THE DEVELOPMENT OF SELF-REGULATION: STABILITY AND PREDICTIVE UTILITY OF LABORATORY TASK PERFORMANCE ACROSS CHILDHOOD AND ADOLESCENCE

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The development of self-regulation is dynamic, involving diverse skills and behavioral manifestations that change considerably across childhood and adolescence. The current study uses data from the NICHD Study of Early Child Care and Youth Development to analyze performance on laboratory tasks of self-regulation during four meaningful age periods: early childhood (36-54 months), during the transition to formal schooling (1st grade), middle childhood (3rd-5th grade), and adolescence (15 years). Primary research aims were to examine: 1) the developmental stability of self-regulation across childhood and adolescence; 2) how self-regulation at multiple points across development predicts various adaptive and maladaptive indicators of adolescent adjustment; and 3) the unique contribution of very early measures of self-regulation to the prediction of later adjustment.

Latent factors derived from self-regulation task performance during the three childhood age periods were robust and stable over time, indicating that individuals' rank-order of self-regulation was largely consistent across childhood. Adolescent measures were more problematic. Self-regulation during early and middle childhood differentially predicted adolescent adjustment. Early childhood self-regulation was related to positive attitudes toward school, and aggressive and antisocial behavior a decade later. Self-regulation in middle childhood, on the other hand, predicted academic achievement in adolescence. Very early indicators of self-regulation predicted both adaptive and maladaptive adjustment. Early childhood self-regulation explained

unique variance in positive attitudes towards school and aggressive and antisocial behavior, beyond what was explained by self-regulation at later points in development. However, early childhood self-regulation was highly correlated with background characteristics. After accounting for the direct effect of gender, ethnicity, school readiness, and family income on adjustment, early childhood self-regulation did not explain additional variance in adolescent outcomes. Thus, individual variability in early self-regulation is meaningful for predicting later adjustment, but not more so than background characteristics that likely contribute to a child's preparedness as he/she transitions to formal schooling. Findings illustrate the cascading effect of self-regulation skills from early childhood through adolescence, while also identifying the relative impact of self-regulation across development for predicting adolescent adjustment. Results highlight the importance of early childhood, as early self-regulation lays the foundation for later self-regulation skills, and ultimately, for successful functioning.

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1.0 INTRODUCTION

Self-regulation is a key aspect of healthy functioning. The ability to control one's emotions and behavior has widespread implications beginning early in life, with lasting effects on adjustment. The development of self-regulation is a dynamic process, that involves a diverse set of skills and abilities which undergo considerable change over time. Although self-regulation has long been understood as a significant contributor to concurrent and subsequent functioning (e.g., McClelland, Geldhof, Cameron, & Wanless, 2015), there are some details surrounding the development and implications of self-regulation that remain unclear.

First, the range of abilities that reflect self-regulation vary greatly across development. Self-regulation in early childhood, which is the developmental focus for many studies, generally involves the control of emotional reactivity and behavioral impulses (e.g., the ability to resist playing with an attractive, yet forbidden toy; Diamond, 2002; Kopp, 1982). These skills are less indicative of self-regulation as children age, since it is expected that older children and teenagers have sufficiently mastered the ability to control such impulses. Over time, more refined cognitive skills take over as primary markers of self-regulation, which include working memory, sustained attention, and planning and problem solving (P. Anderson, 2002; Rueda, Posner, & Rothbart, 2005). Self-regulation is often measured at a single point or over a short period of time, which fails to incorporate the developmental progression of self-regulation across childhood and adolescence. Furthermore, it is common for researchers to use survey

questionnaire methods to assess self-regulation, especially in younger populations. This subjective method has the potential to introduce bias and measurement error. The current study uses performance on tasks administered in a laboratory setting to examine how self-regulation develops from early childhood through adolescence, keeping in mind the age-appropriate behavioral manifestation of such skills.

Second, while relevant literature has undoubtedly established the link between self-regulation and subsequent adjustment, the majority of such studies have focused on the negative consequences of poor self-regulation, which can lead to a range of maladaptive outcomes (e.g., Gottfredson & Hirschi, 1990). What has received less attention is how higher levels of self-regulation can help promote positive, adaptive adjustment. As previously stated, many studies analyze how adjustment is predicted by self-regulation at a single time point. The current study explores how self-regulation across multiple points in childhood and adolescence explains a comprehensive assortment of adolescent adjustment indicators. Specifically, adaptive outcomes span academic achievement, positive attitudes towards school, positive peer environment, and psychosocial competency and judgment. These analyses also examine how self-regulation across development predicts maladaptive outcomes such as aggressive and antisocial behavior.

Third, and finally, the present study explicitly tests the unique impact of very early indicators of self-regulation on later adjustment. There is much evidence to suggest just how important it is for young children to develop proficient self-regulation skills during the preschool years, before they transition to formal schooling (Entwisle, Alexander, & Olson, 2005; McClelland, Ponitz, Messersmith, & Tominey, 2010). However, many studies either collapse multiple assessments of self-regulation measured over time into a composite of general self-regulation ability (e.g., Moffitt, 2011), or take a singular measure of early childhood self-

regulation, to draw conclusions about the strong association between early self-regulation and subsequent adjustment. By including measures of self-regulation at multiple developmentally-salient transition points within the same sample, the current study tests how self-regulation measured in early childhood accounts for adolescent adjustment, beyond what is already explained by self-regulation measured at older ages. Understanding the role early developing skills and competencies play in later adaptive and maladaptive adjustment can help identify an important window for intervention. Targeting the improvement of self-regulation skills in early childhood can have potential benefits that cascade onto later developing self-regulation abilities and eventually, adjustment.

The current study uses data from the NICHD Study of Early Child Care and Youth Development, which followed youth from birth through age 15. Participants completed laboratory tasks of age-appropriate self-regulation skills across childhood and adolescence. In adolescence, indicators of adaptive and maladaptive adjustment were collected by self-report questionnaires and laboratory tasks. Using Structural Equation Modeling (SEM), this study assesses the degree to which laboratory task performance represents underlying self-regulation during four age periods: early childhood (36-54 months), during the transition to formal schooling (1st grade), middle childhood (3rd-5th grade), and adolescence (15 years).

The primary research aims were to examine: 1) the developmental stability of self-regulation across childhood and adolescence; 2) how self-regulation at multiple points across development predicts a range of adaptive and maladaptive indicators of adolescent adjustment; and 3) the unique contribution of very early measures of self-regulation to the prediction of later adjustment. This study expands on existing literature by using laboratory task performance to analyze how behavioral manifestations of self-regulation change over time within the same

sample of youth. Analyses focus on the cascading effect of self-regulation skills from early childhood through adolescence, while also identifying the relative impact of self-regulation across development for predicting adolescent adjustment. Analyses highlight the early childhood developmental period, in an effort to understand how self-regulation acquired early on facilitates adaptive self-regulation skills in older ages, and how those abilities go on to impact successful functioning and adjustment in adolescence.

2.0 REVIEW OF THE LITERATURE

2.1 SELF-REGULATION

Self-regulation is an essential aspect of healthy development and functioning, and the ability to control emotional and behavioral responses is important across an array of situations. Monitoring situational demands and appropriately managing one's reactions are key to adaptive behavioral adjustment, academic success, and interpersonal relationships. There are many ways that self-regulation can manifest given its prominent role in various domains of functioning across the lifespan. The overarching premise is that intentionally regulating behavior in order to achieve a goal or adapt to a situation facilitates success and positive adjustment. Self-regulation has widespread implications for both adaptive and adverse outcomes, beginning early in life, with lasting effects.

The construct of self-regulation has been defined and assessed in numerous ways across several disciplines, though researchers have not agreed on one definition that appropriately accounts for all the ways that self-regulation appears across contexts and development (McClelland et al., 2015). Often, researchers will focus on specific behaviors that reflect an aspect of control, such as complying with external requests, delaying gratification, inhibiting impulsive behaviors, modulating emotional reactions, redirecting attention, or problem solving (e.g., P. Anderson, 2002; Fonagy & Target, 2002; McClelland et al., 2015). These abilities are

multi-dimensional and contextually specific. Accordingly, self-regulation can take many forms. For example, a young child adhering to his mother's warning to not touch a hot stove or run into the street, a preschooler waiting for her turn in a game with friends, a school-age child completing a multi-step algebra problem, or a teen opting to study for a high school exam instead of hanging out with friends are all relevant illustrations of self-regulation. The common thread that ties these examples together is the ability to control behavior in order to adapt to the cognitive, emotional, or social demands of a situation (e.g., Barkley, 2001; Rothbart & Bates, 1998). In the current study, self-regulation is defined as the intentional, purposeful control of emotions, thoughts, or behaviors in order to achieve a goal (Barkley, 1997; Lezak, 1995; Rimm-Kaufman & Wanless, 2012).

Self-regulation includes two distinguishable types of behaviors: "hot" emotion-based behaviors, and "cool" cognitive-based behaviors (C. Blair, Zelazo, & Greenberg, 2005). Hot self-regulation processes are driven by the bottom-up control of thoughts, emotions, and behaviors as one processes information about the environment. Otherwise known as effortful control, hot self-regulation tends to occur in highly affective or emotionally-arousing situations, such as being faced with potential rewards or punishment (Eisenberg, Champion, & Ma, 2004; Rothbart & Ahadi, 1994). Hot self-regulation involves suppressing a prepotent response, and includes skills such as inhibitory control, delay of gratification, re-orienting attention, and emotional regulation. Cool self-regulation, on the other hand, generally refers to the regulation of behavior in affectively-neutral contexts. Cool self-regulation, or executive functioning, is the top-down cognitive processing in situations that do not elicit emotional arousal or motivation, such as problem-solving, working memory, planning, and attentional and cognitive flexibility (Carlson, 2005; Miyake et al., 2000). This is not to say that all self-regulation displayed in an

emotionally-arousing context necessarily represents hot self-regulation. Indeed, top-down cognitive control can be evident in emotionally charged situations, such as a gambling task or risky decision-making in the presence of peers (Zelazo & Carlson, 2012). Hot, affective self-regulation tends to develop first in children, followed by cool, cognitive executive functioning (Davidson, Amso, Anderson, & Diamond, 2006; Rothbart, Posner, & Kieras, 2006), as is discussed in the following section.

The current paper unpacks this complex construct by discussing the components of self-regulation as separate skills. However, it should be noted that these skills are largely interrelated. Youth who exhibit greater self-regulation in one domain are likely to exhibit similar levels of control in other domains (Miyake et al., 2000). 'Self-regulation' will be used throughout the current paper as an umbrella term for effortful control and executive functioning, which represents intentional, goal-directed behavior.

2.1.1 Development of Self-Regulation

Self-regulation must be examined through a developmental lens, since manifestations vary greatly depending on age and context. For instance, we might not be surprised by a toddler who throws the occasional temper tantrum, but this same behavior displayed later in childhood or adolescence would surely reflect poor self-regulation. One must consider the child's developmental stage when evaluating his or her relative degree of self-regulation.

Self-regulation can be viewed as hierarchical, with basic, rudimentary skills emerging first, followed by cognitive capacities that become more complex and integrated over time (Sapienza & Masten, 2011; Stuss, 1992). Empirical studies have charted the growth trajectories of executive functions, supporting this developmental framework. Various self-regulation skills

emerge at different points throughout childhood, following distinct patterns of growth until they coalesce in adolescence (P. Anderson, 2002; C. Blair & Raver, 2012; Calkins, 2007). The developmental progression of self-regulation is pertinent, as success (or failure) mastering these skills can cascade to affect later functioning. Children must negotiate new challenges as they age, and self-regulation plays a key role in many developmental milestones across childhood, adolescence, and into adulthood (Blandon, Calkins, Grimm, Keane, & O'Brien, 2010; Masten & Coatsworth, 1998). Good self-regulatory skills can set a child on a path for success early on, while early difficulties can compromise later functioning. For example, very impulsive children tend to elicit negative reactions from others, which can limit opportunities to practice and acquire self-regulation skills at older ages, subsequently creating a feedback loop of maladaptive behaviors and negative reactions (e.g., Rothbart & Bates, 1998). The following section discusses the behavioral manifestations of self-regulation across the first two decades of life.

Self-regulation is transformed over the course of development from a largely reactive response to external stimuli in infancy, to intentional control of internal mental and emotional states in early childhood (e.g., Barkley, 2001; Kopp, 1989; Rothbart, Posner, & Boylan, 1990). The key developmental tasks for infants are learning to regulate their emotions and attention. Infants are limited in their ability to physically manipulate their environment or remove themselves from a stressful situation. Therefore, they must develop strategies to adapt to their surroundings. Infants learn to focus their attention either towards or away from a stimulus, with techniques such as closing their eyes or turning their head. They also gain control of their emotional reactions with self-soothing techniques, such as thumb-sucking, to cope with stressful environments (Rothbart, Ziaie, & O'Boyle, 1992). Selectively attending to certain stimuli helps to minimize exposure to stressors, which might otherwise lead to an emotional outburst or

temper tantrum. Emotional and attentional control improves throughout toddlerhood (Ahadi & Rothbart, 1994; Kopp, 1989; Rothbart et al., 1992), laying the foundation for effortful control of behavior in early childhood.

In early childhood, toddlers use both emotional and attentional control to regulate their behavioral impulses (Tronick, Als, & Brazleton, 1977). Effortful control refers to the "hot" regulation of instinctive, reactive behaviors in order to achieve an alternative goal, a skill that begins to emerge around two years of age (e.g., Gerardi-Caulton, 2000; Rothbart, 1989). Effortful control in toddlerhood can by displayed by delayed gratification, sustained attention, inhibiting impulsive behavior, or complying with external requests (e.g., Barkley, 2001; Eisenberg, Smith, & Spinrad, 2011; Posner & Rothbart, 2000). Various situations require toddlers to exert effortful control, whether it is resisting a tempting snack (delayed gratification), playing a game of 'Simon Says' (sustained attention), refraining from throwing a toy across the room in a fit of rage (impulse control), or cleaning up a play area (compliance with external requests). Cross-sectional studies suggest that effortful control steadily increases from toddlerhood through the transition to adolescence (Diamond & Taylor, 1996; Ridderinkhof, van der Molen, Band, & Bashore, 1997; Rueda et al., 2004). Early mastery of these skills is vital, as young children who exhibit effortful control tend to better cope with the social and cognitive demands that accompany the transition to formal schooling (Shaw & Gross, 2008). A child who exerts effortful control by waiting his/her turn to speak in class, sharing toys, and following instructions, for example, is more likely to succeed in school.

As children transition to formal schooling and continue through elementary school, they are faced with increasingly complex tasks that call for higher-level cognitive self-regulation, or executive functioning. After gaining control of impulsive behavior, the developmental focus

shifts to executive functions such as planning and problem solving, information processing, cognitive flexibility, working memory, and goal setting (P. Anderson, 2002; Rueda et al., 2005). Academic tasks in a classroom setting can involve processing multiple (and sometimes conflicting) rules, retaining those rules in working memory, and having the attentional flexibility to switch between rules and disregard irrelevant pieces of information. Persisting on a long, complicated task requires children to have sustained attention, without forgetting to monitor progress, strategize, and correct any errors in decision-making (Bell & Deater-Deckard, 2007; Eslinger, 1996; Kirkham, Cruess, & Diamond, 2003; Lyon, 1996). Hence, multiple executive functions are involved in successful goal-directed self-regulation during the transition to formal schooling and middle childhood.

Children who have difficulty with cognitive executive functioning at this age may be less skilled at processing multiple rules or complex information, which can lead them to forget classroom instructions or lose their place in a multi-step task. It is not surprising that many cases of ADHD are diagnosed around the time children begin elementary school, since the classroom environment tends to highlight deficiencies in attention and executive functioning (Berger, Kofman, Livneh, & Henik, 2007; Nigg, 2001). Cross-sectional studies indicate that executive functioning skills improve from early childhood through mid-adolescence, leveling off thereafter (Davidson et al., 2006; Luciana, Conklin, Hooper, & Yarger, 2005). These abilities parallel maturation of the prefrontal cortex in middle childhood (e.g., Kwon, Reiss, & Menon, 2002), and are instrumental for successful executive control in adolescence.

Adolescence is a critical period for self-regulation given the sweeping biological, cognitive, and social changes at this point in development. This is also a time when repercussions from earlier deficits in self-regulation may become evident. The major marker of

self-regulation in adolescence involves the integration of executive functions for 'executive control' (V. A. Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001). Executive control refers to the coordination of previously acquired abilities such as working memory, inhibition, mental shifting, and information processing, which are then called upon as needed (Best, Miller, & Naglieri, 2011; Friedman et al., 2008; Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003; Miyake et al., 2000). Adolescents are faced with complex challenges that require them to process conflicting information, plan and set long-term goals, and control behavioral impulses at a time when they are prone to sensation seeking and risk-taking (Steinberg, 2007). At this age, impaired executive control can lead to poor academic performance, heightened vulnerability to peer pressure, and greater propensity to engage in risky or dangerous behavior (Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; M. Gardner & Steinberg, 2005; Steinberg, 2008).

While many of the brain regions associated with self-regulation have largely developed by adolescence, biological maturation continues throughout the second decade of life (Scherf, Sweeney, & Luna, 2006). The myelination of prefrontal cortices and loss of gray matter throughout adolescence improves interconnectivity between regions of the brain responsible for various executive functions (Giedd et al., 1996; Huttenlocher & Dabholkar, 1997; O'Hare & Sowell, 2008). The improved interconnectivity allows for more fluid and dynamic executive control (e.g., Durston & Casey, 2006; Fair et al., 2009). In a large cross-sectional study of 5-17 year olds, older participants performed better than younger participants on advanced executive control tasks, such as greater monitoring, speed, and accuracy on a computerized planning task, suggesting that executive control consistently improves across adolescence (Best et al., 2011).

To summarize, self-regulation develops from basic, fundamental abilities such as emotional regulation and attentional control in infancy, to effortful control in early childhood,

followed by higher-order cognitive executive functions like working memory, planning, and problem solving, which all coalesce in adolescence (C. Blair & Raver, 2012; Calkins, 2007). Changing social demands, cognitive competencies, and biological interconnectivity promote adolescents' ability to switch between executive functions, and demonstrate global executive control. This hierarchically organized framework alludes to the cascading nature of developing self-regulation, in which success in one early domain can facilitate skills in other domains (e.g., Masten & Coatsworth, 1998). Conversely, early difficulties can undermine later successful development. For example, children with problems exerting effortful control may have difficult interactions with peers and teachers when they enter school. These children might be less receptive to instruction and learning, which can subsequently interfere with cognitive executive functioning in middle childhood and executive control as a teenager. Therefore, it is important to consider the developmental progression of self-regulation as it presents at different ages, and how these early competencies impact later self-regulation and functioning.

2.1.2 Measurement of Self-Regulation

Self-regulation develops such that distinct (yet related) constructs are salient over time. In early years, the focus is mastering effortful control, which allows for cognitive executive functioning later in childhood, and eventual executive control in adolescence. These skills all represent self-regulation as intentional, goal-directed behavior, yet in different ways. Measures must be age-appropriate to adequately capture self-regulation across development.

The two primary methods of measuring self-regulation are via laboratory tasks and questionnaires. Laboratory tasks elicit aspects of self-regulation by presenting subjects with various stimuli, choices, or hypothetical scenarios, such as showing a toddler a tempting snack

and seeing how long they can resist eating it. Tasks must be more advanced to properly capture self-regulation in older populations. To illustrate, the delay discounting task measures future orientation by asking subjects whether they hypothetically would opt to earn a larger financial payout in the future or a smaller payout immediately (Richards, Zhang, Mitchell, & de Wit, 1999). This task is generally administered to adolescents and adults and would not be considered an appropriate index of self-regulation in younger children, which highlights the importance of using developmentally-specific assessments.

In addition to laboratory tasks, survey questionnaires are a popular method of gauging self-regulation. Surveys can quickly gather information from multiple reporters across a range of contexts. The benefit of easily collecting survey data can be diminished by reporter subjectivity and bias, which might compromise the accuracy of the data (Bowling, 2005). Theoretically, laboratory tasks and survey questionnaires should be correlated if they are both adequate methods of capturing self-regulation, yet there is evidence to the contrary. Meta-analyses find that results from laboratory tasks and questionnaires are inconsistent, and only moderately correlated at best (Duckworth & Kern, 2011; Toplak, West, & Stanovich, 2013), suggesting that these two methods are not truly interchangeable.

Laboratory tasks have become increasingly popular, but not without debate about their ecological validity. Some have argued that these tasks are measuring a skillset that is too narrow to generalize to real-world behavior (Bodnar, Prahme, Cutting, Denckla, & Mahone, 2007; Pennington & Ozonoff, 1996). There is a general consensus, however, that such tasks are valid indicators of self-regulation (Falk & Heckman, 2009). The present study includes laboratory tasks that tap into the relevant self-regulation skills developing across childhood and

adolescence. It stands to reason that as compared to survey questionnaires, laboratory tasks are more objective and sensitive to changing skills across development.

In early childhood, successful self-regulation consists of "hot" effortful control of prepotent behavioral impulses. Various paradigms are used to assess aspects of effortful control which include attentional control, impulse control, and delay of gratification. A popular measure of attentional and inhibitory control is the "Go/No Go" task, in which subjects are told to perform one action in response to certain stimuli (e.g., press a button when they see a letter), but to withhold that action when presented with other stimuli (i.e., not press the button when that letter is "X"). Another is the Stroop paradigm, which presents multiple stimuli, and asks subjects to focus on a particular set of criteria while ignoring the rest (MacLeod, 1991; Stroop, 1935). In Mischel and colleagues' (1989) classic test of delayed gratification, 4-year olds were given a marshmallow, and instructed not to eat the marshmallow after the researcher left them alone in the room. If the child resisted eating the marshmallow, they were rewarded with two marshmallows once the researcher returned. Children who delayed their immediate gratification of eating the marshmallow were considered to have higher levels of effortful control. When children are older, delay of gratification is measured with more complicated tasks. For example, a 'gift' task tests how long toddlers can resist peeking inside a large gift bag when they are left alone in a room. The task is modified for use in slightly older preschool populations, by asking children to sit facing away while an experimenter noisily wraps the gift. The presumption is that more refined effortful control is required to resist turning around and peeking while a gift is being wrapped versus looking inside a gift bag (Berger et al., 2007; Carlson, 2005; Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996).

As children transition to formal schooling, self-regulation tasks focus on 'cool' cognitive executive functions, such as working memory, planning and problem solving, and sustained attention. Working memory, planning and problem solving are measured with paradigms such as the Tower of London (Morris et al., 1988; Owen, Downes, Sahakian, Polkey, & Robbins, 1990; Shallice, 1982). In this task, children are instructed to adhere to multiple rules in order to sort different colored balls into a particular arrangement. Children must plan several steps ahead to efficiently arrive at the given solution. Other measures test sustained attention by presenting subjects with a lengthy, repetitive task in which rules apply to certain stimuli (e.g., pressing a button when they see the number 1), but not for others (not pressing a button when they see the number 2). These tasks, such as the Continuous Performance Task (CPT), measure errors of commission and errors of omission that represent impulsivity and inattention, respectively (Nuechterlein, 1991; Nuechterlein & Dawson, 1984; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956). Taken together, laboratory measures of executive functioning can require subjects to pay close, continuous attention, to process and selectively apply multiple rules, and to withhold learned behavioral responses.

In adolescence, more complicated tasks measure individual variability in executive control. During such paradigms, teens might be presented with hypothetical situations or complex puzzles in order to gauge long-term planning, problem solving, and working memory. For example, long-term planning might be assessed with the delay discounting task, with executive control demonstrated by those who hypothetically opt to earn a larger financial payout in the future versus a smaller immediate return (Richards et al., 1999). The Tower of Hanoi is a derivative of the Tower of London task, but with more complicated requirements which involve advanced strategies to arrive at the puzzle's solution (M. C. Welsh, 1991a).

The present study uses performance on behavioral tasks to measure self-regulation across childhood and adolescence. Laboratory tasks can hone in on the most salient self-regulatory competencies during each developmental period. Specifically, tasks of delayed gratification and impulse control assess effortful control in early childhood. Attentional control is also measured in early childhood. Given the contribution of attentional control to executive functioning, this skill is also captured (with age-appropriate tasks) during the transition to formal schooling and middle childhood. Planning, problem-solving, and working memory tasks are introduced during the transition to formal schooling as measures of executive control, and also administered during middle childhood and adolescence. Focusing on these distinct skills can provide a more complete, comprehensive picture of self-regulation as it changes from early childhood through adolescence.

2.2 STABILITY OF SELF-REGULATION

Understanding the developmental course of self-regulation must also include a discussion of individual differences, and how consistent – or stable – these differences are over time. Stability refers to the maintenance of rank-ordered self-regulation over time. Is a young child who is highly regulated compared to peers also likely to exhibit relatively high levels of self-regulation later on? Conversely, do children who are poorly-regulated at one age go on to exhibit low levels of self-regulation at older ages? Beyond describing the typical developmental trajectory of self-regulation, these patterns of individual differences are also informative for understanding how these competencies change over time. Once self-regulation is stable, it can become a

meaningful metric for predicting later self-regulation. Given the myriad skills that emerge across development, measures of stability help estimate how consistent or malleable it is over time.

Short-term longitudinal studies have analyzed the stability of self-regulation across childhood and adolescence. Before age 2, repeated measures of behavioral self-regulation are not significantly correlated, although there is evidence that rank-order of emotional self-regulation is somewhat consistent during this period (Diamond, 1991; Ruff & Rothbart, 1996). Individual differences in behavioral self-regulation emerge in toddlerhood, and are fairly stable across childhood, adolescence, and adulthood (Best & Miller, 2010; Murphy, Eisenberg, Fabes, Shepard, & Guthrie, 1999; Rueda et al., 2005).

