addition to self-regulation (Cameron, Brock, et al., 2012).

The approaches described above can be realized more easily when scholars from different fields are involved on the same research team or who participate in an advisory

capacity, such as on a board that meets annually to review the progress of a project. Regular conversation with scholars and practitioners who have different training, viewpoints, and experiences can open up new research questions and shed light on issues that may otherwise go unnoticed. Scholars who are steeped in data may also want to talk regularly with teachers and clinicians who work with children. A psychologist with clinical training, for example, may be able to easily describe why a child has difficulty with an aspect of an assessment.

CONCLUSIONS

Self-regulation has an impact on numerous developmental outcomes throughout the life span. Relational-Developmental-Systems (RDS) provides an important and useful lens through which to view the development of self-regulation, (Lerner, 2006; Overton, 2006), and this chapter discussed key implications that taking such a relational metatheory has for the study of self-regulation.

From the perspective of RDS and, as well, theories that fall within a relational framework (e.g., dialectical theory, Kuczynski & De Mol, Chapter 9, this *Handbook*, this volume; Sameroff, 2010; dynamic systems theory, Witherington, Chapter 3, this *Handbook*, this volume), the term "self-regulation" may be an oversimplification. Individuals constantly regulate their behavior in reaction to, and with support from, the opportunities and constraints afforded by their environments (Sameroff, 2010). Optimal self-regulation therefore requires orchestrating a diverse set of self-regulatory skills and abilities. Thus, similar to the conceptual shift away from deficit models, which describe where children are lacking in comparison to other children, is an acknowledgment that people develop the most adaptive regulatory strategies for a given context. In other words, it is not as accurate to say a child "has" or "lacks" self-regulation, but to instead to describe the nature of his or her self-regulatory behaviors and the conditions under which he or she self-regulates in ways that optimize development.

Inherent in a relational understanding of self-regulation are decisions about the measures and methodology that are used to study these skills. As such, this chapter also highlighted methodological considerations and advances that are vital to considering the complex processess at play in the development of self-regulation during childhood and adolescence. Of these considerations, the relational interdependence of children's regulatory behaviors and environmental factors is especially important to consider. The chapter also emphasized several ways researchers can continue to explore the context-dependent nature of self-regulation during childhood and adolescence.

Contextual supports are particularly important early in development, when children's survival and states of arousal are determined by whether their caregivers provide food, warmth, and attuned emotional coactions. Moreover, as children enter daycare, preschool, and formal school settings, nonfamilial adults, peers, and learning materials all become part of the regulatory context. For researchers to study self-regulation adequately in all its contexts, it may be helpful to begin by considering the forest for the trees and then decide what to study and when. Studying children across cultures, sociodemographic backgrounds, and instructional settings, for example, may provide researchers with particularly rich examples of person ←→ context relations. Such a nuanced understanding of the development of self-regulation is useful for developing scientifically valid interventions and, as described, may inform youth interventions. A number of interventions have shown promise, especially in the short-term, but more work remains. The field of self-regulation is ripe for creative and interdisciplinary research that incorporates multiple measures, methods, and perspectives to understand how self-regulation unfolds throughout the life span.

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