There is modest stability of effortful control across the toddler and preschool period, as demonstrated by laboratory tests of delayed gratification. Some studies use latency to play with an attractive, but forbidden, toy as an index of such ability. Data suggest a significant association between children's delay of gratification at 14 months and 36 months (r = .30; Friedman, Miyake, Robinson, & Hewitt, 2011). In another study, however, children's ability to resist eating a tempting snack when they were 18 months old was not related to this same ability when they were 30 months old, or 42 months old (Eisenberg, Spinrad, et al., 2010). Yet another study used multiple tasks to measure toddlers' effortful control, such as resisting a tempting snack, modulating their voice, and suppressing the urge to play a tower-building game. Performance on these tasks was highly correlated with a parallel set of tasks one year later (r = .59; Kochanska et al., 1996). Similar patterns of self-regulation development appear in high-risk populations. For example, in a sample of low-income children, individual differences in delayed gratification during a snack and 'gift wrap' task are modestly stable over a 16-month interval (r = .40; Li-Grining, 2007). Taken together, studies of diverse populations suggest that in

toddlerhood, individual differences in effortful control emerged and were modestly stable over short intervals of time.

Children appear to retain their rank-order of self-regulation as they transition to formal schooling. There are moderate to strong correlations between impulse control exhibited as toddlers (2.5 years), preschoolers (4 years), and during the transition to formal schooling (5.5 years; Kochanska, Murray, & Coy, 1997). These associations suggest that children who display higher levels of effortful control as toddlers are likely to display high levels of effortful control as preschoolers and shortly thereafter.

Most studies examine the development and stability of self-regulation during childhood, though far less research has specifically explored how stable self-regulation is from childhood into adolescence. One notable study that used laboratory tasks to assess self-regulation from early childhood and into adolescence measured multiple executive functions across a 7-year period, beginning when children were 5, and following them up when they were 12 (Polderman et al., 2007). At both time points, participants completed a battery of computerized tasks of working memory, selective attention, and sustained attention. Each of these executive functions was moderately correlated at age 5 and at age 12, (*r*'s for separate executive functions ranging from .37 - .39). This degree of stability is particularly noteworthy given the length of the time between assessments. Collectively, these findings suggest that rank-order of self-regulation is fairly consistent throughout childhood and into early adolescence, with childhood indicators of self-regulation predicting similar abilities in the teenage years.

Using a large birth cohort from Dunedin, New Zealand, Moffitt and colleagues (2011) reported that self-regulation is meaningfully stable across an even longer developmental span. Childhood self-control, a construct which overlaps considerably with self-regulation, predicted

comparable skills in early adulthood. Performance on laboratory tasks and surveys from multiple informants including parents, teachers, experimenters, and participants, were aggregated across select points in childhood, adolescence, and adulthood. Self-regulation assessed between the ages of 3 and 11 were combined into one composite score of childhood self-control. Self-control was fairly stable from childhood to adulthood, with the childhood composite score correlating with a self-reported measure of self-regulation when participants were 26 years old (r = .30). In other words, children who performed well on self-control tasks and were perceived as more highly-regulated by adults, were more likely to report high levels of self-regulation themselves when they were young adults. Taken together, these studies provide a convincing argument that the rank-order of self-regulation is generally stable across the first two decades of life and into adulthood.

As evident in this review, there are common shortfalls in existing studies of self-regulation. Often, researchers will use group averages to demonstrate change over time, typically measuring self-regulation at only two time points. With the exception of the Dunedin birth cohort study, few have followed the same sample of children over an extended period of time. Instead, self-regulation tends to be explored across a relatively short interval. An additional limitation is that many studies use questionnaires as the primary index of self-regulation, which introduces a degree of reporter bias or subjectivity. A more objective method of measuring self-regulation over time would incorporate laboratory tasks. Limited age spans and survey questionnaire methodologies both present problems when charting typical change across the entire developmental period of interest. The present study explores the stability of self-regulation as the relative change in performance on behavioral tasks *within the same participant* from early childhood through adolescence. Developmentally-appropriate laboratory

tasks of self-regulation skills from 36 months to 15 years are used to analyze the stability of self-regulation across four meaningful developmental periods: early childhood (36 months – 54 months), the transition to formal schooling (1st grade), middle childhood (3rd grade – 5th grade), and adolescence (15 years).

2.3 SELF-REGULATION AND ADOLESCENT ADJUSTMENT

A wealth of research has been dedicated to the correlates and consequences of individual differences in self-regulation. There is strong consensus that self-regulation affects current and subsequent functioning across a wide array of domains. Overall, the ages that have received that most attention in the literature are early and middle childhood. Extensive, rigorous studies have examined the effects of early self-regulation on subsequent social and cognitive adjustment. Individual variability in children's self-regulation predicts adaptive outcomes in preschool and early school years, such as school readiness, math and reading ability, academic engagement, and relationship quality with peers and teachers (C. Blair & Razza, 2007; Clark, Pritchard, & Woodward, 2010; Dobbs, Doctoroff, Fisher, & Arnold, 2006; Eisenberg, Valiente, & Eggum, 2010; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003; J. A. Welsh, Nix, Blair, Bierman, & Nelson, 2010).

With regard to outcomes, most studies have explored the harmful effect of self-regulation *deficits.* This trend in the literature makes sense given the link between lower levels of self-regulation and severe negative outcomes across the lifespan, such as early mortality, clinical diagnoses, unemployment, criminal offending, and financial instability (Caspi, Moffitt, Newman,

& Silva, 1996; Caspi et al., 1994; Caspi, Wright, Moffitt, & Silva, 1998; Gottfredson & Hirschi, 1990; Heckman, 2007; Kern & Friedman, 2008; Moffitt et al., 2011; White et al., 1994).

Lower levels of early childhood self-regulation in particular are associated with numerous maladaptive outcomes. Children with poor effortful control are likely to exhibit negative behaviors in preschool, including both externalizing and internalizing problems (Calkins & Dedmon, 2000; Eisenberg, Spinrad, et al., 2010; Espy, Sheffield, Wiebe, Clark, & Moehr, 2011; Kochanska & Knaack, 2003). In early and middle childhood, lower levels of impulse control, planning, delayed gratification, and attentional control predict externalizing problems and symptoms associated with attention-deficit/hyperactivity disorder (ADHD; Campbell & von Stauffenberg, 2009; Lemery, Essex, & Snider, 2002). Young children with self-regulation difficulties are more likely to experience to a range of hardships concurrently and over time, as compared to children who show better self-regulation skills as preschoolers and as they transition to formal schooling.

Individual differences in self-regulation later in childhood and adolescence are also linked with assorted negative outcomes. For example, performance on executive functioning tasks when children were 6 and 8 years old was related to externalizing problems at age 7, 10, 14, and 17 (Olson, Schilling, & Bates, 1999). Additionally, in a longitudinal study of Swedish men, teacher-reported task persistence at age 13 predicted academic achievement in late adolescence, and educational attainment, income, and occupation level in middle adulthood (Andersson & Bergman, 2011).

Some literature has explored the lasting impact of early self-regulation on adjustment later in adolescence and adulthood. Perhaps the most well-known study of the effects of early childhood self-regulation is Michel's marshmallow task, which assessed preschoolers' ability to

delay gratification. Individual differences in delayed gratification in preschool predicted many social, cognitive, and mental health outcomes over the lifespan (Mischel et al., 2011). In that sample, better self-regulation during the marshmallow task was associated with higher SAT scores, better social, cognitive, and emotional coping in adolescence (Mischel et al., 1989; Shoda, Mischel, & Peake, 1990), and higher educational achievement, feelings of self-worth, ability to cope with stress, and less recreational drug use in adulthood (Ayduk et al., 2000). Similar associations have been reported in other longitudinal studies, such as parent reports of 4 year-olds' attention span and task persistence predicting math and reading achievement at age 21, and likelihood of completing college by age 25 (McClelland, Acock, Piccinin, Rhea, & Stallings, 2013).

The long-lasting effects of childhood self-regulation were also described in the Dunedin birth cohort study. Experimenters rated the behavioral characteristics of three year olds as they completed various cognitive and motor laboratory tasks (Caspi, 2000). Children who experimenters deemed as under-controlled were more likely to exhibit internalizing and externalizing behavior problems at age 15, have lower quality interpersonal relationships, and be unemployed, abuse alcohol, and attempt suicide at age 21 (Caspi, 2000). In this same sample, the aggregate measure of self-control when children were between 3 and 11 years old also predicted a host of adult outcomes spanning physical health, financial well-being, and criminality (Moffitt et al., 2011). Specifically, children who exhibited low self-control were more likely at age 32 to be in worse physical health, suffer from depression or substance dependence, have lower socioeconomic status, more financial hardships, and be convicted of a criminal offense, even after accounting for IQ and socioeconomic status.

Few studies have captured self-regulation at multiple points across childhood in order to determine which skills and which periods of development are most important for later adjustment. The present study fills this gap by testing how self-regulation across childhood and adolescence predicts various domains of adolescent adjustment. Adolescence is a period of considerable emotional, cognitive, and biological change, second only to the major transformation that defines early childhood (Diamond, 2002; Steinberg et al., 2006; Zelazo, Carlson, & Kesek, 2008), making this a critical time to monitor adjustment.

Many aspects of adolescent functioning rely on an individual's ability to regulate their emotions and behavior. Adolescents are expected to be more autonomous and independent from their families than they were in childhood (Laursen & Collins, 2009; McElhaney, Allen, Stephenson, & Hare, 2009). In general, as teens spend less time with family, they tend to spend more time with peers (Brown, 2004; Brown & Larson, 2009), which can increase the frequency of situations that require teens to exert some form of self-control. The biological and cognitive changes associated with puberty also make teens more susceptible to peer influence, sensation-seeking, and general risk-taking (Chein et al., 2011; M. Gardner & Steinberg, 2005; Somerville, Jones, & Casey, 2010; Stroud et al., 2009). Adolescents engage in more risk-taking behavior than at any other point in development, such as delinquency, substance use, reckless driving, and risky sexual behavior, with potentially dangerous consequences ranging from injury, to arrest, and even death (Johnston, O'Malley, Bachman, & Schulenberg, 2006; Kelley, Schochet, & Landry, 2004; Steinberg, 2008; Steinberg et al., 2008; Zimring, 1998). Since teens are expected to have more control over their behavior than children, the consequences of poor self-regulation tend to be more severe (e.g., Gestsdottir & Lerner, 2008). Thus, the impact of self-regulation on behavioral outcomes remains an important area of research, especially during adolescence.

Executive functions may play a different role in predicting behaviors that are *positive* in nature from those that are *negative*. Martel and colleagues (2007) reported that better executive functioning from preschool through early adolescence, as assessed by questionnaire and laboratory tasks, predicted various psychological, social, and academic outcomes in adolescence. An array of executive function laboratory tasks was administered to participants between 12 and 18 years old, including a planning (Tower of Hanoi), response inhibition (Go-No-Go), and interference control (Stroop) task. Adaptive outcomes surrounding academic and social competence were related to performance on many of the executive function tasks, including response inhibition, interference control, naming speed, and planning. However, the maladaptive outcomes of internalizing and externalizing behavior problems were only predicted by response inhibition, but not other executive functions. Since adaptive and maladaptive behaviors may call upon different executive functions, the present study separately models adaptive and maladaptive adolescent outcomes.

As previously stated, most of the literature on the consequences of individual differences in self-regulation has focused on the relation between *lower* levels of self-regulation and maladaptive outcomes. Symbolic of such a "deficit" model is Barkley's (1997) framework of executive function abnormalities observed in children with ADHD. This framework illustrates how early problems with self-regulation can engender subsequent behavioral problems. Deficit models have also been applied to prevention research on the efficacy of treatment programs in reducing problem behaviors in at-risk youth (Allen & Philliber, 2001; Bierman, 2002).

Historically, far less research has centered on adaptive outcomes, although there has been a recent surge regarding positive youth development. It is just as valuable to understand how improved (or improving) self-regulation can lead to better adjustment, as it is to highlight how

lower levels of self-regulation might lead to maladaptive outcomes (Benson et al., 2006). The present study explores how the development of self-regulation from early childhood through adolescence predicts both adaptive and maladaptive indicators of adjustment. The following sections discuss existing research on the link between self-regulation and adaptive and maladaptive adolescent outcomes, respectively.

2.3.1 Adaptive Adjustment

Successful adjustment in adolescence spans many domains and contexts. How a teen behaves in a school setting may not necessarily translate into how he/she behaves with parents or friends. The strength of the association between self-regulation and adjustment may depend on how closely aligned the executive functions are with the behavioral domain (e.g., G. Geldhof, Little, & Hawley, 2012). For example, academic achievement has a larger correlation with working memory than with impulse control, since working memory is typically used in real-world behaviors representative of academic achievement (Rogers, Hwang, Toplak, Weiss, & Tannock, 2011). The present study considers four separate domains of adaptive adjustment: academic achievement, positive attitudes toward school, positive peer environment, and psychosocial competency and judgment.

2.3.1.1 Academic Achievement

Academic achievement is a fundamental index of successful functioning in adolescence, as it sets the stage for educational and occupational success in adulthood (Masen & Coatsworth, 1998). Academic achievement is assessed in multiple ways, including course grades, standardized test scores, or math and reading ability. Logically, self-regulation facilitates academic achievement,

since children who can better manage their emotions and behaviors in a classroom setting are more receptive to instruction, learning, and ultimately academic success.

Positive associations between self-regulation and academic achievement have been demonstrated across development. There is a robust relation between self-regulation and early indicators of academic achievement, such as school readiness during the transition to formal schooling (e.g., C. Blair & Razza, 2007; Eisenberg, Valiente, et al., 2010), and across elementary school (Li-Grining, Votruba-Drzal, Maldonado-Carreno, & Haas, 2010) and middle school (Duckworth, Tsukayama, & May, 2010). Extending this line of research into early adulthood, attentional persistence on a laboratory task at age 4 predicted likelihood to complete college by age 25 (McClelland et al., 2013).

In studies of adolescent development, youth who exhibit higher levels of self-regulation are likely to show greater academic achievement. Effortful control, as measured by self- and parent surveys, correlated with higher grade-point-averages (GPA) in both the fall and spring semester of the same school year in a sample of 7-12 year olds (Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008). In a cross-sectional sample of high-schoolers, participants and teachers completed surveys of self-regulation and impulse control (Zimmerman & Kitsantas, 2014). Again, self-regulation was related to higher GPAs, and also a higher likelihood of passing state standardized tests of math, reading, and writing. Performance on an executive functioning task of interference control (i.e., Attention Network Task; Fan, McCandliss, Sommer, Raz, & Posner, 2002) was related to academic outcomes in 12-year-olds (Checa, Rodriguez-Bailon, & Rueda, 2008). Specifically, better interference control was associated with higher grades, especially in math classes. Interference control was also used as an indicator of executive functioning, along with various other laboratory tasks, to explore the longitudinal

prediction from self-regulation to academic achievement. Better executive functioning at age 8 predicted higher levels of teacher-rated academic competence (e.g., academic skills, intellectual ability) by age 12 (Harms, Zayas, Meltzoff, & Carlson, 2014). These reported positive links between self-regulation and academic achievement serve as the foundation for the present analyses. The current study expands on findings from extant literature by testing how self-regulation exhibited across multiple points in childhood and adolescence is predictive of academic achievement at age 15, as measured by performance on executive functioning tasks that are reflective of academic competency.

2.3.1.2 Positive attitudes towards school

Successful functioning in school is broader than academic achievement. It is important that teens not only perform well in school (e.g., earn good grades), but that they are also invested in their school and have high-quality relationships with teachers. Across development, youth with higher levels of self-regulation tend to have a more positive perception of their school environment. As early as preschool, individual variability in effortful control predicts closeness with teachers, positive attitudes toward school, and school avoidance across the school year (Silva et al., 2011). During the early school years, children with better self-regulation skills report better relationships with their teachers, greater engagement with school, and greater liking of school (Hamre & Pianta, 2001; Myers & Morris, 2009; Rudasill & Rimm-Kaufman, 2009; Silver, Measelle, Armstrong, & Essex, 2005). In adolescence, school attachment can be observed by teens who value academic achievement, feel connected to their school, or show a commitment and bonding to their teachers (Libbey, 2004). Adolescents who are strongly attached to school also demonstrate stronger conventional social ties, as per Hirschi's (1998) theory of social control. Strong social ties cascade onto positive adjustment in various other

domains, including lower substance use and deviance (Achenbach, Howell, McConaughy, & Stanger, 1995; Hawkins, 1997; Jessor, Van Den Bos, Vanderryn, Costa, & Turbin, 1995), and better psychological well-being (e.g., Bond et al., 2007; Gestsdottir & Lerner, 2008).

Few studies have used performance on laboratory tasks to directly test the link between self-regulation across childhood and subsequent school attachment in adolescence. However, abilities that are related to self-regulation (e.g., future orientation) are related to more positive attitudes towards school, which may conceptually link self-regulation with school attitudes (e.g., Maddox & Prinz, 2003). Self-regulation strategies are tied to perceptions of school and school engagement, as evidenced in Wang and Holcombe's short-term longitudinal study of 7th and 9th grade students. Students who reported using more self-regulation strategies (e.g., planning out steps to complete a homework assignment before getting started) showed higher levels of school engagement, including more school participation, greater affiliation with school, and they also reported higher levels of care and support from their teachers (Wang & Holcombe, 2010). On the other hand, students who used fewer self-regulation strategies were less engaged in school. The same pattern holds across high school, with higher levels of self-regulation correlating with feeling more bonded to a favorite teacher, and with greater intrinsic motivation to succeed in an academic setting (Learner & Kruger, 1997). The current study combines school attachment and teacher bonding into a comprehensive indicator of attitudes towards school. Self-regulation exhibited in early childhood, during the transition to formal schooling, middle childhood, and adolescence is explored in relation to adolescents' positive attitudes towards school.

2.3.1.3 Positive peer environment

One of the most influential socializing contexts for adolescents is the peer group (e.g., Brown, 2004). Various aspects of the peer environment have been explored in relation to self-regulation,

including peer group characteristics and friendship quality. Teens who report greater degrees of self-regulation are more likely to have friends who engage in more prosocial behaviors than those who show less effortful control (Dyson, Robertson, & Wong, 2015).

Evidence is mixed regarding the strength of the relationship between self-regulation and healthy peer relationships in adolescence. Some studies have found that greater executive functioning predicts better social abilities and being liked by peers (e.g., Diamantopoulou, Rydell, Thorell, & Bohlin, 2007). Others, such as Biederman and colleagues (2004) have found no difference in social functioning between youth with executive function deficits (i.e., diagnosed with ADHD) and typically-developing youth. Participants between 6 and 17 years old were compared on multiple social and cognitive outcomes, including a mother report of social functioning. Executive functioning deficits were not associated with greater interpersonal or social difficulty (Biederman et al., 2004). One specific aspect of interpersonal relationships that may be related to self-regulation is friendship quality. Problems with self-regulation may limit teens' ability to form and maintain close friendships. Teens between the ages of 13 and 18 years with a history of ADHD, and ostensibly lower levels of self-regulation, had fewer close friendships, and experienced more rejection by their peers, than those without symptoms of ADHD (Bagwell, Molina, Pelham, & Hoza, 2001). However, in a study of youth of a similar age (11-17 years), teens with more symptoms of ADHD, or more executive function deficits, were likely to have friendships of a higher quality (Glass, Flory, & Hankin, 2012). According to both participants and their friends, teens with higher levels of ADHD symptoms were more likely to have friendships that were nurturing, affectionate, and intimate. This finding is unexpected, in light of the positive association between self-regulation and friendship quality reported elsewhere. These conflicting results illustrate that more research is needed to establish

the relation between self-regulation and friendship quality in adolescence. In the current study, adolescent peer environment combines measures of peer group characteristics and friendship quality. The association between self-regulation and peer environment may vary based on the developmental period in which self-regulation is measured. Acknowledging this possibility, these analyses test how self-regulation across multiple points in childhood and adolescence is predictive of self-reported positive peer environment in adolescence.

2.3.1.4 Psychosocial competency and judgment

As children transition into adolescence, they are faced with situations that become increasingly complex and demanding. An inherent marker of successful functioning in adolescence is psychosocial competency and judgment to navigate these novel situations. Broadly, this reflects the integration of community and social norms as teens learn to function as autonomous beings. Psychosocial competency and judgment underscore the ability to juggle daily demands of school, work, family, and interpersonal relationships, while also working to achieve long-term goals (e.g., Keyes & Ryff, 1998; Ryff, 1989). In other words, psychosocial competency and judgment refers to functioning in a way that positively impacts immediate circumstances and likelihood of achieving future aspirations (Glueck & Glueck, 1974; Steinberg, Chung, & Little, 2004). Herein, psychosocial competency and judgment is understood as a combination of three capacities: psychosocial maturity, future orientation, and resistance to peer influence.

Psychosocial maturity involves various competencies related to teens' ability to set and ultimately achieve meaningful personal goals. Psychosocial maturity is evident when teens rely on personal responsibility to govern their behavior in the absence of adult oversight, develop mastery of their educational or vocational skills, consider others' perspectives, and function collaboratively with others in society (e.g., Dmitrieva, Monahan, Cauffman, & Steinberg, 2012;

Greenberger, 1984; Steinberg & Cauffman, 1996). Components of psychosocial maturity develop linearly across adolescence (Monahan, Steinberg, Cauffman, & Mulvey, 2009; Steinberg & Cauffman, 1996), which parallel growth in self-regulation (Steinberg, 2008). Indeed, there is evidence that self-regulation is associated with higher levels of psychosocial maturity. For example, children who their teachers considered to be highly regulated when they were 8 years old were more likely to self-report higher levels of psychological well-being, financial standing, career stability, self-esteem, independence, and social responsibility in adulthood, all of which are indicators of psychosocial maturity (Laursen, Pulkkinen, & Adams, 2002; Pulkkinen, Nygren, & Kokko, 2002). Self-regulation is also related to concurrent psychosocial maturity in adolescence. In a sample of low-income youth ranging between the ages of 8 and 18 years old, higher levels of self-regulation, as determined by experimenter observation, were associated with global adaptive functioning and social competency at home, in school, and with friends (Buckner, Mezzacappa, & Beardslee, 2009). Some have posited that self-regulation enables individuals to flexibly and fluidly adapt to changing environments by using appropriate strategies for solving cognitive, social, and personal problems (e.g., Block & Block, 1980). Thus, improvements in executive functioning across adolescence are expected to be manifest in higher levels of psychosocial maturity, one indicator of adaptive behavioral adjustment.

Future orientation is also associated with many adaptive outcomes, given that teens who are better able to plan ahead and consider potential negative consequences of their behavior are more likely to avoid engaging in risk-taking (Fong & Hall, 2003; Nurmi, 1991; Trommsdorff, 1986). This is supported by a study by Steinberg et al. (2009), indicating that teens who perform better on laboratory tasks of self-regulation (i.e., delay discounting task) report higher levels of

future orientation, including planning ahead, and anticipating future consequences (i.e., having a "time perspective").

Resisting negative peer influence is another central component of psychosocial competency and judgment. This skill is especially relevant in adolescence when youth are particularly susceptible to the influence of friends' negative behavior (Chein et al., 2011). Indeed, individual variability in self-regulation is associated with resistance to peer influence, as demonstrated in a longitudinal study by Gardner, Dishion, and Connell (2008). Teacher, parent, and self-reports of self-regulation were collected when participants were 17 years old, and participants reported their level of antisocial behavior at age 17, and again when they were 19. Self-regulation and peer deviance interacted to predict the change in antisocial behavior over the two-year period in late adolescence. For those with lower levels of self-regulation, associating with highly deviant peers predicted a significant increase in antisocial behavior over 2 years; for those with higher levels of self-regulation, however, peer deviance did not affect changes in antisocial behavior over time (T. W. Gardner et al., 2008). Thus, higher levels of self-regulation were associated with greater ability to resist deviant peer influence in this sample. Other reviews have echoed this finding. Teens with greater impulse control and delay of gratification, for example, can more easily resist the temptation to engage in sensation-seeking or risky behavior with their friends (e.g., Furby & Beyth-Marom, 1992).

Psychosocial competency and judgment requires the coordination of various abilities such as psychosocial maturity, future orientation, and resistance to peer influence. As youth learn to apply these competencies to daily life experiences, they increase the "psychosocial capital" required to function as an autonomous member of society (Steinberg et al., 2004). Some have reported links between higher levels of self-regulation and indicators related to

psychosocial competency and judgment, though no studies have explicitly tested these associations. Little is known about how the relation between self-regulation and psychosocial competency and judgment varies as self-regulation develops across childhood and adolescence. Given the vital role of psychosocial competency and judgment for healthy adolescent functioning and a successful transition to young adulthood, the current study explores how individual variability in developmental self-regulation relates to this constellation of skills in adolescence.

In sum, academic achievement, positive attitudes towards school, positive peer environment, and psychosocial competency and judgment all reflect valuable domains of adaptive adjustment in adolescence. While higher levels of self-regulation have been linked to better adjustment in these domains, it is still unclear which developmental periods of self-regulation are most impactful for each of these separate outcomes. The current study addresses this gap in the literature by analyzing how self-regulation exhibited during key developmental periods affects adaptive adjustment in adolescence. This study is unique in that it can follow the same sample of participants across childhood and adolescence, in an effort to identify which developmental periods of self-regulation are more predictive of academic achievement, positive attitudes towards school, positive peer environment, and psychosocial competency and judgment. Performance on self-regulation laboratory tasks in early childhood, during the transition to formal schooling, middle childhood, and adolescence is used to predict comprehensive indicators of adjustment across each of these four domains of functioning.

2.3.2 Maladaptive Adjustment

In her seminal taxonomy of the development of antisocial behavior, Moffitt (1993) argues that life-course-persistent antisocial behavior is attributable (at least in part) to neuropsychological

deficits related to self-regulation difficulties (e.g., poor executive functioning, symptoms of ADHD; Moffitt, 1993). Children with cognitive difficulties are more vulnerable to environmental risk, and those who experience both of these risk factors (neuropsychological deficits and cumulative environmental risk) are more likely to engage in antisocial behavior as adults, past the point when most offenders "age out" of crime. Indeed, there is strong evidence of the lasting effects of low levels of self-regulation in childhood. Revisiting the birth cohort study of children from Dunedin, New Zealand, poor self-regulation in childhood predicted higher levels of antisocial behaviors in adolescence. Specifically, children with poor self-control were more likely to smoke cigarettes in adolescence, drop out of high school before graduating, and become (unplanned) teen parents (Moffitt et al., 2011). Lower levels of self-control in childhood also predicted a variety of maladaptive outcomes in adulthood, including poor physical health, depression, substance abuse, unemployment, financial instability, and criminal activity (Caspi, 2000; Moffitt et al., 2011). The present study extends the findings of Moffitt and colleagues by assessing performance on laboratory tasks of self-regulation across multiple points in childhood and adolescence. This method allows us to test how self-regulation across development predicts various maladaptive adolescent outcomes such as adolescent's own risk-taking, externalizing behavior, and aggressive behavior, and peer risk-taking.

2.3.2.1 Aggressive and antisocial behavior

Poor self-regulation has been consistently named as a predictor of maladaptive behavior throughout childhood and adolescence. Self-regulation deficits in early childhood are related to problem behaviors during the transition to formal schooling, externalizing problems in childhood, and delinquent behaviors and aggression in early adolescence (Hill, Degnan, Calkins,

& Keane, 2006; Murray & Kochanska, 2002; Schaeffer, Petras, Ialongo, Poduska, & Kellam, 2003; Tremblay, Pihl, & Vitaro, 1994).

Robust literature has documented the association between low self-regulation and maladaptive teen behaviors, such as antisocial and aggressive acts. The ability to regulate behavior is closely aligned with the construct of self-control that Gottfredson and Hirschi describe as the driving force behind antisocial behavior in their general theory of crime (1990). According to this theory, antisocial and criminal behaviors are committed by poorly regulated individuals who are inclined towards immediate, easy, and simple gratification of their desires, disregard for long-term consequences, poor impulse control and suppression of aggression (Gottfredson & Hirschi, 1990). A plethora of studies support this notion, as lower executive functioning predicts risk-taking, substance use, delinquency, and crime in adolescence (e.g., Brower & Price, 2001; Cauffman, Steinberg, & Piquero, 2005; LeMarquand et al., 1998; Pharo, Sim, Graham, Gross, & Hayne, 2011; Tarter, Kirisci, Habeych, Reynolds, & Vanyukov, 2004; Trentacosta & Shaw, 2009; Vitaro, Arsenault, & Tremblay, 1999). Furthermore, empirical evidence supports the link between self-regulation and aggression. Poor performance on executive function tasks, for example, predicts self-reported aggression in early adolescent boys (Giancola, Moss, Martin, Kirisci, & Tarter, 1996) and middle-adolescent girls (Giancola, Mezzich, & Tarter, 1998). Poor self-regulation is also associated with a broad range of behavioral difficulties, including attention problems, rule-breaking, and non-compliance (Buckner et al., 2009; Oldehinkel, Hartman, De Winter, Veenstra, & Ormel, 2004).

Not surprisingly, self-regulation is also related to peer group affiliations, such that teens who exhibit poor self-regulation are more likely to associate with deviant peers. Effortful control in mid-adolescence, for example, is inversely related to friends' antisocial behavior. In a

cross-sectional study of teens between 11 and 14 years old, youth who reported lower levels of inhibitory and attention control had more deviant or antisocial friends than those with better self-regulation (Dyson et al., 2015). The association between self-regulation and deviant peer groups is also evident in older teens. In Gardner et al.'s short-term longitudinal study of late adolescents that identified a positive link between self-regulation and resistance to peer pressure (see previous section on psychosocial competency and judgment), there was also a link between self-regulation and peer deviance. Self-regulation and deviant peer affiliations were each measured from multiple reporters, including the participant, parents, and teachers, when participants were 17 years old. Teens with lower levels of self-regulation were more likely to associate with deviant peers than teens with better self-regulation (T. W. Gardner et al., 2008). In other words, teens who have difficulty with attention and inhibitory control tend to affiliate with peers who engage in various maladaptive behaviors, such as rule-breaking, substance abuse, or delinquent acts. The current study aims to advance the understanding of the effects of self-regulation across development on adolescent aggressive and antisocial behavior. By following the same sample from early childhood through adolescence, this seeks to identify the developmental period(s) of self-regulation that are most strongly predictive of maladaptive adjustment in adolescence.

Many of the studies cited in this review measure self-regulation at a single time point, then test how individual differences in self-regulation predict positive and negative adjustment outcomes. The present study measures self-regulation during four developmental periods in the same sample of participants in order to identify at what age individual differences in self-regulation are most predictive of adaptive and maladaptive outcomes in adolescence. Given the possibility that executive functions are more strongly related to particular domains of adjustment, the adjustment outcomes are estimated separately by adaptive versus maladaptive indicators. By

using developmentally-appropriate laboratory tasks to measure self-regulation across multiple points in childhood and adolescence, the current study seeks to identify which developmental period of self-regulation is most strongly linked with each domain of adolescent adjustment.

2.4 SIGNIFICANCE OF SELF-REGULATION DURING EARLY CHILDHOOD

The final research aim is to explore how much unique variance in adolescent adjustment can be explained by the earliest indicators of self-regulation. In other words, what is the added value of including measures of early childhood self-regulation, beyond what is already accounted for by self-regulation measured during the transition to formal schooling, middle childhood, and adolescence? Early childhood self-regulation skills are essential for positive adjustment during childhood and across the lifespan (Entwisle et al., 2005; McClelland et al., 2015). Early self-regulation is foundational for later successful functioning due the cumulative nature of development (Sroufe, Egeland, & Kreutzer, 1990).

There are two mechanisms that can explain how self-regulation abilities build upon themselves over time. First, children must establish rudimentary skills before they can begin acquiring more advanced forms of self-regulation (Eisenberg, Hofer, & Vaughan, 2007). For example, basic attentional and emotional control are prerequisites for effortful control of impulsive behavior (Sethi, Mischel, Aber, Shoda, & Rodriguez, 2000; Tronick et al., 1977; Ursache, Blair, Stifter, Voegtline, & Investigators, 2013), and cognitive executive functioning is necessary for executive control in adolescence (Lyon, 1996). Stated another way, successful self-regulation at older ages depends on a child's command of early fundamental skills.

Individual variability in early childhood self-regulation has consequences for later functioning, since these basic skills facilitate growth of self-regulation at older ages.

Second, the cumulative nature of self-regulation is due in part to the transactional effects that a child has on their environment and vice versa. How capable a young child is of regulating his or her behavior will impact how others respond and interact with that child. The reactions from caregivers, parents, and siblings, for example, help shape a child's expectations for what behavior is appropriate and will be rewarded versus what is discouraged. A well-regulated child is likely to elicit positive reactions from others, creating a supportive environment with opportunities to further practice and reinforce self-regulation skills. A toddler who is able to sit and follow along with their parents during story time is more likely to develop a positive association with reading than a poorly-regulated toddler who struggles to sit still and concentrate. The well-regulated toddler might enter school with good habits, routines, and expectations that facilitate learning in a classroom environment. Young children who have difficulty regulating their behavior may develop negative attitudes, tendencies, and behaviors that escalate over time, as negative interpersonal reactions and experiences limit future opportunities to practice good self-regulation skills. It may prove difficult for a child to recover from positive experiences they missed earlier on. An unruly child who is unable to sit still, temper emotional outbursts, or follow directions is likely to have a harder time adjusting to the structure of a classroom setting, forming friendships or bonding with teachers, which can adversely affect their affinity for learning or school engagement down the road. Indeed, Delisi and Vaughn (2014) describe the trajectory of how behavioral "difficulty" in toddlerhood can lead to poor effortful control in childhood, and behavioral dysregulation in adolescence and adulthood. The question remains as

to precisely how impactful these very early indicators and experiences are for later self-regulation and adjustment.

If earlier indicators of self-regulation contribute unique variance to adolescent adjustment outcomes beyond the contribution of measures of self-regulation obtained at older ages, this would illustrate a developmental model in which there is an additive or cumulative effect of self-regulation over time (e.g., Bowlby, 1980; Werner & Kaplan, 1956). Namely, this would demonstrate that early childhood self-regulation skills continue to play a role in behavior and adjustment in adolescence, as compared to the variance in adolescent outcomes simply being explained by the most proximal measures of self-regulation. It is evident that early self-regulation skills contribute to self-regulation over time, and how these skills manifest in one domain reflect competencies in other domains. However, the development of self-regulation is dynamic and complex, and it is not clear just how important early childhood skills are for self-regulation across childhood and adolescence, and for ultimately predicting adaptive or maladaptive adjustment in adolescence.

Masten and colleagues have described a developmental cascade model in which early levels of self-regulation spill over onto subsequent time-points, and spread across different domains and systems within an individual to influence later self-regulation (Masten & Cicchetti, 2010; Masten & Coatsworth, 1998). Children who fail to master early tasks requiring self-regulation are likely to have difficulty navigating social and cognitive demands at older ages, as children with poor self-regulation skills show evidence of a range of difficulties related to adaptive functioning, such as problems forming healthy peer relationships, worse psychological health, and academic achievement at older ages (Masten et al., 2005). Indeed, there is substantial evidence that the dynamic nature of developing self-regulation impacts health and well-being

over time (G. Geldhof, Little, & Colombo, 2010; McClelland et al., 2010). In light of this cascading effect, how influential is early childhood self-regulation in determining a child's developmental course? To what extent does individual variability in early childhood self-regulation explain adolescent adjustment over and above self-regulation measured at older ages?

Early childhood is a period of rapid development and transformation, which allows the effects of variability in self-regulation to be immediately realized (e.g., Diamond, 2002; Garon, Bryson, & Smith, 2008; Shaw & Gross, 2008; Zelazo et al., 2003). Self-regulation changes from rudimentary and reflexive to proactive and reflective control during the preschool years (C. Blair, 2002; Bronson, 2000; Kopp, 1982). Mastery of effortful control can impact other substantial domains of early childhood functioning, such as school readiness (Howse et al., 2003; McClelland et al., 2013; Ursache et al., 2013). Early childhood self-regulation continues to influence cognitive functioning, social adjustment, and behavior after children have transitioned to a classroom setting. Individual variability in early childhood self-regulation predicts academic performance in first grade, even after accounting for child cognitive skills and family characteristics (Raver & Knitze, 2002).

As children transition to formal schooling, they are faced with new intellectual, social, and environmental challenges. The formal school setting tends to be more structured than the home or preschool environment, requiring children to conform to more rules and stricter expectations (Cowan, Cowan, Schulz, & Heming, 1994; Ladd, Kochenderfer, & Coleman, 1996). Interacting with peers and teachers in a school environment involves the constant regulation of behavioral impulses, while simultaneously developing new cognitive executive functioning skills (C. Blair & Raver, 2012; R. J. R. Blair, 2010; Calkins, 2007; Phillips, McCartney, & Sussman, 2006). The transition to formal schooling represents a key

developmental period for both positive change or vulnerability in light of these new challenges. Some children who were well-regulated in early childhood suffer declines in relative self-regulation after struggling to balance the increased attentional and behavioral demands in elementary school (Vanderbilt-Adriance & Shaw, 2008).

There are long-term consequences of early childhood self-regulation, as well. Development of behavioral self-regulation during preschool is an important marker of later functioning and achievement (Masten et al., 2005; McClelland et al., 2007; Mischel et al., 2011). Longitudinal studies have illustrated how the developmental progression from early childhood through adolescence can differ for children with high or low levels of early self-regulation, which demonstrates how early childhood self-regulation continues to impact behavior and functioning over time. Children who demonstrate greater effortful control are more likely to foster positive relationships with teachers and peers in school, which leads to higher levels of academic engagement and motivation (Hamre & Pianta, 2001; Silva et al., 2011). Conversely, less-regulated children tend to develop poor relationships with teachers, which can increase feelings of frustration, disengagement from school, and lower academic motivation and achievement (Ladd, Birch, & Buhs, 1999; Ladd & Burgess, 2001). Low levels of self-regulation in preschool predict poor academic performance and being held back in elementary school, increased likelihood of dropping out of high school and delinquent behavior in adolescence (Raver & Knitze, 2002). Thus, how well-regulated a child is when they enter school is vital for later functioning and adjustment.

If very early indicators are uniquely relevant for adjustment many years later, this could identify an important window for intervention in early childhood. Some have found that self-regulation skills are modifiable at this young age (Raver et al., 2011). This underscores a recent

wave of programs and interventions that seek to understand how improving preschoolers' self-regulation can reduce maladaptive behaviors (Belfield, Nores, Barnett, & Schweinhart, 2006).

To date, however, few studies have explicitly tested how much additional variance is explained by self-regulation measured in early childhood in contrast to measures obtained at older ages. Theoretically, it stands to reason that early childhood self-regulation would uniquely account for individual variability in adolescent adjustment, although research surrounding this specific question is lacking. Due to the cascading and cumulative nature of prior self-regulation skills and experiences building upon each other over time, the most proximal measures of self-regulation (i.e., in adolescence or middle childhood) are expected to be most strongly related to adolescent adjustment outcomes. That being said, it is expected that self-regulation measured in early childhood adds unique variance to explain later adjustment, beyond what is explained by self-regulation measured at older ages.

The current study expands on existing literature by examining how much unique variance in adolescent adjustment is attributable to early childhood self-regulation. Using laboratory tasks that measure self-regulation skills that are salient in early childhood (i.e., effortful control) to predict selected outcomes, the present analyses can identify the added value of early childhood self-regulation, above and beyond what is already accounted for by more proximal indicators of self-regulation. Finally, these analyses allow for the strength of the impact of early childhood self-regulation to vary across domains of adaptive and maladaptive adolescent adjustment.

2.5 STATEMENT OF PURPOSE

Successful adjustment in many domains of functioning such as health, wealth, and public safety, depend on an individual's ability to regulate their own behavior (Moffitt et al., 2011). Self-regulation predicts better adjustment both concurrently and over time, and this effect is evident across most of the lifespan. Development of the executive functions that comprise self-regulation is dynamic, as these capacities undergo considerable change during childhood and adolescence, and growth in one executive function is often related to growth in other executive functions. Executive functions play a critical role in the regulation of behavior and subsequent adjustment, but it is unclear how the development of executive functions at earlier age periods impacts this association. No study to date has followed the same sample of youth from childhood through adolescence to test how adolescent adjustment is predicted by performance on self-regulation laboratory tasks across multiple points in development. The current study examines the development of self-regulation across childhood and adolescence, how well self-regulation predicts adaptive and maladaptive adjustment in adolescence, and the value of including very early indicators of self-regulation when predicting adolescent adjustment.

2.5.1 Research Question 1: What is the stability of self-regulation from early childhood through adolescence, as measured by laboratory task performance?

Executive functions that tap into an underlying construct of self-regulation were measured throughout childhood and adolescence, via performance on behavioral laboratory tasks. Laboratory assessments were divided into four time periods that represent developmentally salient age periods: early childhood, the transition to formal schooling, middle childhood, and

adolescence. Latent factors of self-regulation were derived at each of these four age periods, and the stability of self-regulation was tested by predicting self-regulation at each age period from the prior adjacent age period (see Figure 1).

Hypothesis 1: The prediction of latent self-regulation from each age period to the next adjacent age period will be significant and positive. Specifically, self-regulation in early childhood will predict self-regulation during the transition to formal schooling; self-regulation during the transition to formal schooling will predict middle childhood self-regulation; middle childhood self-regulation will predict adolescent self-regulation.

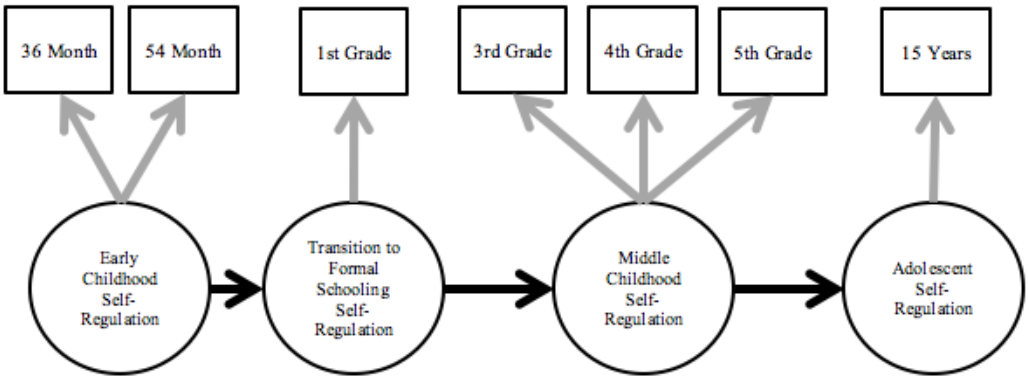

Figure 1. Hypothetical model of self-regulation from early childhood through adolescence

2.5.2 Research Question 2: How is self-regulation from early childhood through adolescence related to adaptive and maladaptive adjustment in adolescence?

This research question tests how well measures of self-regulation from early childhood to adolescence predict positive and negative indices of adjustment in adolescence. The association between laboratory task performance across development and adolescent outcomes was examined with indicators of: a) adaptive adjustment, and b) maladaptive adjustment. Adaptive

adjustment was assessed across multiple contexts to determine how self-regulation is linked to later positive behaviors and attitudes in various contexts. Specifically, four composite outcome variables were used to define adaptive adjustment: academic achievement, positive attitudes towards school, positive peer environment, and psychosocial competency and judgment. Maladaptive adjustment was defined by one composite of aggressive and antisocial behavior.

More proximal indicators of self-regulation (i.e., in adolescence) are expected to be more strongly related to adolescent adjustment than self-regulation at earlier time points (i.e., in early childhood). Due to the cascading effects of earlier experiences and levels of self-regulation building over time, later measures of self-regulation should inherently include some historical variability between individuals (e.g., Kagan, 1980, 1999; Lewis, 1997; Masten & Cicchetti, 2010; Masten & Coatsworth, 1998). Thus, it is hypothesized that adolescent self-regulation will better predict concurrent adjustment than will measures of self-regulation obtained in childhood.

Hypothesis 2a: Latent self-regulation from early childhood through adolescence will be positively associated with adaptive adjustment in adolescence, with higher levels of self-regulation at each of the four age periods predicting higher scores on adaptive outcomes. Specifically, higher levels of self-regulation predict better academic achievement, positive attitudes towards school, positive peer environment, and psychosocial competency and judgment in adolescence (see Figure 2, Model 2a). Self-regulation measured at older ages will have a stronger association with adaptive adjustment in adolescence, as compared to self-regulation obtained at younger ages.

Hypothesis 2b: Latent self-regulation from early childhood through adolescence will be negatively associated with maladaptive adolescent adjustment, with lower levels of self-regulation at each of the four age periods predicting more aggressive and antisocial behavior in

adolescence (see Figure 2, Model 2b). More recent measures of self-regulation will have a stronger association with with aggressive and antisocial behavior in adolescence than measures of self-regulation obtained earlier in childhood.

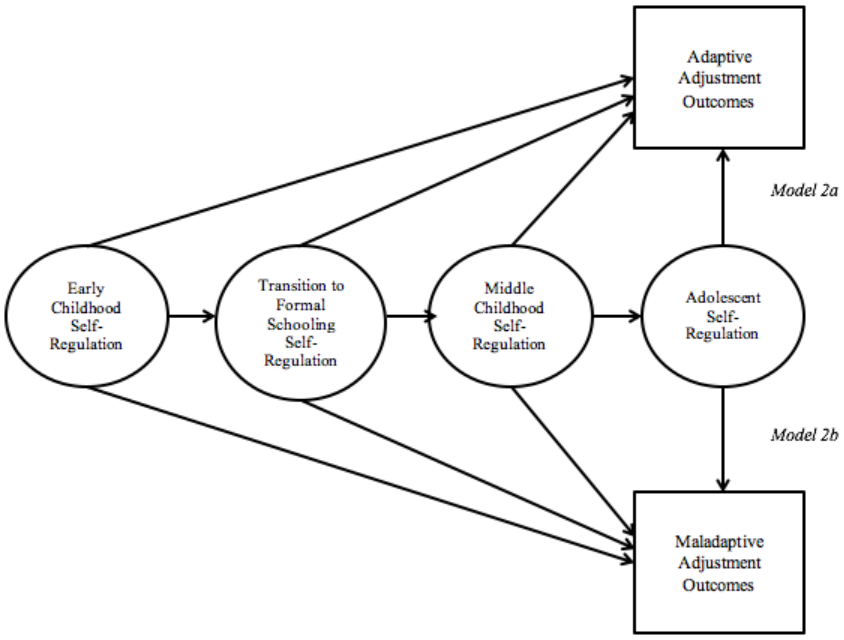

Figure 2. Hypothetical model of the development of self-regulation predicting adolescent adaptive (Model 2a) and maladaptive (Model 2b) adjustment outcomes

2.5.3 Research Question 3: Does early childhood self-regulation explain unique variance in adolescent adjustment, after accounting for self-regulation during the transition to formal schooling, middle childhood, and adolescence?

The final research question examines the added value of the earliest indicators of self-regulation when predicting adolescent adjustment. Self-regulation is a reliable predictor of adolescent adjustment when measured concurrently and during the childhood years leading up to adolescence, but it is unclear how much additional variance is explained by including very early levels of self-regulation, such as during early childhood.

There is reason to believe that self-regulation prior to first grade is related to adolescent adjustment above and beyond self-regulation once children transition to formal schooling. Early childhood measures of self-regulation typically focus on behaviors associated with effortful control, such as attentional control, impulse control, and delayed gratification. These capacities are salient indicators of self-regulation during early childhood, as individual differences in effortful control emerge around the first birthday and develop through the preschool years (Posner & Rothbart, 2000). Self-regulation in early childhood, which the present study measures at 36 months and 54 months, represents abilities that are considered trait-like or temperamental, versus more state-dependent, fluid tendencies at older ages. Mastering self-regulation processes early sets the stage for more cognitive-based executive functioning to develop later in childhood and adolescence (Calkins & Fox, 2002). The current study explored whether self-regulation in early childhood is a unique, meaningful predictor of later adjustment outcomes. The significance of self-regulation in early childhood was tested by analyzing whether adolescent adjustment was more strongly predicted when early childhood measures of self-regulation were included in the model, in contrast to models that did not include early measures. Thus, these model comparisons demonstrated the unique variance explained by early childhood self-regulation, above and beyond self-regulation from the transition to formal schooling through adolescence.

Hypothesis 3a: Early childhood self-regulation will improve the prediction of adaptive adolescent adjustment, explaining additional variance beyond self-regulation during the transition to formal schooling, middle childhood, and adolescence. A model that estimated paths from self-regulation at all age periods (from early childhood through adolescence) to adaptive outcomes in adolescence (Figure 2, Model 2a) will have better incremental fit than a model that only estimates paths from self-regulation from the transition to formal schooling and later to

adaptive adolescent outcomes (Figure 3, Model 2a). In other words, early childhood self-regulation will be a meaningful predictor of adolescent adjustment even after accounting for self-regulation measured at later points in childhood and adolescence. A model that includes early childhood indicators of self-regulation will not only fit the data better than the comparison model that omits the path from early childhood, but the former will also explain a larger proportion of variance in adaptive outcomes in adolescence.

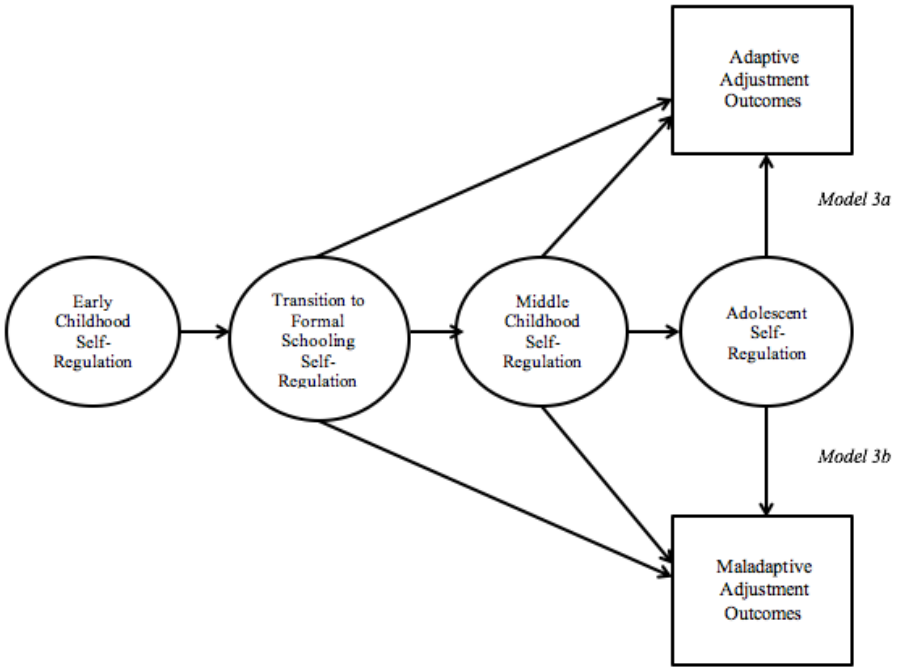

Figure 3. Hypothetical model predicting adolescent adjustment from self-regulation during the transition to formal schooling, middle childhood, and adolescence (Model 3a and 3b)

Hypothesis 3b: Early childhood indicators of self-regulation will explain more variance in maladaptive adolescent adjustment beyond that accounted for by self-regulation once children transition to formal schooling in first grade. Including the path from early childhood self-regulation to maladaptive adjustment will better predict maladaptive adjustment by a) providing better incremental model fit, and b) explaining a larger proportion of variance in outcomes than a

model that only includes self-regulation during the transition to formal schooling, middle childhood, and adolescence (Figure 2, Model 2b versus Figure 3, Model 3b, respectively).

These analyses are unique in several ways. They allow for a clear test of stability of self-regulation from childhood through adolescence by using developmentally-appropriate behavioral tasks of executive functions. Also, the effect of self-regulation on adjustment is analyzed for both positive, adaptive outcomes (i.e., academic achievement, positive attitudes towards school, positive peer environment, and psychosocial competency and judgment), as well as negative, maladaptive outcomes (i.e., aggressive and antisocial behaviors). Self-regulation is often explored in relation to negative outcomes, hence the array of adaptive outcomes considered in the current analyses expand the understanding of the link between self-regulation and positive, adaptive adjustment. Finally, using data from the same sample followed from early childhood through adolescence, the current study can identify the value added by very early indicators of self-regulation when predicting both adaptive and maladaptive adjustment in adolescence. Taken together, these analyses contribute to the literature on self-regulation by providing a comprehensive, developmental view of the construct as it relates to several indicators of adolescent adjustment.

3.0 METHOD

3.1 PARTICIPANTS

The present study uses data collected as part of the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD). The SECCYD, a large, prospective longitudinal study, recruited participants from 10 locations (Charlottesville, VA; Irvine, CA; Lawrence, KS; Little Rock, AR; Madison, WI; Morganton, NC; Philadelphia, PA; Pittsburgh, PA; Seattle, WA; and Wellesley, MA). The cohort of children was born in 1991, and followed from birth through 15 years of age. Shortly after giving birth, mothers were approached in the hospital, and screened for eligibility to participate in the study. Of the 8,986 mothers who were screened, 5,416 were eligible to participate. Exclusion criteria included mothers who were under 18 years of age, mothers who could not speak English, families who planned to move in the following 3 years, families who lived in extremely unsafe neighborhoods, newborns with a known disability, or non-singleton births (NICHD Early Child Care Research Network [ECCRN], 2005; Vandell et al., 2010). A random selection of the eligible families who completed a home interview when the newborn was 1 month old comprised the final group of study participants (1,364 families). Attrition in this longitudinal study was low, with 1,009 of the participating families (74%) completing the last interview when youth were 15 years old.

The majority of participating families were non-Hispanic white, and about half of the study participants were male. The sample was relatively diverse, as 26% of mothers reported having a high school diploma or less, and 21% of families were considered low-income or poverty-stricken (Vandell et al., 2010).

3.2 PROCEDURE

Informed consent was obtained from each of the participating families at each assessment period. The institutions at each of the study sites received IRB approval for the study procedures. Data were collected in four phases, as determined by participant age: Phase I - from birth through 36 months; Phase II – from 54 months through 1st grade; Phase III – from 2nd grade through 6th grade; and Phase IV – from 7th grade through 15 years.

To create a comprehensive picture of child development, data from each phase were collected across a variety of settings, including the home, at school, and in the laboratory. Trained research assistants utilized many different data collection methods, such as in-person interviews, phone calls, checklists, behavior observation, laboratory tasks, standardized cognitive tests, and physical and biological measures. Data were collected from multiple reporters, including the child participants, parents, childcare providers, friends, and teachers. Self-regulation data across the four phases, and adjustment data in adolescence will be utilized to address the research questions posed in the current study.

3.3 MEASURES

3.3.1 Background Characteristics

All models controlled for the background characteristics of gender, ethnicity, family income, and school readiness. Child *gender* (1 = Male, 2 = Female) was collected at birth, and males comprised 51.7% of the total sample. Parents reported on child *ethnicity* at the 1-month interview. Options for ethnicity included American Indian, Eskimo, Aleut; Asian or Pacific Islander; Black or Afro-American; White; or Other. For the present analyses, ethnicity will be recoded into 3 dummy variables, as White (as the reference category, 80.4%), Black (12.9%), and all other ethnicities (6.7%). *Family Income* was used as a proxy for socioeconomic status, and was assessed as the average total income-to-needs ratio from the 1-month interview through the 36-month interview. Income-to-needs ratios are calculated at each interview as the total family income divided by the poverty threshold for a household for that year, with larger income-to-needs ratios representing higher SES (sample $M = 3.38$, $SD = 2.7$). *School Readiness* was measured by the Bracken Basic Concepts Scale (BBCS) at 36 months (Bracken, 1984). The BBCS contains 5 subscales of cognitive ability to assess school readiness (e.g., letter identification, number/counting). Scores on the 5 subscales were added to create an aggregate score of school readiness ($\alpha = .93$, $M = 14.76$, SD = 9.92).

3.3.2 Self-Regulation Laboratory Tasks

Self-regulation executive functions were assessed across multiple visits ranging from 36 months to 15 years. Tasks were divided into 4 developmental periods, and are discussed in turn: early

childhood, transition to formal schooling, middle childhood, and adolescence (see Appendix A for descriptive information on self-regulation performance tasks). Within each developmental period, laboratory tasks are organized by the executive function assessed.

3.3.2.1 Early Childhood Self-Regulation (36 month – 54 month)

Early childhood self-regulation was assessed at 36 months and 54 months, and measured delay of gratification, impulse control, working memory, and sustained attention. All data on self-regulation were collected during laboratory visits.

Delay of Gratification. During the 36 month visit, the Forbidden Toy Task operationalized *delay of gratification* as the length of time (in seconds) the child waited to play with an attractive toy after they were instructed not to touch the toy. Latency to touch was calculated as time to either minimally or actively engage with the toy, whichever was shorter. Longer latencies to touch the attractive toy indicated better delay of gratification. At the 54 month visit, a tempting snack task measured the amount of time (in minutes) the child waited to eat the snack once they were left alone in the room. The child was given the choice to either eat the snack, or wait until the experimenter returned, in which case they would be rewarded with a larger snack. Longer latencies to eat the snack indicated better *delay of gratification*.

Impulse Control. The Day/Night Stroop (Gerstadt, Hong, & Diamond, 1994) was administered during the 54 month visit, and measured impulsivity by instructing children to name cards within a deck as either "day" or "night" when each card was individually turned over. Instructions were to say "day" when they were presented black cards with a moon and stars, and to say "night" for white cards with a bright sun. Impulsivity was measured as the percentage of conflicting cards (black "day" cards, or white "night" cards) that the child named incorrectly.

Impulsivity scores were reversed to indicate the percentage of cards the child correctly named, with higher scores illustrating greater *impulse control*.

Working Memory. The Woodcock-Johnson Psycho-Educational Battery (WJ) was administered during the 54 month visit (Woodcock, Johnson, & Mather, 1990). The WJ Memory for Sentences subscale assessed short-term *working memory.* Children were presented a series of words or short phrases, and instructed to recall and repeat the words after they were provided an incomplete sentence for context. Higher standardized scores represent a greater number of words and/or phrases correctly recalled, and thus better short-term working memory.

Sustained Attention. The Continuous Performance Task (CPT) was administered during the 54 month laboratory visit as a measure of sustained attention (Halperin, Sharma, Greenblatt, & Schwartz, 1991). During this task, familiar images, such as pictures of fish or flowers, were presented on a computer screen. Children were instructed to press a button whenever the target stimulus, a picture of a chair, appeared on the screen. Participants were instructed not to press the button when the target stimulus was absent. Images were presented in blocks of 10 stimuli, with the target stimulus (a chair) randomly appearing two times in each block. There were 22 blocks of stimuli, with 44 target stimuli presented across a total of 220 images. The CPT was also administered at later interviews, with more complex target stimuli for older participants.

Two types of errors represented deficits in self-regulation: errors of commission, when children pressed the button for non-target stimuli, indicating impulsivity; and errors of omission, when children failed to press the button for target stimuli, indicating inattention. A composite score of sustained attention was calculated as the proportion of accurate responses to target stimuli (attention) minus the commission errors of responses to non-target stimuli (impulsivity). Higher scores represent greater *sustained attention* (active attention without impulsivity errors).

3.3.2.2 Transition to formal schooling (1st grade)

Self-regulation during the transition to formal schooling was assessed when participants were in 1st grade, specifically testing working memory, planning, and sustained attention.

Working Memory. In addition to the WJ Memory for Sentences subscale that was administered in early childhood, the first grade interview also included the WJ Memory for Names subscale. The Memory for Names subscale presented participants with pictures of space creatures, to which they assigned novel names. Participants were instructed to recall the creature names when they were later shown a picture of the space creature. Standardized scores on this subscale were used to evaluate long-term *memory retrieval*, with higher scores indicating better memory retrieval. The WJ Memory for Sentences subscale assessed short term *working memory* in 1st grade, as it did in early childhood.

Sustained Attention. The CPT was again administered in 1st grade. Children were presented with a series of letters and instructed to press a button when they saw the target stimuli. The 1st grade target stimuli (the letter "X") was more advanced than the 54 month target stimuli (a chair). Images were presented in blocks of 10 stimuli, with the target stimulus randomly appearing two times in each block. There were 30 blocks of stimuli, with 60 target stimuli presented across a total of 300 images. A composite score was again calculated as the proportion of accurate responses to target stimuli (representing attention) minus the commission errors of responses to non-target stimuli (impulsivity), with higher scores representing greater *sustained attention.*

Planning and Problem Solving. The Tower of Hanoi task was administered during the 1st grade visit as a measure of planning and problem solving (M. C. Welsh, 1991b). Children were presented with a puzzle consisting of three vertical pegs holding disks of varying sizes.

The goal was for children to move the disks between the pegs so that the disks were arranged in a specific pattern, known as the goal state. Participants were given three rules to follow when moving the disks: move one disk at a time, move only the top disk, and larger disks cannot be placed on top of a smaller disk. Successful completion of the Tower task required children to think multiple steps ahead of their next move in order to abide by the rules. Children were scored on the number of moves they took to complete the task, with higher scores representing more efficient task completion (i.e., a score of 6 if completed in the fewest number of possible moves, a score of 0 if unable to complete within a set number of trials; Borys, Spitz, & Dorans, 1982). The Tower of Hanoi consisted of 6 tasks, and planning efficiency scores were summed across all tasks to yield a total planning efficiency, with higher scores indicating better *planning and problem solving.*

3.3.2.3 Middle Childhood (3rd Grade – 5th Grade)

Middle childhood self-regulation was assessed in 3rd grade, 4th grade, and 5th grade, measuring working memory, sustained attention, and planning and problem solving.

Working Memory. The WJ battery was administered in 3rd grade. The same WJ subscales that were evaluated during the transition to formal schooling were again administered in middle childhood: memory for sentences assessed short-term *working memory*, while memory for names assessed long-term *memory retrieval*. Again, standardized scores for both subscales reflected better *working memory* and *memory retrieval*, respectively.

Sustained Attention. The CPT was administered in 4th grade, and was similar to the CPT administered in 1st grade, but slightly more challenging. Participants were again presented a series of letters on a computer screen, and asked to press a button when the target stimulus appeared. The target stimulus was the letter "X" presented immediately following the letter "A."

Only an X following an A was the target, not an X preceded by another letter. Letters were presented in blocks of 12, with the target stimulus randomly appearing twice in each block. There were 45 blocks of stimuli, with 90 target stimuli presented across a total of 540 letters. A composite score was calculated as the proportion of accurate responses to target stimuli (representing attention) minus the commission errors of responses to non-target stimuli (impulsivity), with higher scores indicating better *sustained attention.*

Planning and Problem Solving. The Tower of Hanoi planning task was administered in 3rd grade and 5th grade, and utilized a similar protocol as in 1st grade. The Tower task required children to move disks of assorted size between 3 vertical pegs so that the disks mirrored the "goal state" arrangement illustrated by the researcher. Children were presented with a series of 6 tasks, which increased in difficulty. Planning efficiency scores were given for each task, which represented children's ability to arrange the disks in as few moves as possible. Planning efficiency scores were aggregated across all trials to produce a total planning efficiency score, with higher scores reflective better *planning and problem solving.*

3.3.2.4 Adolescence (15 years)

At age 15, working memory, planning, and impulse control measures were administered.

Working Memory. The OSPAN task required participants to complete a series of mental math problems while remembering the correct order of individually presented letters (Turner & Engle, 1989). Span scores were calculated in each of the 7 trials, and incorporated a variety of accuracy and error indicators, including math errors, response times, and correct letters identified. Total span scores were summed across all trials as a measure of *working memory*, with higher values representing greater working memory capacity.

Planning and Problem Solving. The Tower of London that was administered in adolescence is an extension of the Tower of Hanoi planning task completed in childhood (Asato, Sweeney, & Luna, 2006). The Tower of London task required participants to complete the puzzle by moving virtual balls between a series of pegs in as few moves as possible, while adhering to various rules about the balls' movement (i.e., the tall peg can hold 3 balls, the middle peg can hold 2 balls, and the shortest peg can hold only 1 ball). In contrast to the Tower of Hanoi, which used the number of moves made as the measure of self-regulation, the Tower of London task measures the total time (in seconds) the participant took to make their first move. The time to first move, which was averaged across the 20 test trials, assessed the degree of *planning, problem solving,* and *future orientation* exhibited by the participant. Longer latencies reflect more planning prior to the first move.

Impulse Control. The BART (Lejuez et al., 2007) task instructed participants to pump up a computerized balloon without exploding it, with each press of a button simulating one "pump." Participants were rewarded with fake money when they opted to stop pumping the balloon before it reached the point of explosion, with a larger 'payout' given for more inflated (but not exploded) balloons. An Index of Riskiness was calculated as an average number of pumps on balloons that did not explode across 20 trials, with higher scores representing a higher propensity for risk-taking. Index scores were reversed (i.e., each score subtracted from the highest score in the sample, which was 78) so that higher values indicate greater *impulse control.*

3.3.3 Adolescent Adjustment Outcomes

At age 15, participants reported on their adjustment across various domains, including attitudes, behavior, academic achievement, and peer group characteristics. These outcomes are

conceptualized as either positive, adaptive adjustment, or negative, maladaptive adjustment, and are discussed in turn. Composite indicators were created to reduce the number of outcomes predicted in the models. Measures that align functionally and theoretically were combined into each composite outcome, creating a more robust indicator of adjustment. For example, a measure of teacher bonding and a measure of school attachment were combined into one aggregate indicator of "positive attitudes towards school," which captures how connected an individual is to their teacher, and more generally, to their school. Composite outcomes were derived from measures of adjustment across a similar context, which were at least moderately correlated with one another (i.e., sub-indicators of any composite score were correlated at ~.4 or higher). Composite scores within multiple domains of adaptive adjustment, and one composite score of maladaptive adjustment, were created by averaging the standardized indicators within each domain (see Figures 4 and 5 for illustrations of adaptive and maladaptive adjustment outcome composite scores, respectively). For example, the scores from future consideration and planning, psychosocial maturity, and resistance to peer pressure were standardized, then averaged together to create an aggregate measure of psychosocial competency and judgment. These composite outcomes were used to analyze how self-regulation across development is linked with adolescent adjustment related to academic achievement, positive attitudes towards school, positive peer environment, psychosocial competency and judgment (adaptive outcomes), and aggressive and antisocial behavior (maladaptive outcomes).

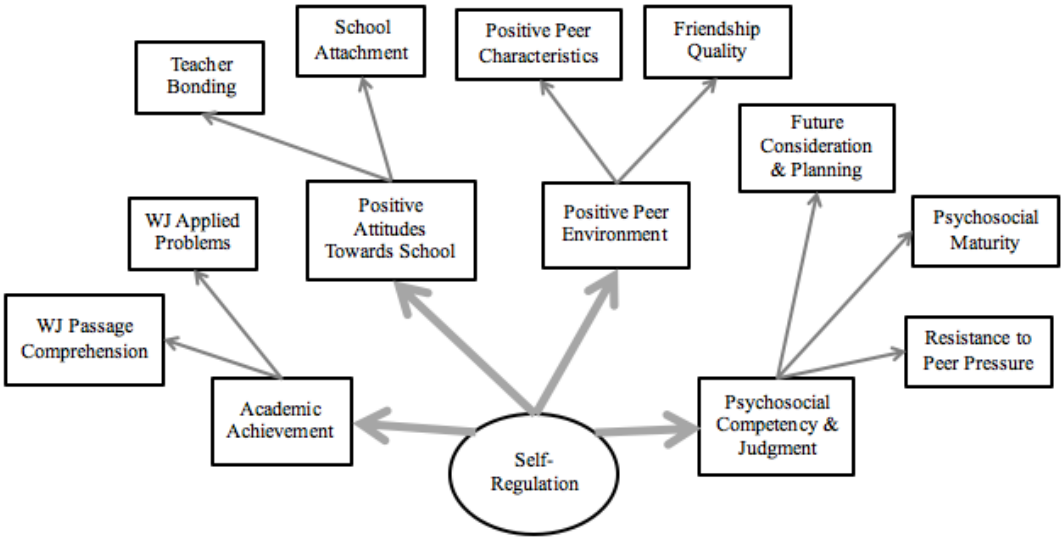

Figure 4. Adaptive adjustment outcomes measured in adolescence

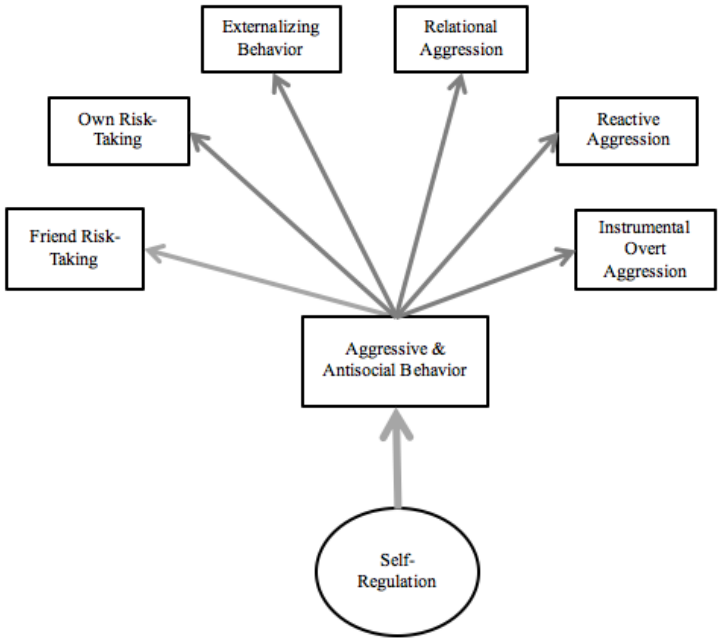

Figure 5. Maladaptive adjustment outcomes measured in adolescence

3.3.3.1 Adaptive Adolescent Adjustment Outcomes

Adaptive adolescent adjustment was measured by academic achievement, positive attitudes towards school, positive peer environments, and psychosocial competency and judgment. Correlations between scores contributing to each adaptive composite are available in Table 1.

Table 1. Correlations of Adaptive Adolescent Adjustment Outcomes

	1.	2.	3.	4.	5.	6.	7.	8.
1. WJ Passage Comprehension	-							
2. WJ Applied Problems	.671**	-						
3. School Attachment	.140**	.123**	-					
4. Teacher Bonding	.090**	.077*	.638**	-				
5. Positive Peer Characteristics	.098**	.120**	.489**	.470**	-			
6. Friendship Quality	.012	-.061	.332**	.243**	.298**	-		
7. Future Consideration & Planning	.120**	.106**	.278**	.305**	.339**	.250**	-	
8. Psychosocial Maturity	.148**	.151**	.371**	.288**	.403**	.301**	.362**	-
9. Resistance to Peer Pressure	.060	.017	.193**	.147**	.330**	.288**	.306**	.471**

**p<.01; *p<.05; Shaded boxes indicate outcomes averaged together into composite score

Academic Achievement Composite Score. The academic achievement laboratory assessments included the Passage Comprehension and Applied Problems subscales of the Woodcock-Johnson Psycho-Educational Battery-Revised (WJ). During the Passage Comprehension section of the WJ, participants were presented with a short passage that was missing a key word and were instructed to identify the missing word from with a series of multiple-choice options. The Passage Comprehension subscale probes vocabulary skill and comprehension. For the Applied Problems section of the WJ, participants are given a series of

short practical math problems and are required to apply a variety of mathematical procedures to perform relatively simple calculations to derive the correct answer. Standard scores for the Passage Comprehension and Applied Problems subscales represent academic achievement, as determined via laboratory assessment. The Passage Comprehension and Applied Problems subscales are significantly correlated (r = .67), and were standardized and averaged into a single composite score of academic achievement.

Positive Attitudes Towards School Composite Score. Adolescents completed self-reports of two measures of positive attitudes toward school: school attachment and bonding to teachers. School attachment was aggregated from 5 items on the "What My School is Like" questionnaire, answered from 1 ("Not true at all") to 4 ("very true"). Participants were asked to rate the level to which they were invested in, and connected to, their school (e.g., "I feel like I am a part of my school"). Averaged composite school attachment scores with higher values indicate greater *school attachment* (α = .76). Teacher bonding was measured with 16 questions about the quality of the participant's relationship with the teacher to whom they felt closest that year. Items such as "How much does this teacher help you figure out or fix things?" were rated from "Little or none" (1) to "The most!" (5). Responses were averaged to obtain a measure of the adolescents' perception of the social and practical support provided by their teacher, or their *teacher bonding* (α = .93). The school attachment and bonding to teacher scales are significantly correlated (r = .64), and were standardized and averaged into a single composite score of positive attitudes towards school.

Positive Peer Environment Composite Score. Indicators of a positive peer environment included positive peer group characteristics and friendship quality. To gauge positive peer group characteristics, participants reported on the academic achievement and moral characteristics of

the friends with whom they spend the most time. Participants reported how many (1 = "'none of them," to 5 = "all of them") of their friends engaged in positive activities such as working hard at school, and negative activities such as being mean to other kids (negative behaviors were reverse coded). The 15 items in the 'Positive Orientation Towards Academic Achievement' and 'Moral Behavior' subscales were summed to create a total *positive peer group* characteristics score, with higher scores indicating more positive peer group characteristics (α = .84). Adolescents' perception of friendship with their best friend was assessed with a 28-item Friendship Quality Questionnaire (Parker & Asher, 1989, 1993). Participants identified their "very best friend" and rated how true several statements were about the quality of their friendship (ranging from "not true at all" [1], to "really true" [5]). This measure contained six subscales, including intimate disclosure (i.e., "I always tell my friend about my problems"), conflict and betrayal (i.e., "My friend and I get mad at each other a lot"), and companionship and recreation (i.e., "My friend and I like to hang out together"). A total friendship quality score was computed as the average of 28 items across the 6 subscales, with higher values representing more positive and higher *friendship quality* (α = .92). Positive peer characteristics and friendship quality are significantly correlated (r = .30), and were standardized and averaged into one composite of positive peer environment.

Psychosocial Competency and Judgment Composite Score. Psychosocial competency and judgment, or the awareness of individual and interpersonal demands and sound decision making across contexts, was measured in adolescence. *Future Consideration and Planning* was assessed via Cauffman and Woolard's (1999) Future Outlook Inventory (FOI). The FOI includes 8 short scenarios that represent the ability to consider future consequences, and plan accordingly, such as "I will keep working at difficult, boring tasks if I know they will help me get ahead later." Participants reported how true each of the statements was of him or her, from "Never" (1)

to "Always" (4). Responses across the 8 items were averaged to create a composite score of future consideration and planning across a variety of contexts, with higher scores indicating better future consideration and planning. *Psychosocial maturity* was measured with the Psychosocial Maturity Inventory (Greenberger & Bond, 1976), and assessed teens' ability to manage their behaviors and attitudes, comprised of such constructs as self-reliance and work orientation. Participants responded to 30 items (e.g., "Hard work is never fun") on a scale from 1 ("strongly disagree") to 4 ("strongly agree") such that higher values represented a lesser degree of personal responsibility. Items were reversed and averaged together, resulting in a total psychosocial maturity score (i.e., higher values indicate greater psychosocial maturity; $\alpha = .88$). Adolescents' ability to stand up to peer pressure was captured in an adaptation of Steinberg and Monahan's (2007) Resistance to Peer Influence (RPI) instrument. The RPI gives 9 descriptions of individuals succumbing to peer pressure (e.g., I go along with my friends just to keep them happy), and asks how well each applied to the participant (1 = "not at all true" to 4 = "very true"). A total *Resistance to Peer Pressure* score was calculated as the sum of all items, with higher scores representing better ability to resist peer pressure ($\alpha = .69$). Future consideration and planning, psychosocial maturity, and resistance to peer pressure are significantly correlated, and were standardized and averaged into a single composite score of psychosocial competency and judgment. Table 2 shows the correlations between the adaptive and maladaptive composites.

Table 2. Correlations of Adolescent Adjustment Composite Scores

	1.	2.	3.	4.
1. Academic Achievement Composite	-			
2. Positive Attitudes Towards School Composite	.134**	-		
3. Positive Peer Environment Composite	.059	.523**	-	
4. Psychosocial Competency & Judgment Composite	.146**	.380**	.514 **	-
5. Aggressive & Antisocial Behavior Composite	-.145**	-.445**	-.461**	-.452**

**p<.01

3.3.3.2 Maladaptive Adolescent Adjustment Outcomes

Maladaptive adjustment in adolescence reflects problem behaviors exhibited by the participants and their friends. One composite score of aggressive and antisocial behavior was created as an indicator of maladaptive adjustment in adolescence. Correlations between scores contributing to each adaptive composite score are available in Table 3.

Table 3. Correlations of Maladaptive Adolescent Adjustment Outcomes

	1.	2.	3.	4.	5.	6.
1. Friend Risk-Taking	-					
2. Own Risk-Taking	.666**	-				
3. Externalizing Behavior	.604**	.554**	-			
4. Relational Aggression	.299**	.352**	.494**	-		
5. Reactive Aggression	.477**	.550**	.556**	.501**	-	
6. Instrumental Overt Aggression	.329**	.472**	.438**	.552**	.534**	-

**p<.01

Aggressive and Antisocial Behavior Composite Score. Negative outcomes in the peer context were conceptualized as the amount of risk-taking exhibited by the participant's friends. Participants reported the proportion of their friends that engaged in 25 different risk-taking behaviors, such as threatening to beat someone up, or running away from home. Responses were recoded as either "none" or "some" friends engaged in each of the activities, and summed across all items to create a composite *friend risk taking* variable, with higher values indicating more risk-taking ($\alpha = .92$).

The participant's own maladaptive behaviors and attitudes included risk-taking, externalizing behavior, and three types of aggression. Participants reported on their own risk-taking behavior by indicating how often they engaged in 35 different risky behaviors, such as riding in a car without a seatbelt, selling drugs, or getting arrested. Adolescents reported how many times they had exhibited each risk behavior, from "not at all" (0), "once or twice" (1), or

"more than twice" (2). Responses were averaged to create a *risk taking* composite score; the square root of the composite score will be used in analyses with more risk taking represented by higher composite values (α = .91). The Youth Self-Report (YSR; Achenbach & Edelbrock, 1987) was administered as a measure of emotional and behavioral problems within the last 6 months. Participants were presented a list of behaviors and asked how well each described him or her, from "not true" (0) to "very true or often true" (2). The *externalizing behavior* subscale evaluated the frequency of delinquent and aggressive behaviors such as sudden change in mood or feelings, lying, cheating, and not feeling guilty after misbehaving. Standardized T-scores were derived from the aggregate of the 30 externalizing behavior items, with higher t-scores indicating more frequently displayed delinquent and aggressive behavior. (α = .94). Aggression was measured from 18 items that tap into multiple forms of aggressive behavior (Little, Henrich, Jones, & Hawley, 2003). Participants indicated whether it was not at all true (1) to completely true (4) that they exhibited acts related to three types of aggression: pure relational aggression (e.g., "I tell my friends to stop liking someone"), overt-reactive aggression (e.g., "when I feel threatened, I often threaten them back"), and overt-instrumental aggression (e.g., "I often start fights to get what I want"). Items loaded onto the *relational*, *reactive*, and *instrumental aggression* subscales (α = .68, .81, and .82, respectively). Higher values on each aggression subscale correspond to a greater likelihood and variety of aggressive behavior being exhibited by the participant. Friend risk-taking, participant risk-taking, externalizing behavior, relational aggression, reactive aggression, and instrumental overt aggression are significantly correlated (see Table 3), and were standardized and averaged into a single composite score of aggressive and antisocial behavior.

3.4 ANALYTIC PLAN

Analyses for the present study were conducted with a series of structural equation models (SEM), using MPlus (version 7; Muthen & Muthen, 1998-2012). Models increased in complexity, as the SEM from research question 1 expanded to include pathways of interest in the proceeding research question. SEM is an optimal analytic technique to test the current research questions, since it can include both observed manifest variables and unobserved latent variables in one predictive model.

Two types of models are used in SEMs with latent variables: a structural model and a measurement model. The structural model represents the relation among latent variables; the measurement model assesses how latent variables are associated with observed variables. The structural model and the measurement model combine to form the entire structural equation model. The structural equation model in research question 1 examined the stability of derived latent factors of self-regulation across the four developmental periods (early childhood, transition to formal schooling, middle childhood, and adolescence). Research questions 2 and 3 expanded this model to evaluate the prediction of observed, manifest adolescent outcomes by latent self-regulation.

Structural equation modeling establishes significant relations between variables by comparing the covariance structure of the observed variables with the covariance of the model specified by the researcher. The observed covariance represents the actual relations naturally occurring between the variables, which the model covariance attempts to replicate by specifying particular parameters. A substantiated model, or one that provides good fit, is evident if there is no significant difference between the observed covariance and the model covariance. Models are defined by either freeing or fixing parameters such as factor loadings, factor correlations, factor

variances, error variances or error covariances. A free parameter is estimated by the SEM, whereas a fixed parameter is set (usually equally to zero, or equal to another parameter) so that it is not estimated.

Maximum likelihood (ML) estimation method was used for all models. One requirement for ML estimation is multivariate normality, which was tested with Mardia's skewness test and Mardia's kurtosis test in MPlus (Mardia, 1970, 1974). A significant result on either Mardia's skewness or kurtosis test indicates the data is not normally distributed. For such models with variables that do not satisfy the multivariate normality assumption, the Satorra-Bentler χ^2 rescaling factor (c) will be used to correct for non-normality of the test statistic and standard errors (Satorra & Bentler, 1988, 1994). The interpretation of the Satorra-Bentler χ^2 statistic is the same as the χ^2 statistic, which tests the null hypothesis that two sample distributions do not differ from each other.

The goodness-of-fit of a model is assessed by a variety of model fit indices that are divided into absolute (i.e., how well the observed covariance matrix is replicated by the model covariance matrix) and incremental (i.e., whether the model provides an improvement in fit over a null model) indices. The fit of each SEM was determined by the collection of the following indices. The χ^2 statistic (or Satorra-Bentler χ^2 statistic) tests the null hypothesis that there are no significant differences between the observed and model covariance matrices. The standardized root mean-square residual (SRMR) represents the average difference between the observed and model correlation matrices, with scores $\leq .08$ indicating good model fit (Hu & Bentler, 1999). The root mean square error of approximation (RMSEA) estimates the amount of approximate error, and accounts for sample size and degrees of freedom in a model. The RMSEA favors parsimony, or simpler models, with $\leq .06$ indicating good fit (Hu & Bentler, 1999). The

Comparative Fit Index (CFI) assesses improvement in fit over a baseline model, with values ≥ .95 demonstrating good fit (Hu & Bentler, 1999). The Tucker-Lewis Index (TLI) estimates incremental model fit over a baseline model with values ≥ .90 representing good model fit (Hu & Bentler, 1999).

Finally, the last two model fit indices will be used to compare the models in research question 3: the Akaike Information Criteria (AIC) and the Sample-Size Adjusted Bayesian Information Criteria (ssBIC; Akaike, 1973, 1974; Henson, Reise, & Kim, 2007; Schwarz, 1978). These two metrics assess how well a model covariance replicates the observed covariance, while accounting for the number of estimated parameters, and adjusting for model complexity. Models with smaller AIC and ssBIC values indicate better fit (Burnham & Anderson, 2004). The overall model fit was determined by interpreting results across all of the applicable fit indices, while using theory to arrive at the final assessment of model fit. In addition to analyzing overall model fit, individual parameters (e.g., regression coefficients) are tested for significance with z-tests.

Latent factors of self-regulation were derived by regressing each of the relevant variables onto an unobserved, newly constructed variable. To identify the factor, one factor loading within each latent variable must be fixed to 1. Factors and/or their error terms are allowed to correlate to account for manifest variables that are theoretically related. In the current analyses, tasks that were administered multiple times within the same age period were allowed to correlate. For example, the Tower of Hanoi planning efficiency scores at 3rd grade and 5th grade were allowed to correlate within the middle childhood latent factor of self-regulation, since this same task appears twice in the same age period, and would logically be highly related. Furthermore, subscales from the same behavioral measure were allowed to correlate, such as the two scales from the Woodcock-Johnson (Memory for Names and Memory for Sentences).

All manifest variables were standardized when included in a model to facilitate interpretation of results across constructs and across development. Missing data was addressed with full information maximum likelihood (FIML), which uses all available data to impute missing values within each analysis.

Hypothesis 1: One structural equation model (SEM) tested the hypothesis that there is a significant and positive prediction of latent self-regulation from each age period to the next adjacent age period. Stability of self-regulation from early childhood through adolescence was examined by estimating the following paths: early childhood self-regulation predicts self-regulation during the transition to formal schooling, which then predicts middle childhood self-regulation, which then predicts adolescent self-regulation (see Figure 1). Early childhood self-regulation was regressed onto background characteristics to control for gender, ethnicity, family income, and school readiness.

Model fit indices were evaluated to determine how well the model fit the patterns in the observed data. If the fit indices indicated good fit, each pathway of self-regulation from one developmental period to the next adjacent developmental period was examined for significance. Significant parameter estimates suggest that self-regulation at one age period predicts self-regulation at the next adjacent age period. Standardized significant parameter estimates represent the degree of stability in self-regulation across each developmental transition, with larger parameter estimates representing greater stability.

In the case that the fit indices for the hypothesized model in Figure 1 did not demonstrate good fit, then the model was respecified to potentially improve fit. Model modification is conducted by freeing parameters that were formerly fixed, then fixing parameters that were formerly free. If the model in Figure 1 did not demonstrate adequate fit, then fixed paths would

be freed. If necessary, paths from laboratory tasks to the latent self-regulation factor that are either non-significant, or have a low factor loading (<.3), would be fixed to zero. This method would identify any laboratory tasks that do not significantly contribute to an underlying latent factor of self-regulation at that point in development. Similarly, if the regression from the latent self-regulation factor at one age period onto the previous age period is not significant, then that path would be fixed to zero. This model modification would inform the development of self-regulation across childhood and adolescence, as non-significant paths from one age period to the next adjacent age period would represent a developmental transition across which self-regulation is not reliably stable. Model fit indices were re-examined for alternative models to evaluate whether model fit had improved.

Hypothesis 2a: Another SEM tested how latent self-regulation from early childhood through adolescence is associated with adaptive adjustment in adolescence, and if higher levels of self-regulation at each of the four age periods predict higher scores on adaptive outcomes. Specifically, this model examined whether higher levels of self-regulation predict more academic achievement, positive attitudes towards school, positive peer environments, and psychosocial competency and judgment at age 15. Furthermore, it was hypothesized that measures of self-regulation assessed later in development were be more strongly related to adaptive adolescent adjustment than earlier measures of self-regulation.

Adaptive outcomes in adolescence were represented by four composite indicators of adjustment: academic achievement, positive attitudes towards school, positive peer environment, and psychosocial competency and judgment. Each of these composite outcomes is comprised of separate measures of adolescent behaviors or attitudes that manifest in similar contexts or serve similar functions. For example, the composite indicator 'psychosocial competency and judgment'

includes measures of future consideration and planning, psychosocial maturity, and resistance to peer pressure. These three scales are theoretically aligned with each other, as they assess an individual's psychosocial intelligence, conscientiousness, future orientation, and decision making. In addition to being theoretically related, these indicators are also statistically related. The 'sub-indicators' of a composite outcome must be at least modestly correlated with one another, with a bivariate correlation coefficient about .40 or higher.

Preliminary analyses support deriving the four composite outcomes of adaptive adolescent adjustment: academic achievement, positive attitudes towards school, positive peer environment, and psychosocial competency and judgment. Composite scores were calculated by averaging the standardized sub-indicator variables within each domain of adjustment (Figure 4), and were treated in the model(s) as observed variables.

The hypothesized association between self-regulation and adaptive adjustment at age 15 is illustrated in Model 2a (Figure 2). In this model, the effect of self-regulation across development on adaptive adjustment is estimated with paths from self-regulation across the four developmental periods (early childhood, transition to formal schooling, middle childhood, and adolescence) to each adaptive outcome. Early childhood self-regulation was regressed onto background characteristics to account for the effects of gender, ethnicity, family income, and school readiness. Fit indices determined how well this model explains the observed data.

If Model 2a demonstrated adequate fit, parameter estimates from self-regulation to each of the adaptive adjustment outcomes were assessed for significance and effect size. Larger standardized parameter estimates indicate that the level of self-regulation from childhood through adolescence has a larger impact on that domain of adaptive adjustment, as compared to estimates of adjustment outcomes with smaller or non-significant parameters. How well the

model explains each adaptive adjustment outcome is determined by R^2 values, or the amount of variance accounted for in the outcome. R^2 values range from 0 to 1, with higher values indicating that the model explained a larger proportion of variance in the outcome.

Model comparisons test the hypothesis that measures of self-regulation assessed later in development are more strongly associated with adaptive adolescent adjustment than earlier measures of self-regulation. To do so, the model would be respecified to constrain the parameters from a) more recent self-regulation to adaptive adjustment outcomes and b) earlier measures of self-regulation to adaptive adjustment outcomes to be equal. Model 2a, which allows the prediction of adolescent adjustment by self-regulation across development to be freely estimated, would be compared to models that fix the estimate by self-regulation at adjacent age periods to be equal. Evidence of a stronger association between more recent measures of self-regulation and adaptive adjustment, compared to the association between earlier measures of self-regulation and adaptive adjustment would be demonstrated if the unconstrained model (Model 2a) shows significantly better model fit. If the unconstrained model fits the data better, the larger of the two parameter estimates that were fixed to be equal in the alternate model would indicate the stronger association to adolescent adaptive adjustment. Specifically, this hypothesis was supported if the prediction from adolescent self-regulation to adaptive adjustment is greater than the prediction from early childhood, the transition to formal schooling, and middle childhood self-regulation.

Hypothesis 2b: A separate SEM tested the hypothesis that latent self-regulation from early childhood through adolescence is inversely related to maladaptive adolescent adjustment, with lower levels of self-regulation at each of the four age periods predicting more aggressive and antisocial behavior in adolescence. Additionally, it was hypothesized that more recent

measures of self-regulation are more strongly associated with aggressive and antisocial behavior in adolescence than earlier measures of self-regulation.

Preliminary analyses suggest that all measures of negative behaviors and attitudes in adolescence can be combined into one composite indicator of maladaptive adolescent adjustment. The 'aggressive and antisocial behavior' adjustment composite is an aggregate of friends' risk-taking, own risk-taking, externalizing behavior, relational aggression, reactive aggression, and instrumental overt aggression (see Figure 5). These six sub-indicators were standardized and averaged to create the aggressive and antisocial behavior composite score.

Model 2b illustrates the hypothesized association between self-regulation from early childhood through adolescence and adaptive adjustment at age 15 (see Figure 2). In this model, the effect of self-regulation across development on maladaptive adjustment is estimated with paths from self-regulation across the four developmental periods (early childhood, transition to formal schooling, middle childhood, and adolescence; see Model 1) to aggressive and antisocial behavior in adolescence. Early childhood self-regulation was regressed onto background characteristics to control for gender, ethnicity, family income, and school readiness. Fit indices evaluated the model's goodness-of-fit. Parameter estimates and the proportion of variance accounted for in aggressive and antisocial behavior determined how large of an effect self-regulation has on maladaptive adjustment in adolescence.

The same method implemented for adaptive adjustment outcomes was utilized for maladaptive adjustment outcomes. Model comparisons test whether more recent measures of self-regulation are more strongly associated with aggressive and antisocial behavior in adolescence than earlier measures of self-regulation. An unconstrained model, which freely estimates the path from self-regulation at all age periods to maladaptive adjustment, would be

compared to a model(s) that constrain the paths from multiple age periods to maladaptive adjustment to be equal. If the unconstrained model fits significantly better than the alternate model, the larger of the two fixed parameters indicate that self-regulation during that age period has a stronger association to maladaptive adjustment.

Hypothesis 3a: Two models were compared to test the hypothesis that early childhood self-regulation contributes unique variance to adaptive adolescent adjustment after accounting for self-regulation from the transition to formal schooling through adolescence. In other words, a model that estimates paths from the earliest indicators of self-regulation to adaptive outcomes in adolescence (Figure 2, Model 2a) will provide better fit than a model that only estimates the effect of self-regulation on adaptive adjustment once children transition to formal schooling (Figure 3, Model 3a). Furthermore, it was hypothesized more variance in adaptive adolescent outcomes is accounted for when the earliest indicators of self-regulation are included, compared to the explanation by more recent measures of self-regulation during the transition to formal schooling, middle childhood, and adolescence.

A model comparison assessed the value added in predicting adaptive adjustment when including indicators of self-regulation in early childhood (see Figure 3). Specifically, does estimating the path from self-regulation in early childhood to adolescent adaptive adjustment improve the prediction of these outcomes, above and beyond what is explained by self-regulation in the transition to formal schooling, middle childhood, and concurrently in adolescence?

A model of adaptive adolescent adjustment predicted by self-regulation from the transition to formal schooling through adolescence (Model 3a) was compared to a model of adaptive adjustment predicted by self-regulation at all age periods (Model 2a). In the model that omits the path from early childhood self-regulation to adolescent adjustment (i.e., comparison

model), a path from the three most recent assessments of self-regulation to each of the four adaptive adjustment composites was estimated, while paths from early childhood self-regulation to adolescent adjustment was not. In both models, early childhood self-regulation was regressed onto background characteristics to control for gender, ethnicity, family income, and school readiness. Model fit indices assessed the goodness-of-fit, while standardized parameter estimates demonstrated the strength of the relation between self-regulation and adolescent adjustment. The amount of variance that is explained by the model, as represented by R^2, was interpreted for each adjustment outcome (i.e., academic achievement, positive attitudes towards school, positive peer environment, and psychosocial competency and judgment).

A series of model comparisons were conducted to determine whether the full developmental model significantly improves prediction of outcomes over a comparison model which omits paths from early childhood self-regulation to adolescent outcomes. First, relative model fit was analyzed with a χ^2 difference test, which tests if one model fits the data significantly better than a nested, competing model. A significant χ^2 difference test result suggests that the full developmental model fits the data better than the respective comparison model that estimates fewer paths (i.e., omits paths from early childhood self-regulation to adolescent adjustment). The Akaike Information Criteria (AIC) and Sample-Size Adjusted Bayesian Information Criteria (ssBIC) were explored for both models. Smaller AIC and ssBIC values are indicative of better model fit, favoring more parsimonious models over more complex models. If the developmental model of self-regulation has lower AIC and ssBIC values than the comparison model that does not estimate the effect of early childhood self-regulation, this would suggest that early childhood indicators of self-regulation account for meaningful variance in

adolescent adaptive adjustment, beyond what is explained by self-regulation from first grade through adolescence.

Hypothesis 3b: Another series of model comparisons tested the hypothesis that early childhood self-regulation accounts for unique variance in maladaptive adolescent adjustment, beyond what is explained by self-regulation during the transition to formal schooling, middle childhood, and adolescence. This hypothesis would be supported if maladaptive adolescent adjustment is better explained by a full developmental model of self-regulation, as evidenced by a) better incremental model fit, and b) a statistically reliable increase in prediction of aggressive and antisocial behavior. The same model comparison method which examined hypothesis 3a was used to test maladaptive outcomes in hypothesis 3b.

In sum, competing models of self-regulation predicting adolescent adjustment were tested via a) χ^2 difference test of relative model fit, b) examining the significance of parameter estimates from self-regulation to adolescent outcomes, c) comparing the variance explained in outcomes, and d) analyzing overall model fit across various indices. Taken together, these analyses illustrate the value of including early childhood indicators of self-regulation when predicting adaptive and maladaptive adjustment in adolescence.

4.0 RESULTS

4.1 DESCRIPTIVE STATISTICS

Descriptive statistics for variables representing performance on self-regulation laboratory tasks are presented in Appendix A. Analysis of missing data patterns found that data was missing completely at random, meeting the requirement for FIML imputation (Little's MCAR test, $\chi^2(4462) = 5012.38$, $p < .01$). Independent samples t-tests and chi-square likelihood tests were conducted to assess whether participants who completed the adolescent interview differed from those who were missing these data. Males were significantly more likely to be missing data from the adolescent interview ($\chi^2 = 4.7$, $p = .03$). Those who did not complete the age 15 interview had significantly lower scores on the Bracken Basic Concepts Scale of school readiness at 36 months ($t = 2.37$, $df = 1157$, $p = .018$). Missingness did not vary by ethnicity or family income when participants were 36 months.

4.2 HYPOTHESIS 1

Hypothesis 1: Self-regulation is stable from early childhood through adolescence. The stability of self-regulation from early childhood through adolescence was assessed by using performance on behavioral tasks to derive self-regulation latent factors at each of the four age periods. Latent

factors were then included in one SEM in which self-regulation at each age predicted self-regulation at the next adjacent age, after accounting for background characteristics in early childhood. The stability of self-regulation would be illustrated by latent factors at each age period significantly and positively predicting self-regulation at the next adjacent age period.

Deriving latent factors of self-regulation. Laboratory task performance variables loaded onto one latent factor of self-regulation in each of the first three age periods: early childhood, the transition to formal schooling, and middle childhood. The behavioral tasks in adolescence did not load onto one latent factor of self-regulation, as shown by poor model fit indices, so adolescent self-regulation was instead calculated as a composite score. Models of latent self-regulation at each age period are discussed in turn.

Early childhood self-regulation loaded onto one latent factor from five laboratory tasks administered when children were 36 months to 54 months old, with good model fit indices: Satorra-Bentler $\chi^2(5) = 9.396$, $p = .09$; *CFI* = .987; *TLI* = .975; *RMSEA* = .027; *SRMR* = .018. Factor loadings ranged from .221 to .620 (see Table 4).

Table 4. Factor Loadings of Early Childhood Self-Regulation

Task (age)	β
Delay of Gratification Forbidden Toy (36 months)	.413
Working Memory WJ Memory for Sentences (54 months)	.452
Delay of Gratification Tempting Snack (54 months)	.575
Impulse Control Day/Night Stroop (54 months)	.221
Sustained Attention CPT (54 months)	.620

Self-regulation during the transition to formal schooling was comprised of performance on four behavioral tasks administered when children were in first grade, that loaded onto one latent factor with good model fit indices: Satorra-Bentler $\chi^2(1) = .196$, $p = .6582$; *CFI* = 1.00; *TLI* = 1.00; *RMSEA* = .00; *SRMR* = .003. Factor loadings ranged from .307 to .432 (see Table 5).

Table 5. Factor Loadings of Transition to Formal Schooling Self-Regulation

Task (age)	β
Working Memory WJ Memory for Names (1st grade)	.307
Working Memory WJ Memory for Sentences (1st grade)	.405
Planning Tower of Hanoi (1st grade)	.432
Sustained Attention CPT (1st grade)	.408

Middle childhood self-regulation was assessed with five laboratory tasks when children were in 3rd grade, 4th grade, and 5th grade; all of these loaded onto one latent factor with good model fit indices: Satorra-Bentler $\chi^2(4) = 9.075$, $p = .0593$; *CFI* = .990; *TLI* = .975; *RMSEA* = .034; *SRMR* = .020. Factor loadings ranged from .332 to .719 (see Table 6).

Table 6. Factor Loadings of Middle Childhood Self-Regulation

Task (age)	β
Planning Tower of Hanoi (3rd grade)	.688
Working Memory WJ Memory for Names (3rd grade)	.332
Working Memory WJ Memory for Sentences (3rd grade)	.418
Sustained Attention CPT (4th grade)	.377
Planning Tower of Hanoi (5th grade)	.719

A latent self-regulation variable using measures obtained in adolescence could not be derived from the three behavioral tasks administered at age 15. The three tasks (i.e., BART risk-taking score, OSPAN working memory score, and Tower of London planning score) did not load onto one latent factor of self-regulation, based on poor model fit indices. Because at least three indicators are needed to create a latent factor and only three behavioral tasks were considered valid indicators of adolescent self-regulation, it was necessary for all three to load on the latent factor. However, poor model fit indicated that these three behavioral measures did not collectively represent a meaningful underlying construct of self-regulation during adolescence.

In order to retain a measure of self-regulation during adolescence, a composite self-regulation score was calculated in lieu of a latent factor for age 15 behavioral task performance.

Of the three self-regulation variables (i.e., BART risk-taking score, OSPAN working memory score, Tower of London planning score), the BART risk-taking propensity score was uncorrelated with the other two variables and is not considered further. The remaining two tasks – OSPAN and Tower of London – were significantly, albeit modestly, correlated (r = .193, p < .01), and were therefore used to create a composite score of adolescent self-regulation. The OSPAN and Tower of London scores were standardized and averaged together to create an equally weighted composite of self-regulation at age 15. The adolescent composite score was treated as a manifest variable, as compared to the three earlier age periods, in which self-regulation was represented by latent variables.

The bivariate correlations of background characteristics and self-regulation factors at each age period are presented in Table 7. Gender was generally unrelated to latent self-regulation, except in early childhood when females tended to exhibit more self-regulation than males. White ethnicity, higher family income, and greater school readiness were associated with higher latent self-regulation scores across development.

Table 7. Correlation of Background Characteristics and Self-Regulation Factors

	1.	2.	3.	4.	5.	6.	7.
1. Sex	-						
2. Ethnicity	.023	-					
3. Family Income	.058*	-.110**	-				
4. School Readiness	.171**	-.200**	.394**	-			
5. Early Childhood Self-Regulation	.162**	-.221**	.264**	.442**	-		
6. Transition to Formal Schooling Self-Regulation	.029	-.226**	.287**	.546**	.484**	-	
7. Middle Childhood Self-Regulation	.058	-.206**	.257**	.408**	.432**	.600**	-
8. Adolescent Self-Regulation	-.007	-.078*	.147**	.310**	.297**	.474**	.427**

*p < .05, **p < .01

Developmental Stability of Self-Regulation from Early Childhood through Adolescence. Results of the model testing the stability of self-regulation from early childhood through adolescence, as measured by performance on laboratory tasks, are presented in Figure 6. The model fit the observed data well, according to model fit indices: Satorra-Bentler $\chi^2(132) = 429.551$, $p < .01$; *CFI* = .921; *TLI* = .901; *RMSEA* = .045; *SRMR* = .046.

This model suggests that self-regulation is largely stable from early childhood through middle childhood, and remains stable although to a weaker degree from middle childhood to adolescence. Specifically, the prediction of self-regulation from early childhood to the transition to formal schooling is significant with a standardized regression coefficient (β) of .924. Self-regulation during the transition to formal schooling also largely predicts middle childhood self-regulation (β = .933). Middle childhood self-regulation goes on to predict adolescent self-regulation, but to a lesser degree than the earlier transitions (β = .546). Some, but not all background characteristics were associated with self-regulation. Ethnicity, family income, and school readiness were related to self-regulation, with White ethnicity, higher family income, and greater school readiness each associated with greater self-regulation. Gender was not a significant covariate.

Taken together, there is evidence that self-regulation is stable from early childhood through adolescence, especially during the developmental periods between early childhood (36 months – 54 months) and middle childhood (3rd grade – 5th grade). A significant portion of variance (R^2) in self-regulation was explained at each of the four age periods. The model accounted for 53% of variance in self-regulation in early childhood, 85% during the transition to formal schooling, 87% in middle childhood, and 30% in adolescence. It is not surprising that such a large portion of self-regulation was explained during the transition to formal schooling

and middle childhood, since each of these age periods is predicted by the next youngest age period, with regression coefficients above .90.

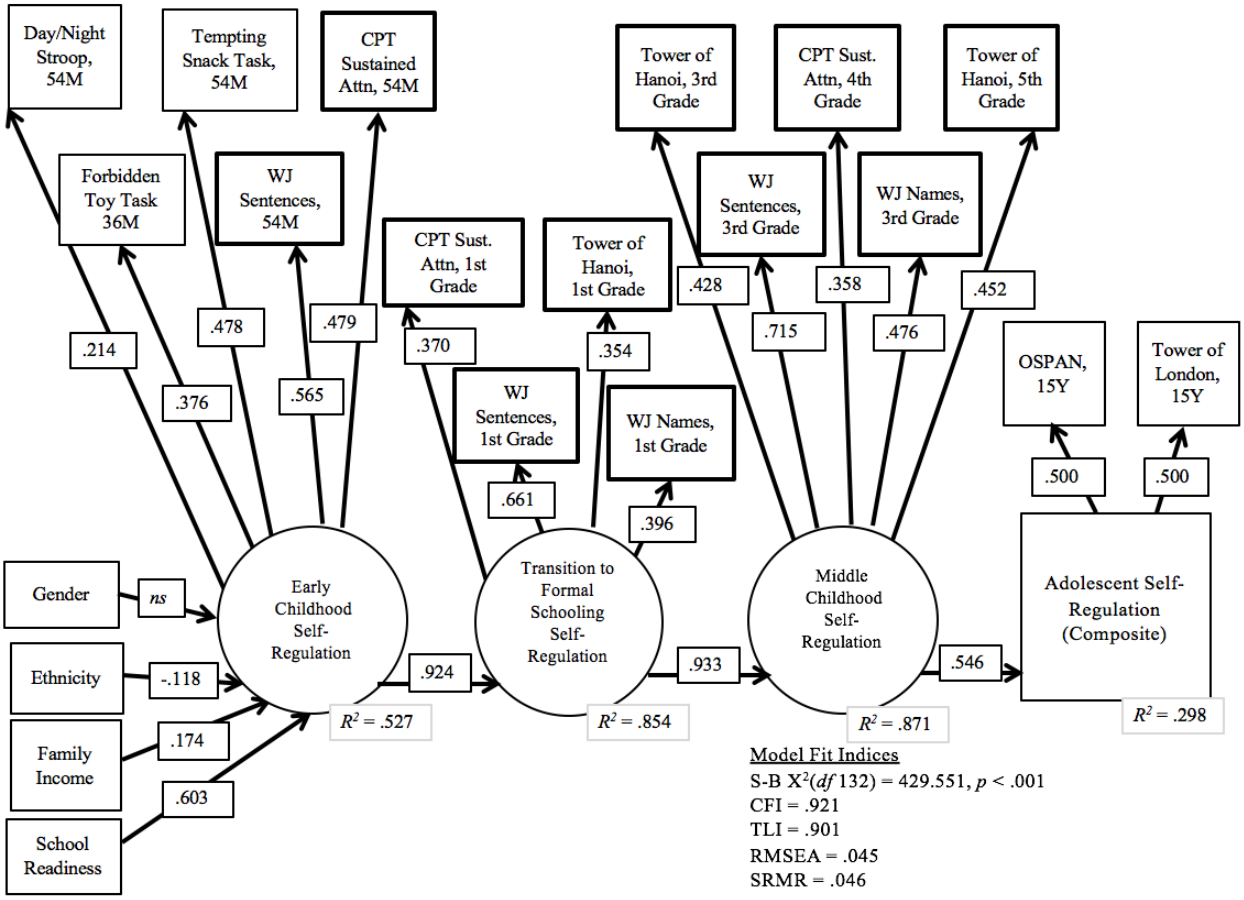

Figure 6. Self-Regulation Stability from Early Childhood through Adolescence

4.3 HYPOTHESIS 2A

Hypothesis 2A: Latent self-regulation from early childhood through adolescence is positively associated with adaptive adolescent adjustment, with higher levels of self-regulation at each of the four age periods predicting higher levels of adaptive adjustment.

Adaptive adjustment outcomes. Four composite scores of adaptive adjustment were created from behavioral tasks and self-report measures at age 15: academic achievement, positive attitude towards school, positive peer environment, and psychosocial competency and judgment. Composite scores were calculated by averaging the standardized scores of the variables that comprise each adaptive outcome. Table 8 presents descriptive information for the adolescent adjustment scores, and the respective variables that comprise each composite.

Table 8. Descriptive Statistics of Adolescent Adjustment Composite Scores

	Mean	*SD*	*Min.*	*Max.*
Academic Achievement Composite	-.002	.92	-3.96	3.70
WJ Passage Comprehension Std. Score	107.71	15.72	44	160
WJ Applied Problems Standard Score	102.92	14.22	48	168
Positive Attitudes towards School Composite	-.002	.91	-3.42	1.22
School Attachment	3.30	.57	1	4
Teacher Bonding	3.17	.68	1	4
Positive Peer Environment Composite	.00	.81	-4.00	1.72
Positive Peer Characteristics	57.22	7.60	15	75
Friendship Quality	4.16	.56	2.21	5
Psychosocial Competency & Judgment Composite	.002	.77	-2.53	1.91
Future Consideration & Planning	2.62	.49	1	4
Psychosocial Maturity	3.33	.36	1.3	4
Resistance to Peer Pressure	28.75	3.65	17	36
Aggressive & Antisocial Behavior Composite	.004	.77	-1.25	4.04
Friend Risk-Taking	9.66	6.08	0	25
Own Risk-Taking	6.16	5.67	0	53
Externalizing Behavior	49.3	9.91	25	86
Relational Aggression	1.34	.37	1	3.17
Reactive Aggression	1.69	.57	1	3.83
Instrumental Overt Aggression	1.13	.29	1	3.5

SD = Standard Deviation; *Min* = Minimum; *Max* = Maximum
Note. Contributing variables are standardized and averaged together to create Composite Score

Bivariate correlations among background characteristics and the adjustment outcomes in adolescence are presented in Table 9. As can be seen in the table, there were low to moderate correlations between background characteristics and outcome measures in the expected direction, with positive adjustment outcomes generally positively correlated with being female, white, and

having higher income and school readiness. There were small, but significant correlations between adolescent academic achievement and both positive attitudes toward school, and psychosocial competency and judgment. Positive attitudes toward school, positive peer environment, and psychosocial competency and judgment were also related to one another at a low to moderate degree.

Table 9. Correlation of Background Characteristics and Adolescent Adjustment Composite Scores

	1.	2.	3.	4.	5.	6.	7.	8.
1. Gender	-							
2. Ethnicity	.023	-						
3. Family Income	.058*	-.110**	-					
4. School Readiness	.171**	-.200**	.394**	-				
5. Academic Achievement	-.025	-.210**	.324**	.510**	-			
6. Positive Attitudes Towards School	.101**	-.114**	.133**	.168**	.134**	-		
7. Positive Peer Environment	.305**	-.106	.082*	.083*	.059	.523**	-	
8. Psychosocial Competency & Judgment	.166**	.012	.066*	.075*	.146**	.380**	.514**	-
9. Aggressive and Antisocial Behavior	-.090**	.159**	-.155**	-.160**	-.145**	-.445**	-.461**	-.452**

*p<.05, **p<.01

Modeling the effect of developmental self-regulation on adaptive adolescent adjustment. Hypothesis 2a was examined with a model that regressed the four adaptive adjustment composites onto self-regulation in early childhood, during the transition to formal schooling, middle childhood, and adolescence, accounting for background characteristics in early childhood (see Appendix C).

Model fit indices indicated that the initial conceptual model did not adequately fit the observed data: Satorra-Bentler $\chi^2(192) = 627.118$, $p < .01$; *CFI* = .914; *TLI* = .889; *RMSEA* = .045; *SRMR* = .049. Specifically, the CFI and TLI indices were poor. Modification indices were obtained in MPlus to identify which paths could be freed to improve model fit. The model was

modified to free paths that were theoretically justifiable, such as allowing variables within the same age period to correlate (e.g., 1st Grade Sustained Attention with 1st Grade WJ Memory for Sentences). In total, six paths were freed, which improved model fit: Satorra-Bentler $\chi^2(186) = 566.743$, $p < .01$; *CFI* = .925; *TLI* = .900; *RMSEA* = .043; *SRMR* = .048.

The modified model of developmental self-regulation predicting adaptive adjustment outcomes in adolescence is presented in Figure 7. Contrary to the hypothesis that adolescent outcomes would be uniquely predicted by self-regulation at multiple age periods, many of the adaptive outcomes were predicted by self-regulation at only one developmental period. This finding is not very surprising given the stability of self-regulation from early childhood through adolescence demonstrated in research question 1.

Middle childhood self-regulation predicted age 15 academic achievement ($\beta = .679$). Middle childhood self-regulation was also marginally related to adolescent psychosocial competency and judgment ($\beta = .348$, $p = .09$). Early childhood self-regulation was associated with positive attitudes towards school in adolescence ($\beta = .661$), while this outcome was inversely related to concurrent adolescent self-regulation ($\beta = -.108$). None of the self-regulation latent variables predicted perceptions of a positive peer environment in adolescence.

Taken together, higher levels of self-regulation across development are associated with more adaptive adjustment in adolescence, including academic achievement and (to a lesser degree) positive attitudes towards school and psychosocial competency and judgment. Generally, adaptive outcomes were predicted by a single age period of self-regulation. Since self-regulation is largely stable from early childhood through adolescence, it makes good sense that only one age period would statistically predict adolescent adjustment. Once a significant

path from self-regulation to adjustment is established, capturing self-regulation at multiple other age periods does not explain additional variance in the outcomes.

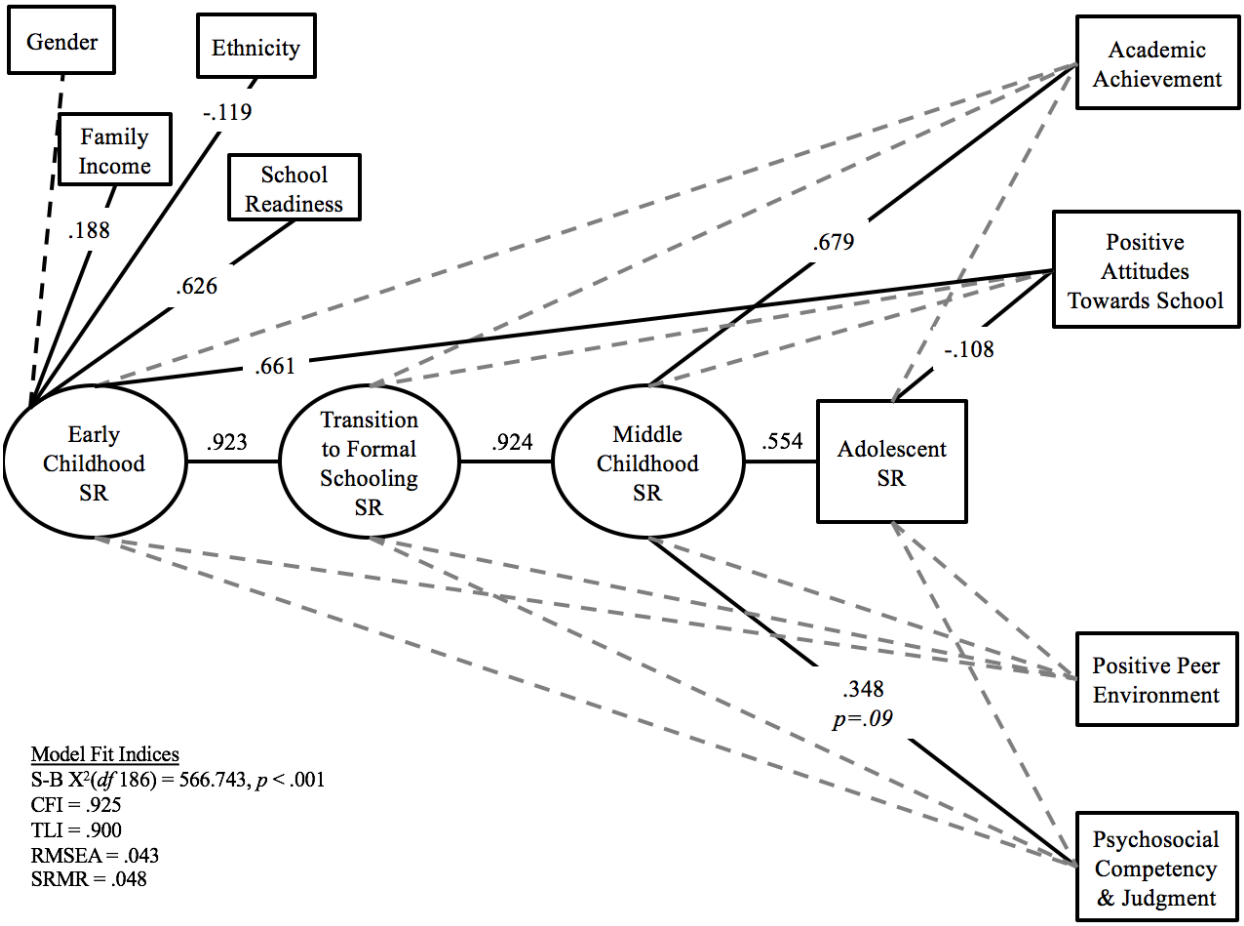

Figure 7. Developmental Self-Regulation Predicting Adaptive Adolescent Adjustment

4.4 HYPOTHESIS 2B

Hypothesis 2B: Latent self-regulation from early childhood through adolescence is negatively associated with maladaptive adolescent adjustment, with lower levels of self-regulation at each of the four age periods predicting higher levels of aggressive and antisocial behavior.

Maladaptive adjustment outcomes in adolescence. One composite score of maladaptive adjustment was created from adolescent self-report measures: aggressive and antisocial behavior. The composite score was calculated by averaging the standardized scores of the following scales: own risk-taking, friend risk-taking, externalizing behavior, relational aggression, reactive aggression, and instrumental overt aggression (see Table 8). Bivariate correlations between background characteristics and the aggressive and antisocial behavior composite score are presented in Table 9. Being female, White ethnicity, higher family income, and better school readiness were each associated with less aggressive and antisocial behavior at age 15.

Modeling the effect of developmental self-regulation on maladaptive adolescent adjustment. Hypothesis 2b was examined by regressing aggressive and antisocial behavior onto self-regulation in early childhood, during the transition to formal schooling, middle childhood, and adolescence, accounting for background characteristics in early childhood (see Appendix D). The model fit the observed data well: Satorra-Bentler $\chi^2(141) = 412.896$, $p < .01$; *CFI* = .929; *TLI* = .907; *RMSEA* = .041; *SRMR* = .044 (see Figure 8). As was the case when predicting adaptive adjustment, the hypothesis that multiple age periods of self-regulation would uniquely predict maladaptive adjustment was not supported. Aggressive and antisocial behavior at age 15 was solely predicted by self-regulation at one age period: early childhood ($\beta = -.566$).

Higher levels of self-regulation in early childhood were associated with lower levels of aggressive and antisocial behavior in adolescence. Self-regulation during the transition to formal schooling, middle childhood, and adolescence did not explain any additional portion of the maladaptive outcome. As seen in previous models, the developmental stability in self-regulation from early childhood to adolescence led to only the most critical age period – early childhood – significantly predicting later maladaptive adjustment.

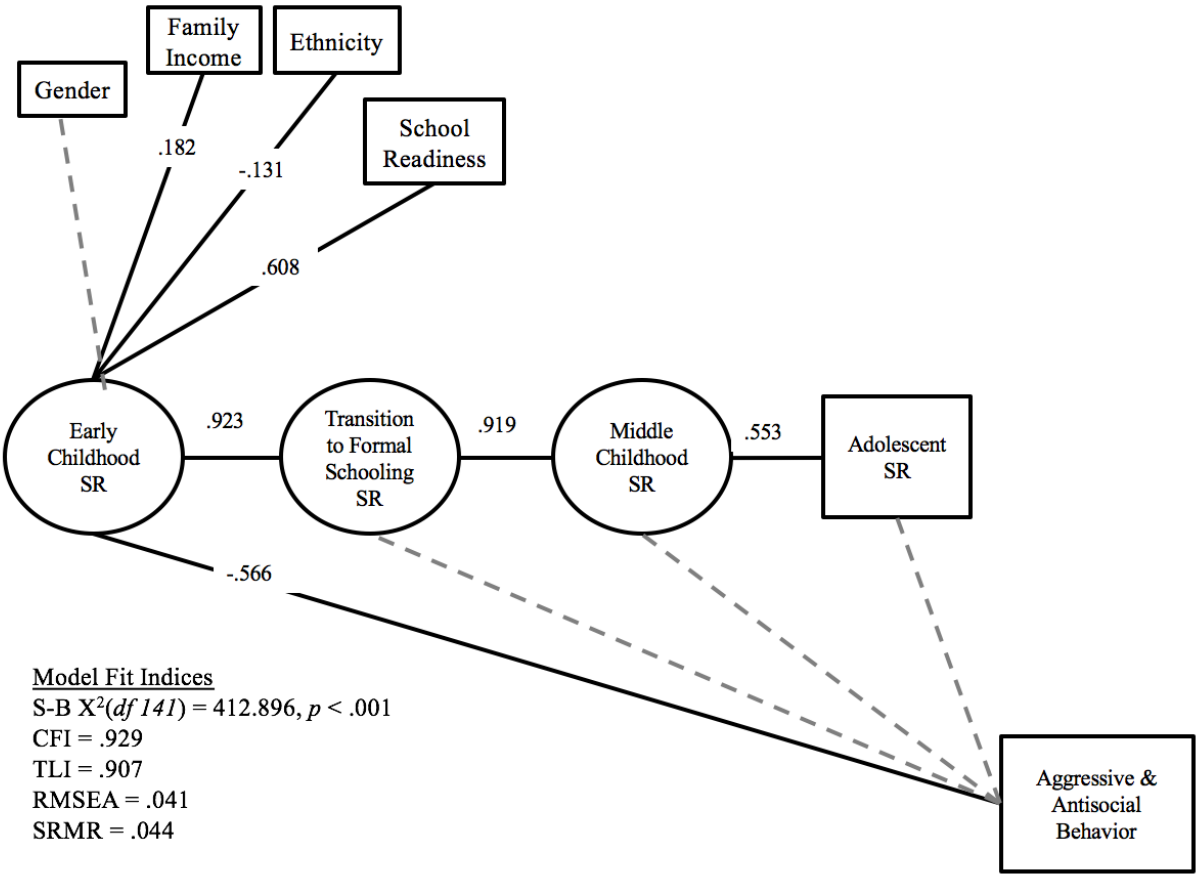

Figure 8. Developmental Self-Regulation Predicting Maladaptive Adolescent Adjustment

4.5 HYPOTHESIS 3A

Hypothesis 3A: Early childhood self-regulation will contribute unique variance to adaptive adolescent adjustment after accounting for self-regulation from the transition to formal schooling through adolescence.

To assess the degree to which early childhood self-regulation explains unique variance in adaptive adjustment beyond what is already accounted for during the transition to formal

schooling, middle childhood, and adolescence, the full developmental model (Figure 7) was compared to a model that omitted the paths from early childhood to each of the four adaptive adolescence outcomes. The impact of early childhood self-regulation was analyzed by comparing the two models on a variety of indicators: The Satorra-Bentler χ^2 difference test, absolute and incremental fit indices, significant prediction of outcomes, proportion of variance explained in outcomes, and AIC and ssBIC values of comparative model quality.

The comparison model of self-regulation from the transition to formal schooling through adolescence predicting adaptive adjustment had adequate fit: Satorra-Bentler $\chi^2(191) = 579.062$, $p < .01$; *CFI* = .923; *TLI* = .901; *RMSEA* = .042; *SRMR* = .048 (see Figure 9). Many of the significant paths from the full developmental model remained when early childhood self-regulation effects were not estimated. Middle childhood self-regulation predicted academic achievement, and was marginally associated with psychosocial competency and judgment in adolescence ($\beta = .723$, and $\beta = .326$ [$p = .096$], respectively). Adolescent self-regulation was negatively related to positive attitudes toward school ($\beta = -.135$). Positive peer environment was not associated with self-regulation at any age period. All of these findings were present in the full developmental model.

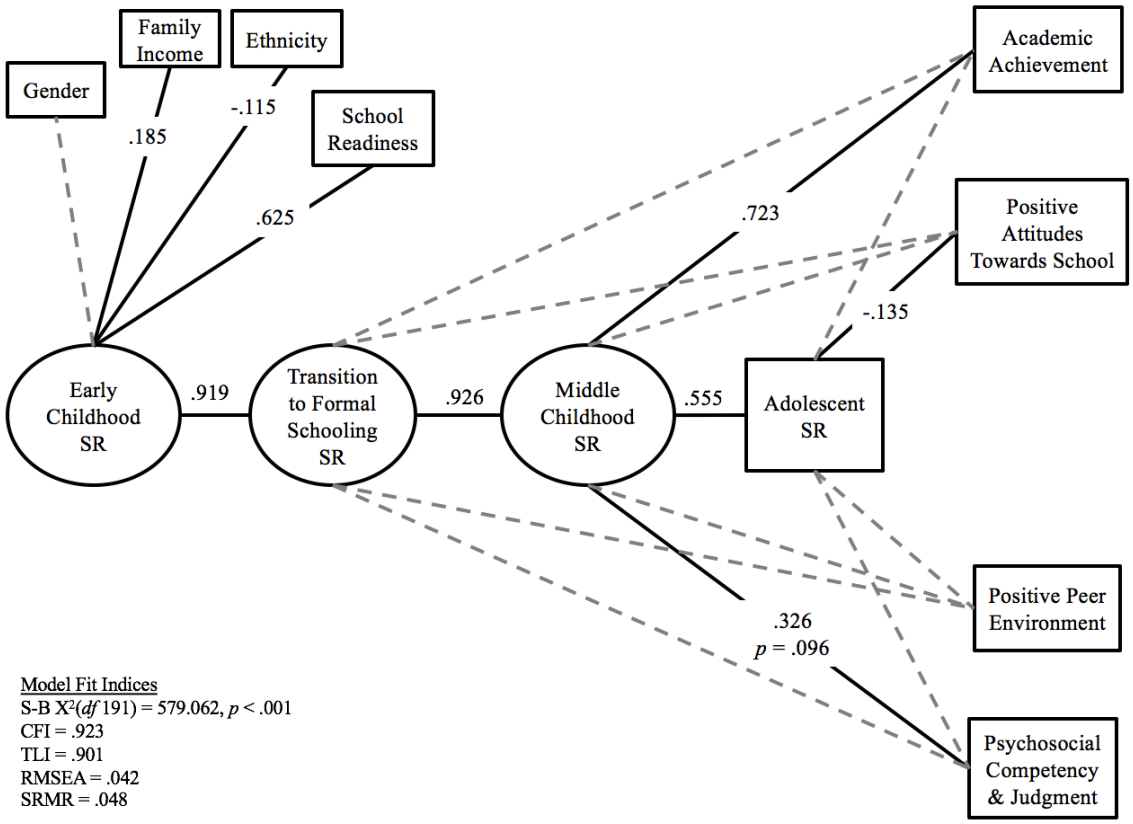

Figure 9. Self-Regulation from the Transition to Formal Schooling through Adolescence Predicting Adaptive Adolescent Adjustment

The most notable difference between the full developmental model and the comparison model (that omits early childhood self-regulation) was the prediction of positive attitudes towards school in adolescence. In the full developmental model, positive attitudes towards school were the only adaptive outcome predicted by early childhood self-regulation. When paths from early childhood self-regulation were omitted, positive attitudes toward school were only associated with concurrent adolescent self-regulation, but no prior age period. The inverse relation indicated that greater adolescent self-regulation correlated with less positive attitudes towards school, an effect that was also observed in the full developmental model.

Beyond examining the path coefficients from the two models, a series of model comparisons tested the relative fit when paths from early childhood self-regulation to adaptive

outcomes were omitted. The Satorra-Bentler χ^2 difference test established that the two models did significantly differ in fit: *S-B* χ^2 difference (Δ *df* = 5) = 12.331, *p* = .031. Specifically, the full developmental model accounted for patterns in the observed data significantly better than the comparison model.

The absolute and incremental fit indices, however, did not show strong evidence that the full developmental model had better fit than the comparison model. Both models had similar fit statistics for *CFI, TLI, RMSEA, SRMR, AIC,* and *ssBIC* indices, as presented in Table 10. The proportion of variance each model explained in the four adaptive adjustment outcomes can also be found in Table 10. Estimating the effects of early childhood self-regulation (full developmental model; top panel) explained more variance in three of the four adjustment outcomes, based on larger R^2 values. The R^2 values in the full developmental model (versus the comparison model; bottom panel) were .672 for academic achievement (versus .652), .084 for positive attitude toward school (versus .037), and .035 for positive peer environment (versus .009). Both models explained a similar amount of variance in psychosocial competency and judgment (.034 and .032, respectively).

Table 10. Model Fit Statistics of Developmental Model and Comparison Model of Self-Regulation Predicting Adaptive Adjustment

Model and Adjustment Outcomes	*S-B* χ^2	*CFI*	*TLI*	*RMSEA*	*SRMR*	*AIC*	*ssBIC*	R^2
Developmental Model (Fig. 7)	566.74**	.925	.900	.043	.048	117738	117921	
Academic Achievement								.672
Positive Attitudes Toward School								.084
Positive Peer Environment								.035
Psychosocial Competency & Judgment								.034
Comparison Model (Fig. 9)	579.06**	.923	.901	.042	.048	117740	117915	
Academic Achievement								.652
Positive Attitudes Toward School								.037
Positive Peer Environment								.009
Psychosocial Competency & Judgment								.032

**p<.01

In sum, early childhood self-regulation improves the prediction of adaptive adjustment in adolescence, beyond what is already explained by self-regulation during the transition to formal schooling, middle childhood, and adolescence. Omitting paths from early childhood self-regulation reduced the amount of variance that was accounted for in multiple indicators of adaptive adjustment. In the comparison model, positive attitudes toward school were (inversely) related to concurrent adolescent self-regulation, but no prior period of self-regulation. In contrast, early childhood self-regulation predicted positive attitude toward school in adolescence, when this path was freely estimated in the full developmental model ($\beta = .661$). Furthermore, the full developmental model demonstrated better model fit than the comparison model, according to the Satorra-Bentler χ^2 difference test (but not based on other relative and absolute fit indices). The full developmental model explained a greater proportion of variance in three of the adaptive adjustment outcomes: academic achievement, positive attitude toward school, and positive peer environment (although both models similarly predicted psychosocial competency and judgment). Taken together, results support the hypothesis that early childhood self-regulation contributes unique variance to adaptive adolescent adjustment after accounting for self-regulation from the transition to formal school through adolescence.

4.6 HYPOTHESIS 3B

Hypothesis 3B: Early childhood self-regulation will explain additional variance in maladaptive adolescent adjustment, beyond what is accounted for by self-regulation during the transition to formal schooling, middle childhood, and adolescence.

The same methodology that explored adaptive adjustment in hypothesis 3a was implemented to understand the importance of early childhood self-regulation when predicting maladaptive adjustment in adolescence. The Satorra-Bentler χ^2 difference test, model fit indices, significant prediction of maladaptive outcomes, proportion of variance explained in outcomes, and AIC and ssBIC values were contrasted for the full developmental model of self-regulation versus the comparison model that omitted paths from early childhood self-regulation.

The comparison model of self-regulation from the transition to formal schooling through adolescence to maladaptive adjustment in adolescence adequately fit the data: Satorra-Bentler $\chi^2(142) = 418.848$, $p < .01$; *CFI* = .928; *TLI* = .907; *RMSEA* = .041; *SRMR* = .045 (see Figure 10). Path coefficients indicate a modest association between self-regulation during the transition to formal schooling and aggressive and antisocial behavior in adolescence, with better self-regulation correlating with less aggressive and antisocial behavior at age 15 ($\beta = -.309$, $p = .063$).

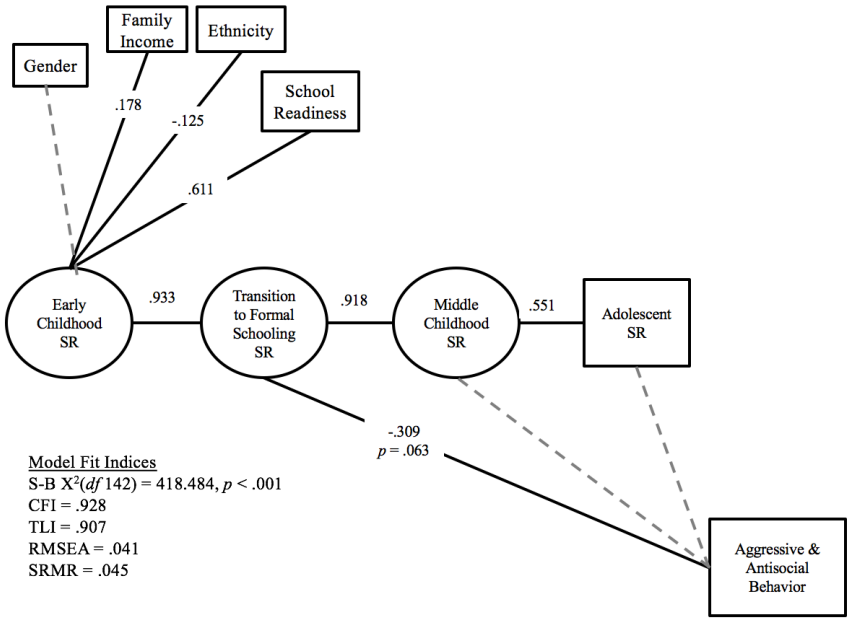

Figure 10. Self-Regulation from the Transition to Formal Schooling through Adolescence Predicting Maladaptive Adolescent Adjustment

The Satorra-Bentler χ^2 difference test demonstrated that the two models did significantly differ in model fit: *S-B* χ^2 difference (Δ *df* = 1) = 5.791, *p* = .016. The full developmental model better explained the relationships in the observed data than the comparison model that omitted paths from early childhood to maladaptive adjustment. Table 11 contains the respective model fit statistics and proportion of variance accounted in aggressive and antisocial behavior. The absolute and incremental model fit indices were similar, suggesting that omitting the path from early childhood self-regulation did not adversely impact model fit across all indices. Estimating the early childhood period of self-regulation explained more variance in aggressive and antisocial behavior in adolescence, based on larger R^2 values in the developmental model (.075) versus the comparison model (.049).

Table 11. Model Fit Statistics of Developmental Model and Comparison Model of Self-Regulation Predicting Maladaptive Adjustment

Model and Adjustment Outcomes	*S-B* χ^2	*CFI*	*TLI*	*RMSEA*	*SRMR*	*AIC*	*ssBIC*	R^2
Developmental Model (Fig. 8)	412.90**	.929	.907	.041	.044	112152	112291	
Aggressive & Antisocial Behavior								.075
Comparison Model (Fig. 10)	418.48**	.928	.907	.041	.045	112155	112292	
Aggressive & Antisocial Behavior								.049

***p*<.01

These results demonstrate that early childhood self-regulation improves the prediction of maladaptive adjustment in adolescence, over and above self-regulation during the transition to formal schooling, middle childhood, and adolescence. Early childhood self-regulation predicted less aggressive and antisocial behavior at age 15 (β = -.566) in the full developmental model. When the path from early childhood self-regulation was omitted, aggressive and antisocial behavior was only marginally related to self-regulation during the transition to formal schooling (β = -.309, *p* = .063). The full developmental model provided better model fit per the Satorra-

Bentler χ^2 difference test, and explained more variance in aggressive and antisocial behavior than the comparison model. The two models had similar values for absolute and relative fit indices. Taken together, this series of model comparisons supports the hypothesis that early childhood self-regulation explains unique variance in maladaptive adolescent adjustment, beyond what is accounted for by self-regulation at later ages.

4.7 SUPPLEMENTAL ANALYSES

Estimating the effect of self-regulation on adolescent adjustment over and above the variance explained by background characteristics. The original analyses did not account for the relation between background characteristics and adaptive outcomes. However, as it is evident from the correlations presented in Table 9, adolescent adjustment was significantly correlated with gender, ethnicity, family income, and school readiness. Because the initial models did not separate the effects of background characteristics from the effects of developmental self-regulation, an additional set of analyses were conducted to more clearly isolate the direct contribution of self-regulation on adolescent adjustment, over and above the variance explained by associations between background characteristics and outcomes. These supplementary models regressed the adolescent outcomes onto gender, ethnicity, family income, and school readiness, in addition to self-regulation across development. Thus, research questions 2 and 3 were re-analyzed with the following supplemental models, to further understand how self-regulation contributes to adaptive and maladaptive adjustment in adolescence.

Supplemental Hypothesis 2A. Latent self-regulation from early childhood through adolescence is positively associated with adaptive adolescent adjustment over and above the direct effect of background characteristics.

This supplemental hypothesis was tested with a model that regressed adaptive adjustment onto background characteristics and self-regulation at each age period, to parse any variance in adaptive adjustment that is explained by gender, ethnicity, family income, and school readiness (see Appendix E). The supplemental model provided good fit to the observed data: Satorra-Bentler $\chi^2(171) = 435.904$, $p < .01$; *CFI* = .948; *TLI* = .924; *RMSEA* = .037; *SRMR* = .042. There was one significant path from self-regulation to adaptive adjustment: middle childhood self-regulation predicted academic achievement in adolescence (see Figure 11). There was also a marginal trend for middle childhood self-regulation to predict better psychosocial competency and judgment ($\beta = .403$, $p = .056$). Adolescent self-regulation was marginally related to lower levels of two adaptive outcomes: positive attitudes towards school ($\beta = -.087$, $p = .062$), and psychosocial competency and judgment ($\beta = -.086$, $p = .058$).

In the original set of analyses, multiple indicators of adolescent adaptive adjustment were related to self-regulation at earlier ages. For example, middle childhood self-regulation predicted academic achievement and was marginally related to psychosocial competency and judgment. Early childhood self-regulation predicted positive attitudes towards school, which were also related to lower self-regulation in adolescence.

When the effects of background characteristics on the outcomes were included, a different picture of the effect of developmental self-regulation on adaptive adjustment in adolescence emerged. Most notably in the supplemental model, positive attitudes towards school were no longer predicted by early childhood self-regulation, and the inverse association with

adolescent self-regulation became marginal (β = -.087, p = .062). One trend that did emerge was the relation between psychosocial competency and judgment and lower adolescent self-regulation. Academic achievement was still predicted by middle childhood self-regulation. Middle childhood self-regulation continued to predict psychosocial competency and judgment at a marginal level. Positive peer environments were not associated with self-regulation at any age period, as was the case in the original model.

Therefore, accounting for the direct effect of gender, ethnicity, family income, and school readiness on adaptive adjustment more clearly isolates the effect of developmental self-regulation on these outcomes. In this supplemental analysis, self-regulation significantly predicts only one adaptive outcome in adolescence: academic achievement.

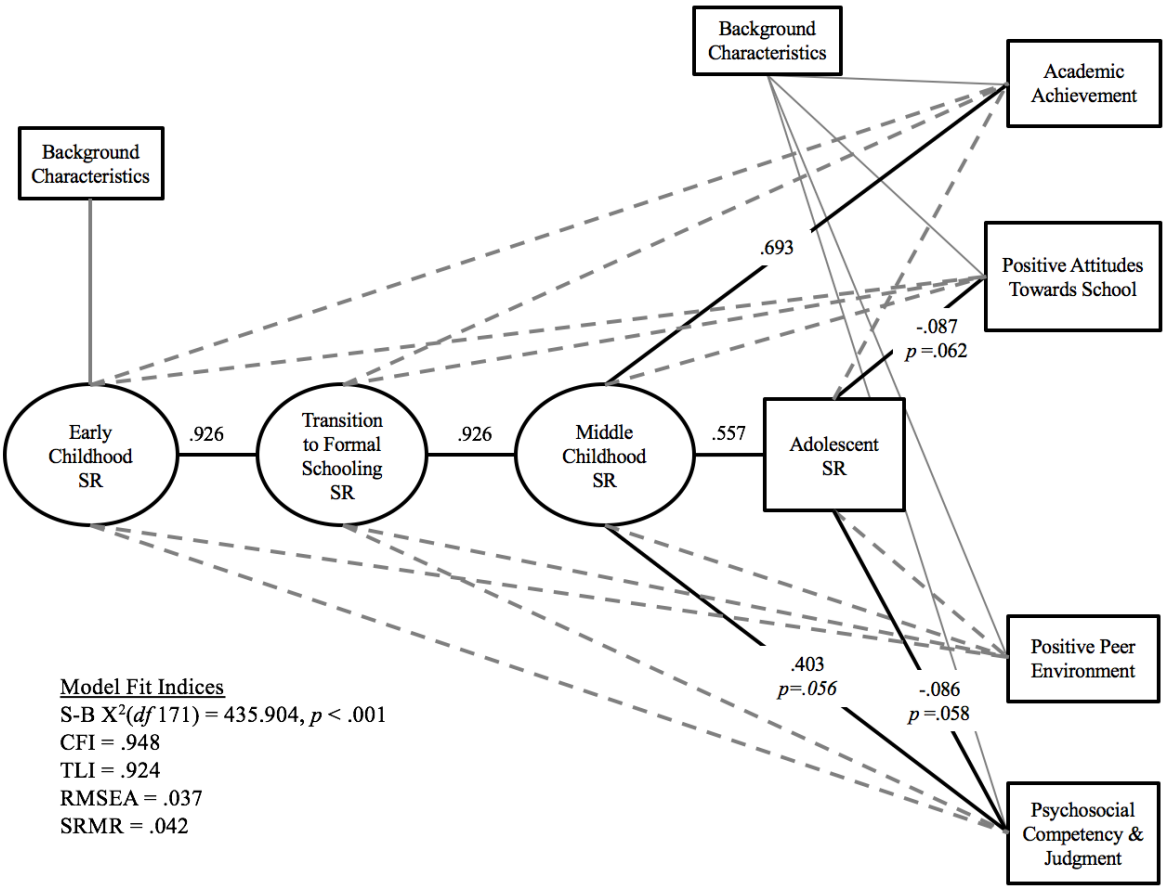

Figure 11. Adaptive Adolescent Adjustment Outcomes Regressed on Background Characteristics and Developmental Self-Regulation

Supplemental Hypothesis 2B. Self-regulation from early childhood through adolescence will be negatively associated with maladaptive adolescent adjustment over and above the direct effect of background characteristics.

Just as adaptive adjustment is directly influenced by background characteristics, it is also likely that *maladaptive* adjustment in adolescence is explained by gender, ethnicity, family income, and school readiness. A supplementary model analyzed the contribution of developmental self-regulation over and above background characteristics, by directly controlling for these indicators on aggressive and antisocial behavior (see Appendix F). The supplemental

model provided good fit to the observed data: Satorra-Bentler $\chi^2(137) = 391.001$, $p < .01$; *CFI* = .934; *TLI* = .911; *RMSEA* = .040; *SRMR* = .044.

In the original test of hypothesis 2b, self-regulation in early childhood predicted less aggressive and antisocial behavior in adolescence. When background characteristics were included directly on the outcome, self-regulation no longer predicted maladaptive adjustment in adolescence (see Figure 12). Thus, according to these results, self-regulation does not account for any additional variance in aggressive and antisocial behavior at age 15, beyond what is already explained by background characteristics.

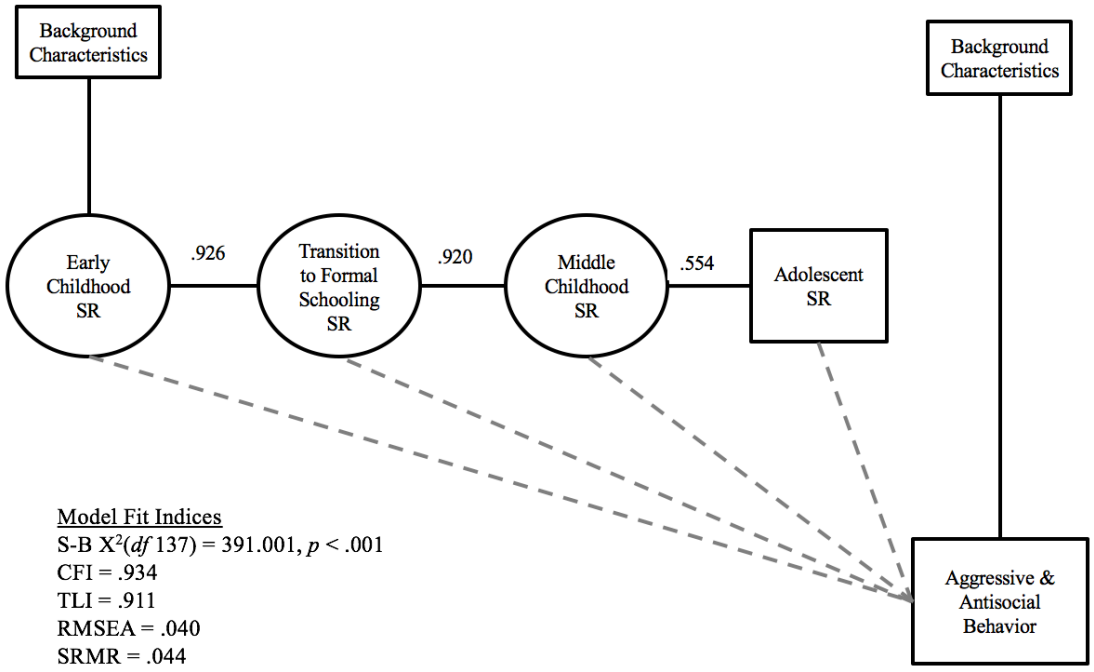

Figure 12. Maladaptive Adolescent Adjustment Outcomes Regressed on Background Characteristics and Developmental Self-Regulation

Supplemental Hypothesis 3A. Early childhood self-regulation will contribute unique variance to adaptive adolescent adjustment over and above self-regulation from the transition to formal schooling through adolescence and the direct effect of background characteristics.

The unique impact of early childhood self-regulation on adolescent adjustment was also tested when adolescent outcomes were regressed directly on background characteristics. A comparison model that omitted paths from early childhood self-regulation to adaptive outcomes was contrasted with the full developmental model (Figure 11), both of which estimated the direct effect of background characteristics on outcomes.

The comparison model provided good fit to the observed data: Satorra-Bentler $\chi^2(173) = 432.924$, $p < .01$; *CFI* = .949; *TLI* = .926; *RMSEA* = .036; *SRMR* = .043 (see Figure 13). The associations between self-regulation and adaptive adjustment in the full developmental model were also evident when paths from early childhood self-regulation were omitted in the comparison model. Specifically, middle childhood self-regulation predicted academic achievement, and was marginally related to psychosocial competency and judgment ($\beta = .735$, and $\beta = .396$ [$p = .055$], respectively). Lower adolescent self-regulation was also moderately related to concurrent positive attitudes towards school ($\beta = -.082$, $p = .076$), and psychosocial competency and judgment ($\beta = -.081$, $p = .078$). Self-regulation did not predict positive peer environment in either the full developmental model or comparison model.

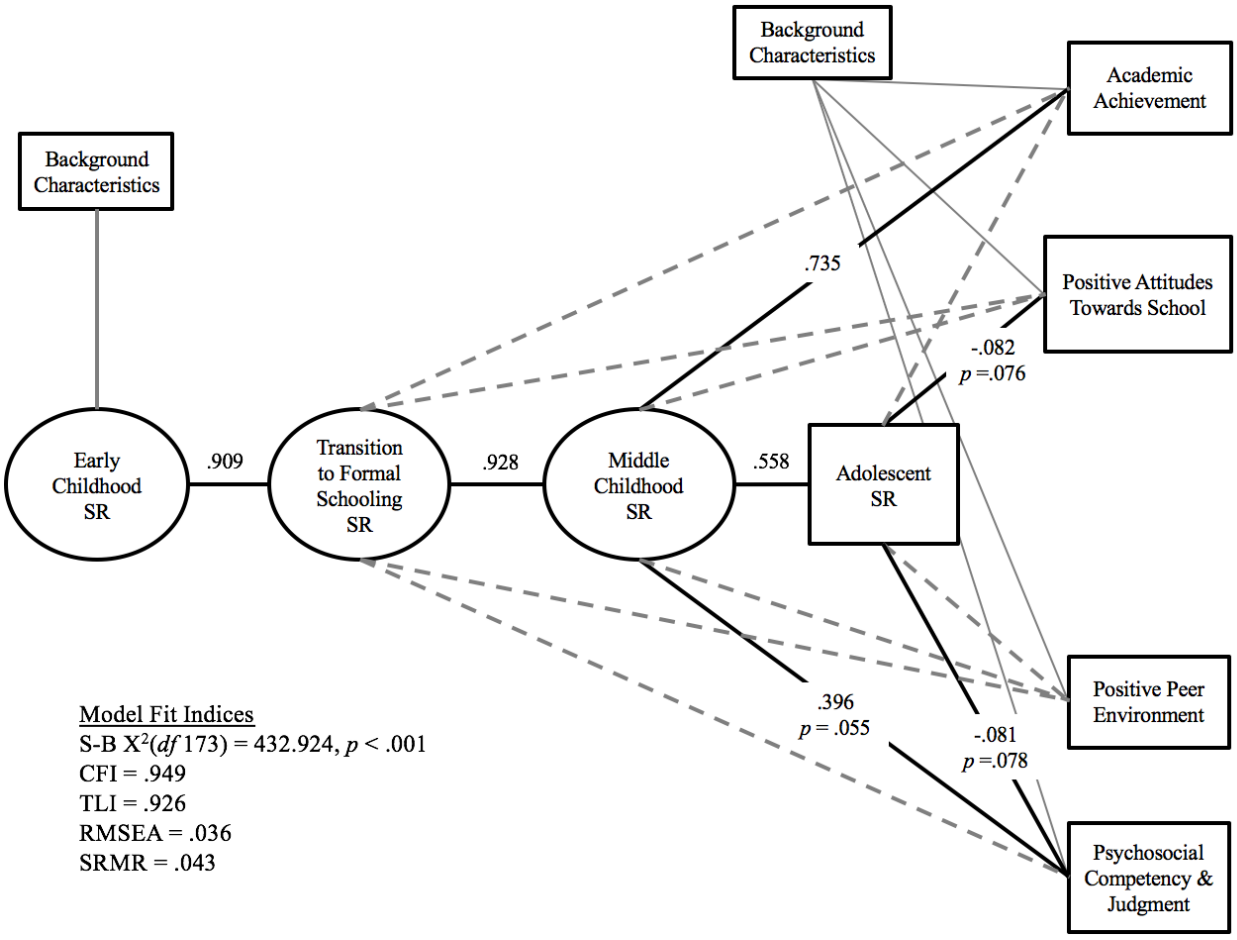

Figure 13. Adaptive Adolescent Adjustment Outcomes Regressed on Background Characteristics and Self-Regulation from Transition to Formal Schooling through Adolescence

A series of model comparisons suggested that omitting paths from early childhood self-regulation did not negatively impact the prediction of adaptive adjustment outcomes. The comparison and full developmental model did not significantly differ in terms of fit, based on the Satorra-Bentler χ^2 difference test: *S-B* χ^2 difference (Δ *df* = 2) = 3.049, *p* = .218. Absolute and incremental fit indices also suggest that the full developmental model and comparison model are very similar (Table 12). Both models similarly accounted for positive attitudes towards school, positive peer environment, and psychosocial competency and judgment. The largest difference

was the prediction of academic achievement, which was better explained by the developmental model (R^2 = .685; top panel) than the comparison model (R^2 = .648; bottom panel).

Table 12. Model Fit Statistics of Developmental Model and Comparison Model of Self-Regulation Predicting Adaptive Adjustment with Outcomes Regressed on Background Characteristics

Model and Adjustment Outcomes	*S-B* χ^2	*CFI*	*TLI*	*RMSEA*	*SRMR*	*AIC*	*ssBIC*	R^2
Developmental Model (Fig. 11)	435.90**	.948	.924	.037	.042	117637	117849	
Academic Achievement								.685
Positive Attitudes Toward School								.052
Positive Peer Environment								.110
Psychosocial Competency & Judgment								.076
Comparison Model (Fig. 13)	432.92**	.949	.926	.036	.043	117631	117838	
Academic Achievement								.648
Positive Attitudes Toward School								.051
Positive Peer Environment								.108
Psychosocial Competency & Judgment								.073

**p<.01

The supplemental analysis estimated the direct effect of background characteristics on adjustment, and demonstrated that omitting the paths from early childhood self-regulation to age 15 outcomes made little difference in predicting these adolescent outcomes. Since early childhood self-regulation did not significantly predict any of the adolescent outcomes in the full developmental model, there was little noticeable change in how well the outcomes were predicted or model fit when these paths were not estimated. In other words, it is not surprising that dropping these non-significant paths did not drastically change the model results.

In sum, supplementary analyses examined the unique contribution of early childhood self-regulation, after accounting for the impact of gender, ethnicity, family income, and school readiness on adaptive adjustment. When the effect of developmental self-regulation was partitioned from other confounding background characteristics, early childhood self-regulation was not a unique predictor of adaptive adjustment beyond self-regulation from the transition to

formal school through adolescence. Although the original analyses suggested that early childhood was a meaningful age period for predicting adolescent adaptive adjustment, this finding was wiped out when background characteristics were included directly on outcomes.

*Supplemental Hypothesis 3B. Early childhood self-regulation will contribute unique variance to maladaptive adolescent adjustment over and above self-regul*ation from the transition to formal schooling through adolescence and the direct effect of background characteristics.

The unique impact of early childhood self-regulation on maladaptive adolescent adjustment was also analyzed with outcomes regressed directly on background characteristics. A comparison model omitted paths from early childhood self-regulation to aggressive and antisocial behavior, and was contrasted with the full developmental model (Figure 12). The comparison model had adequate fit: Satorra-Bentler $\chi^2(138) = 391.596$, $p < .01$; *CFI* = .934; *TLI* = .912; *RMSEA* = .040; *SRMR* = .044 (see Figure 14).

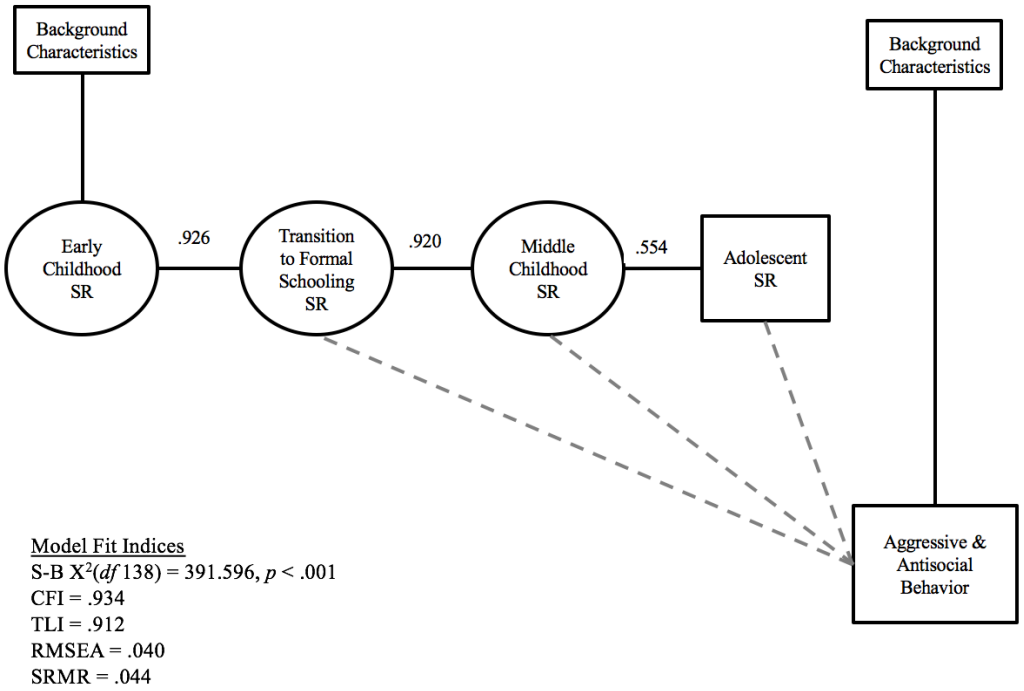

Figure 14. Maladaptive Adolescent Adjustment Outcomes Regressed on Background Characteristics and Self-Regulation from Transition to Formal Schooling through Adolescence

In both the full developmental model and comparison model, no age period of self-regulation predicted aggressive and antisocial behavior in adolescence. Excluding the path from early childhood self-regulation to maladaptive adjustment in adolescence did not adversely impact model fit, based on the Satorra-Bentler χ^2 difference test (*S-B* χ^2 difference [Δ *df* = 1] = .595, *p* = .440), similar fit statistics, and similar proportions of variance explained in aggressive and antisocial behavior (R^2 = .065, and .059, respectively). See Table 13 for model fit statistics of the full developmental model versus the comparison model.

Table 13. Model Fit Statistics of Developmental Model and Comparison Model of Self-Regulation Predicting Maladaptive Adjustment with Outcomes Regressed on Background Characteristics

Model and Adjustment Outcomes	*S-B* χ^2	*CFI*	*TLI*	*RMSEA*	*SRMR*	*AIC*	*ssBIC*	R^2
Developmental Model (Fig. 12)	391.00**	.934	.911	.040	.044	112138	112285	
Aggressive & Antisocial Behavior								.065
Comparison Model (Fig. 14)	391.60**	.934	.912	.040	.044	112137	112282	
Aggressive & Antisocial Behavior								.059

***p*<.01

In the supplemental analyses that include the effect of background characteristics directly on maladaptive adjustment, there was little difference when the path from early childhood self-regulation to aggressive and antisocial behavior was excluded. Since early childhood self-regulation did not significantly predict maladaptive adjustment in adolescence when it was freely estimated, there was no meaningful difference in how well self-regulation predicted maladaptive adjustment when this path was omitted.

When the effect of developmental self-regulation was parsed from the effect of background characteristics on adolescent maladjustment, early childhood self-regulation was not a unique predictor of aggressive and antisocial behavior. In the original analyses, early childhood self-regulation explained additional variance in maladaptive outcomes (beyond self-regulation at later ages); this finding was not supported when the direct effect of background characteristics on maladaptive outcomes were considered.

5.0 DISCUSSION

5.1 SUMMARY

Three research aims were explored in the present study: 1) the developmental stability of self-regulation from early childhood, the transition to formal schooling, middle childhood, and adolescence; 2) how variability in self-regulation across development accounts for adaptive and maladaptive adjustment in adolescence; and 3) the unique impact of very early indicators of self-regulation when predicting adolescent adjustment. The last two research questions were also analyzed with supplemental models that accounted for the influence of background characteristics on adjustment, to identify the relation between self-regulation and adolescent outcomes independent of gender, ethnicity, school readiness, and family income.

Results demonstrated that latent factors of self-regulation in early childhood, during the transition to formal schooling, and middle childhood are robust and stable across this developmental period. Performance on laboratory tasks administered during the age 15 interview did not sufficiently represent an underlying capacity to self-regulate, in contrast to the three earlier childhood periods. Therefore, a composite score of self-regulation in adolescence was calculated in lieu of a latent factor. In general, children maintained their rank-order of self-regulation from middle childhood to adolescence, although to a lesser degree than at earlier developmental periods. Individual variability in self-regulation predicted two indicators of

adaptive adjustment in adolescence: positive attitudes towards school and academic achievement. After accounting for the direct effect of background characteristics on adjustment, however, self-regulation continued to predict only academic achievement. With regard to maladaptive adjustment, self-regulation was associated with less aggressive and antisocial behavior in adolescence, although this relation was not significant when maladaptive adjustment was also regressed onto background characteristics.

Very early indicators of self-regulation are meaningful for both adaptive and maladaptive adjustment in adolescence. Early childhood self-regulation explained unique variance in positive attitudes towards school and aggressive and antisocial behavior at age 15, beyond what was already explained by self-regulation measured during the transition to formal schooling, middle childhood, and adolescence. When accounting for the effect of background characteristics on adjustment, however, early childhood measures of self-regulation did not add to the prediction of adolescent adjustment. Thus, self-regulation acquired in early childhood lays the foundation for developing good self-regulation skills later in development, and ultimately, for successful functioning in domains that rely on the ability to monitor and regulate behavior. Self-regulation, especially in early childhood, however, is also highly correlated with background characteristics measured at early ages. Any unique variance in adolescent adjustment that was explained by early self-regulation was attenuated after considering how gender, ethnicity, family income, and school readiness directly account for adolescent adjustment. So, individual variability in early childhood self-regulation is important for predicting later adjustment, but not more so than various stable and time-varying background characteristics.

5.2 DEVELOPMENTAL STABILITY OF SELF-REGULATION

Performance on tasks administered in the laboratory proved a reliable method for measuring self-regulation across childhood and adolescence. This supports a growing body of research on the validity of objective behavioral assessments of self-regulation (in contrast to survey measures), even though laboratory tasks tap into different skills and use different paradigms depending on the subject's age (e.g., Duckworth & Kern, 2011). The laboratory tasks in the present study tested developmentally appropriate components of self-regulation, with the primary focus of tasks in early childhood being on effortful control skills, while increasingly advanced cognitive executive functioning skills were measured at older ages.

As predicted, an underlying capacity to regulate behavior was reflected in how well children performed on laboratory tasks. Specifically, a latent factor of self-regulation was derived for each of the three younger age periods: early childhood, during the transition to formal schooling, and middle childhood. It is particularly noteworthy that these measures coalesced to form robust latent indicators, given that two of the three childhood factors spanned a period of one and a half years, and two years, respectively. Early childhood self-regulation included measures of delayed gratification, impulse control, working memory and sustained attention when children were between 36 and 54 months old. That a child's ability to resist eating a tempting snack when they were three years old loaded onto the same factor as a measure of their working memory when they were four and a half years old is impressive, given the remarkable change that occurs during this year and half in early childhood. The same is true for the middle childhood indicator. Laboratory tasks of planning and problem solving, working memory, and sustained attention were administered in 3rd, 4th, and 5th grade, and they all contributed to one latent self-regulation factor. This speaks to the validity of the selected laboratory paradigms that

were able to capture planning and problem solving abilities in 3rd grade and again in 5th grade, even in light of the cognitive gains typically demonstrated across this two-year period.

One finding that was not in line with the hypothesis was that behavioral tasks administered during the oldest interview did not load onto a latent factor of adolescent self-regulation. A composite score of self-regulation was calculated in lieu of a latent factor at age 15. The adolescent composite was created from two modestly correlated measures of working memory (OSPAN) and planning (Tower of Hanoi). The task that did not statistically cohere with the others measured impulsivity and risk-taking (BART), and was subsequently excluded from analyses. But why would impulse control, which is considered an important aspect of self-regulation during adolescence, not correlate with working memory, planning and problem solving? It is possible that working memory and planning represent a "cold" cognitive dimension of executive functioning, while impulsivity, risk-taking, and sensation-seeking align with "hot" regulatory skills that depend on context or emotional state. Support for such a dual-systems model of adolescent self-regulation has been set forth in previous literature, in which cognitive control and reasoning skills develop on a different trajectory than socio-emotional capacities such as psychosocial maturity, reward processing, and impulse control (Steinberg, 2007). Therefore, it stands to reason that impulse control would not load onto the same underlying factor of adolescent self-regulation, since it represents a type of executive functioning that is developmentally distinct from cognitive control, working memory, and planning.

Self-regulation was largely stable from childhood through adolescence. This suggests that children who exhibited high levels of self-regulation in early childhood, such as better delay of gratification and impulse control, were likely to also show high levels of self-regulation during the transition to formal schooling (e.g., sustained attention), in middle childhood (e.g.,

working memory), and as a teenager (e.g., planning). The rank-order stability of self-regulation was extremely high from early childhood through middle childhood. Self-regulation from middle childhood to adolescence was modestly stable (β = .55) compared to earlier developmental transitions, yet still significant.

There are various theoretical and methodological factors which could explain the relatively weaker stability in self-regulation from middle childhood to adolescence. For instance, there was a longer time between the middle childhood and adolescent visits (~5 years) than between earlier measurement periods; many cognitive, biological, and social changes occur during these years, the impact of which are not evaluated in the current study until age 15. It is also possible that childhood self-regulation measures included a more comprehensive assessment of various executive functions, while the measures of self-regulation in adolescence only account for one domain, that of cognitive control. A more inclusive set of tasks assessing executive functioning in adolescence may have been more strongly related to middle childhood self-regulation. Thus, the prediction from middle childhood to adolescence may be limited by methodological constraints, since latent factors were derived across childhood, but only a composite score could be used to represent self-regulation in adolescence.

Taken together, these findings contribute to existing literature that highlights the validity of behavioral task performance as a proxy for self-regulation skills. Rank-order stability of self-regulation over time was demonstrated with developmentally salient measures, with tasks in younger years focusing on effortful control skills such as impulse control, and older ages focusing on cognitive executive functioning capacities such as working memory and sustained attention. That behavioral tasks in adolescence did not load onto one latent factor of self-regulation underscores the importance of understanding precisely which skills represent self-

regulation across development. Despite the variability of specific tasks administered at different interviews, there was marked stability over time, demonstrating that children's self-regulation relative to their peers remained largely consistent across childhood and into adolescence.

The strong developmental stability speaks to the cascading nature of self-regulation skills building upon themselves over time. Children must master basic, fundamental aspects of self-regulation early in development in order to acquire more advanced executive functions later on. Yet, the importance of self-regulation in early childhood is two-fold, as appropriately regulating emotion and behavior will influence the reaction children elicit from others and their environment (Rothbart & Bates, 1998). The complex, transactional relationship between a child and their environment means the experiences and expectations that are established at a very young age continue to affect how children adapt to new situations over time (e.g., Masten & Coatsworth, 1998). Self-regulation is crucial for navigating the novel interpersonal, academic, and behavioral demands when children transition to a structured formal school setting (Phillips et al., 2006). Missing key self-regulation 'milestones' early on can make it increasingly difficult to catch up to peers, potentially placing children on a maladaptive trajectory. The gap in relative self-regulation appears to widen after children begin elementary school (McClelland, Acock, & Morrison, 2006). Those who have mastered the control of their emotions and behaviors are likely to continue to practice and acquire good self-regulation skills, while poorly-regulated children may tend to elicit negative reactions from peers, parents, and teachers that reinforce low levels of self-regulation (R. J. R. Blair, 2010; McClelland et al., 2006; Rimm-Kaufman, Pianta, & Cox, 2000). The compounding effects of early self-regulation skills and experiences may then influence behavior later childhood and adolescence. Contexts, demands, and manifestations of self-regulation change with age, but the transactional effect that a child has on his/her

environment remains. Thus, it is not surprising that children's rank-order of self-regulation relative to peers is largely consistent across childhood and adolescence, even though different skills are tested across development.

5.3 THE EFFECT OF SELF-REGULATION ON ADOLESCENT ADJUSTMENT

The extent to which self-regulation predicts adolescent adjustment varies based on the outcome. Some indicators of adjustment were associated with self-regulation in early childhood, while others were related to self-regulation in middle childhood. Regarding adaptive adjustment, higher levels of self-regulation in early childhood predicted positive attitudes towards school (i.e., school attachment, teacher bonding) in adolescence. Higher levels of self-regulation in middle childhood predicted academic achievement and were marginally related to psychosocial competency and judgment in adolescence. The association between early childhood self-regulation and positive attitudes towards school in adolescence is in line with previous findings. Children with better self-regulation skills in early childhood are likely to establish high-quality relationships with their teachers, attachment to school, and academic engagement in the early school years (e.g., Hamre & Pianta, 2001; Myers & Morris, 2009; Rudasill & Rimm-Kaufman, 2009; Silva et al., 2011; Silver et al., 2005). It is reasonable that the association between early childhood self-regulation and positive attitudes towards school would extend into adolescence. Children who display good self-regulation skills in preschool are better able to sit still, follow directions, and stay on-task in a classroom setting. All of these can facilitate better reactions from and relationships with teachers, thus creating a supportive educational environment, positive attitudes toward learning, and attachment to school. Children who develop strong bonds

to teachers and school early on are also likely to continue to have positive attitudes towards school over time. Few studies, if any, have explicitly tested how self-regulation measured at various points across development predicts attitudes towards school in adolescence. The current study adds to existing literature by identifying when in development individual differences in self-regulation best predict positive attitudes toward school. Self-regulation in early childhood appears to explain adolescent's positive attitudes toward school better than self-regulation measured during older ages. Individual variability in early self-regulation, then, goes on to influence how attached youth feel to their teachers and their school, as evidenced by the positive effect of self-regulation on this adjustment domain a decade later.

The link between middle childhood self-regulation and academic achievement supports existing findings indicating that better executive functioning in middle childhood (e.g., working memory, sustained attention) predicts academic performance and achievement in adolescence (e.g., Harms et al., 2014). The present study expands on this by exploring how academic achievement is predicted by self-regulation measured at multiple points across development. Of the four age periods, self-regulation during middle childhood was the best predictor of adolescent academic achievement. This aligns with a developmental perspective, since the self-regulation skills that are the primary focus of middle childhood incorporate cognitive executive functions such as working memory, planning and problem solving, and sustained attention. These executive functions undergird the competencies required for adolescent academic achievement. In other words, the self-regulation skills tested during the middle childhood interviews appear to be more important for successful academic achievement than the self-regulation skills tested during earlier interviews (e.g., effortful control).

A stronger association between self-regulation and psychosocial competency and judgment was expected based on literature that connects childhood self-regulation with outcomes associated with psychosocial competency and judgment. For example, Eisenberg and colleagues (2014) cite several empirical studies that show a positive link between childhood self-regulation and higher levels of conscientiousness in adolescence and adulthood, including responsibility, maturity, perseverance, and orderliness. All of these outcomes are theoretically related to components of the psychosocial competency and judgment composite used in the current study. Despite these considerations, data in the current study did not find a significant relation between self-regulation across development and adolescent psychosocial competency and judgment.

Self-regulation also predicted maladaptive adjustment. Youth who exhibited greater self-regulation in early childhood were less likely to report aggressive and antisocial behavior in adolescence. Specifically, children who demonstrated greater effortful control on a combination of tasks measuring delay of gratification, impulse control, and sustained attention when they were 36 to 54 months old showed significantly lower levels of aggression, externalizing behavior, and risk-taking themselves or by their friends when they were 15. Other studies have reported a similar inverse relation between teenagers' executive functioning and aggression, problem behavior, and affiliation with delinquent peers (e.g., Buckner et al., 2009; Giancola et al., 1998; Giancola et al., 1996). The strong relation between early childhood self-regulation and maladaptive adjustment in adolescence reflects the long-term consequences of very early indicators of poor self-regulation. Moffitt's seminal study of persistent antisocial behavior across the lifespan (Moffitt, 1993), the Dunedin birth cohort study (Caspi, 2000; Moffitt et al., 2011), and many others highlight how early difficulties regulating behavior can promote delinquency, aggression, and externalizing problems over time. Many studies have focused on

how self-regulation measured at a single time point is related to maladaptive adjustment. The current study is unique in that it tests the relative predictive strength of self-regulation *across* development on adolescent aggressive and antisocial behavior. As such, early childhood self-regulation is a better predictor of maladaptive adolescent adjustment than self-regulation measured at later ages.

Taken together, these results are consistent with a developmental cascade framework of self-regulation (e.g., Masten & Cicchetti, 2010; Masten & Coatsworth, 1998). Compared to the other age periods, self-regulation during early childhood accounts for the most variance in positive attitudes toward school and aggressive and antisocial behavior in adolescence, while self-regulation during middle childhood is most salient for predicting academic achievement. Early self-regulation skills are uniquely important for predicting positive attitudes towards school and aggressive and antisocial behavior, even beyond self-regulation at later ages. These two domains of functioning involve social, emotional, and interpersonal skills, which are reminiscent of the self-regulation milestones of early childhood: effortful control, impulse control, and emotion regulation. How successful children are at acquiring these skills in early can set children on a path that has implications for various types of functioning, including behavioral adjustment, interpersonal relationships, and school attachment (e.g., Calkins & Howse, 2004; Degnan, Calkins, Keane, & Hill-Soderlund, 2008). Young children who have difficulty controlling their impulses and behaviors may find it hard to adjust to the structure of a classroom environment, expectations from teachers, or forming quality friendships – especially with well-regulated children who can serve as a positive influence (e.g., Calkins & Hill, 2007; Thompson & Meyer, 2007). Stated another way, self-regulation skills acquired before children transition to formal schooling are the building blocks for later markers of interpersonal success

that include developing a positive attitude towards teachers and school, and limiting aggressive and antisocial behavior or affiliating with deviant peers in adolescence.

When predicting academic achievement, however, the most salient developmental period of self-regulation was during middle childhood. The skills needed for academic achievement are closely aligned with the cognitive executive functions that are the developmental focus of middle childhood: working memory, sustained attention, planning and problem solving (e.g., Denckla, 1989; Kirkham et al., 2003). For instance, the capacity to remember directions, apply rules and problem-solving strategies, disregard irrelevant information, and stay on-task are all contributing factors for academic success, which the present study measures as participants' ability to comprehend a written passage and solve a series of applied math problems (Woodcock et al., 1990). While early self-regulation skills serve as the foundation for later abilities, this finding suggests that executive functioning in middle childhood best accounts for variability in adolescent academic achievement.

Adolescent self-regulation also correlated with some concurrent aspects of adjustment. Adolescent self-regulation composite scores were linked with positive attitudes towards school, but not in the expected direction. Based on prior research (e.g., Tangney, Baumeister, & Boone, 2004), it was hypothesized that teens who exhibit greater self-regulation at age 15 would report more adaptive adjustment during the same interview. However, the current findings suggest that teens who performed better on adolescent executive functioning tasks tasks (e.g., working memory, planning and problem solving) were *less* likely to report positive attitudes towards school. There is evidence that socio-emotional abilities and cognitive, intellectual abilities follow two distinct developmental trajectories. Skill in one of these domains does not necessarily translate to the other, and a 'gap' in these relative abilities is not uncommon,

particularly in adolescence (Steinberg, 2010; Steinberg et al., 2009). Although a teen might demonstrate proficient executive functioning, they may not exhibit the same proficiency in socio-emotional domains, such as bonding with teachers or school attachment. Teens who are more adept at executive functioning tasks may be less reliant on the interpersonal, social bonds with teachers or school which comprise this domain of functioning. Conversely, teens who exhibit relatively poor self-regulation may be more heavily dependent on, and invested in the socio-emotional aspects of school, as a way of compensating for the intellectual components of academic success and achievement. Indeed, one large study of teens found that school engagement can be separated into affective (i.e., school attachment), behavioral (i.e., school attendance and participation), and cognitive (i.e., intellectual competency, applying self-regulation strategies to achieve task-oriented goals) dimensions (Archambault, Janosz, Morizot, & Pagani, 2009). In this study, the majority of youth reported relatively high levels of behavioral and cognitive engagement (i.e., behavioral self-regulation and cognitive executive functioning), but lower levels of affective engagement. Many experienced disengagement from school across mid-adolescence, in that they continued to attend class, comply with rules, and so on, but their commitment to school dropped significantly from age 12 to age 16. Therefore, adolescents may exhibit good cognitive self-regulation skills, but this may not manifest in a positive attitude toward school or teachers. The findings from Archambault et al (2009), and Steinberg et al's (2009) dual systems model of intellectual versus socio-emotional development, support the current findings that more highly skilled and well-regulated youth may report less motivation, attachment, or investment in school during adolescence (and vice versa).

Alternatively, the inverse relation between self-regulation and positive attitudes towards school in adolescence might be an artifact of the measurement of adolescent self-regulation.

Similar to concerns that were cited regarding the stability of self-regulation (see previous section) may limit the prediction of adolescent self-regulation to certain types of adjustment. Aspects of "hot" self-regulation, such as impulse control or sensation seeking, that were not included in the adolescent composite might better map onto socio-emotional adjustment exhibited in a school or peer setting (i.e., positive attitudes towards school or positive peer environments). Finally, directionality cannot be inferred since positive attitudes towards school were measured at the same time as adolescent self-regulation. Therefore, it is unclear whether a teen's self-regulation influences how they feel about school, or whether attitudes towards school somehow impact performance on laboratory tasks of self-regulation.

Furthermore, self-regulation at each age period did not uniquely contribute to adolescent adjustment, as was expected. When including measures of self-regulation at each of the four age periods, positive attitudes towards school were predicted by self-regulation in early childhood and (inversely) in adolescence. Academic achievement and aggressive and antisocial behavior were each only predicted by self-regulation in early childhood. That said, it was not necessary to test the relative strength from each developmental period to adolescent adjustment. It is not that self-regulation during each age period does not independently predict adjustment on its own. Instead, when including measures of self-regulation at each of the four time points which are all highly correlated, only the age period(s) that accounts for the most relative variance in outcomes was statistically significant. This is a by-product of the strong stability of self-regulation over time. After accounting for self-regulation at one point in childhood, not much explanatory power was gained by including self-regulation at other periods during childhood. To illustrate, self-regulation during the transition to formal schooling did not significantly predict any type of adjustment, but that is not to say that self-regulation in first grade is inconsequential. Rather,

individual variability in self-regulation during the transition to formal schooling is already somewhat included in assessments of self-regulation at other ages.

Supplemental analyses were conducted to disentangle the effects of self-regulation from related background characteristics when predicting adolescent adjustment. By accounting for the direct effect of gender, ethnicity, school readiness, and family income on adolescent adjustment, overlapping variance between these covariates and self-regulation was partialled out. Therefore, any significant paths represented the effect of self-regulation on adjustment independent of statistically and theoretically related background characteristics (see Moffitt et al., 2011). In this case, self-regulation significantly predicted only one adjustment outcome over and above controls for background characteristics: middle childhood self-regulation predicted adolescent academic achievement. Results from the supplemental models suggest that some background characteristics are more informative for particular domains of adjustment. Academic achievement was significantly predicted by gender, family income, and school readiness – all in the expected direction. Positive attitudes towards school were predicted by each of the four background characteristics. Aggressive and antisocial behavior was related to gender, ethnicity, and family income measured in early childhood.

The key finding is that regressing adjustment on background characteristics and self-regulation weakened the statistical relations between self-regulation and adjustment. Background characteristics were highly correlated with early childhood self-regulation, so when shared variance between these two sets of predictors was attributed to background characteristics, the significant relations between early childhood self-regulation and later adjustment were attenuated. Conceptually, this suggests that individual variability in early self-regulation does predict various domains of adolescent adjustment, but not more than other

background characteristics that are evident in early childhood. Early childhood self-regulation predicted positive attitudes towards school and aggressive and antisocial behavior in adolescence, but not when also considering how these outcomes vary based on gender, ethnicity, school readiness, and family income.

Specifically, gender and family income predicted academic achievement, positive attitudes towards school, and aggressive and antisocial behavior in adolescence. Ethnicity was significantly related to positive attitudes towards school and aggressive and antisocial behavior. School readiness was a particularly strong predictor of academic achievement and positive attitudes towards school when outcomes were regressed directly on background characteristics. After accounting for how these largely stable background characteristics explain adolescent adjustment, including measures of children's performance on laboratory self-regulation tasks did not add much in terms of predicting adjustment.

Altogether, these findings highlight the importance of early childhood as a developmental period. Early self-regulation skills and background characteristics overlap and collectively contribute to how prepared a young child is when they enter formal schooling (Birch & Ladd, 1998; Eisenberg, Valiente, et al., 2010; Montroy, Bowles, Skibbe, & Foster, 2014; Williford, Whittaker, Vitiello, & Downer, 2013). School readiness was measured by the Bracken Basic Concepts Scale when the participant was 36 months old. This assessment of cognitive ability is likely also tapping into characteristics and environmental inputs that are relevant for developing self-regulation, such as resources in the home, environmental supports, skills and habits reinforced by parents, exposure to reading, and so forth. The school readiness measure inherently overlaps with self-regulation, since the Bracken requires that a child exert basic behavioral and attentional control when completing the task. Including such highly related

background characteristics, therefore, may have limited the prediction from self-regulation to outcomes (e.g., academic achievement and positive attitudes towards school). In addition, any measure of school readiness will arguably contain not only some elements of self-regulation, but also of cognitive functioning. Therefore, the overlap between measures of school readiness and self-regulation in the present study should be taken into account when interpreting these results.

Thus, it is not simply self-regulation skills such as impulse control, but also the cognitive aspects of school readiness, and other background characteristics that set the stage for successful adjustment during the transition to formal schooling. It is important to consider all contributing factors, as high levels of behavioral self-regulation during this critical transition increases the likelihood of having healthy interactions with peers and teachers, learning appropriate strategies for classroom procedures, and acquiring information in an academic setting. These variables coalesce to influence later self-regulation, which cascades onto behavioral functioning, academic success, and various other domains of functioning over time.

5.4 UNIQUE IMPACT OF EARLY CHILDHOOD SELF-REGULATION ON ADOLESCENT ADJUSTMENT

The final research aim was to examine the unique role early childhood self-regulation plays in later adaptive and maladaptive adjustment. It was hypothesized that very early indicators of self-regulation explain additional variance in adolescent adjustment, beyond what is explained by self-regulation at later ages. Results partially supported the hypothesis, as including measures of self-regulation in early childhood improved the prediction of some, but not all, adjustment

outcomes. Early childhood self-regulation uniquely explained two adolescent outcomes: positive attitudes towards school and aggressive and antisocial behavior.

When measures of early childhood self-regulation were omitted, models accounted for less variance in these outcomes. In comparison models that excluded indicators of self-regulation in early childhood, positive attitudes towards school were inversely related to concurrent adolescent self-regulation but no prior period; self-regulation during the transition to formal schooling was marginally related to less aggressive and antisocial behavior. Including early childhood self-regulation improved model fit and accounted for more variance in outcomes, demonstrating that early indicators of self-regulation uniquely explain positive attitudes towards school and aggressive and antisocial behavior in adolescence. These results are consistent with existing literature on the importance of early childhood self-regulation exhibited for later adjustment, since mastering effortful control skills lays the foundation for more advanced executive functioning and subsequent adaptive adjustment (e.g., Calkins & Fox, 2002; DeLisi & Vaughn, 2014; Masten & Cicchetti, 2010; Masten & Coatsworth, 1998).

There are practical implications for these results. If individual differences in early childhood self-regulation uniquely explain adaptive functioning a decade later, this could reveal an important window for intervention. Early childhood self-regulation predicting positive attitudes towards school and aggressive and antisocial behavior at age 15 underscores the theoretical rationale of recent programs and interventions aimed at promoting childhood self-regulation to ultimately improve later adjustment (Diamond & Lee, 2011; Flook, Goldberg, Pinger, & Davidson, 2015; Schonert-Reichl et al., 2015). In this fairly nascent field of research, the effectiveness of these programs across domains of adjustment is yet to be seen. Based on the

current findings, some types of adjustment may be better explained by more proximal self-regulation measures, in contrast to early childhood.

Per findings from supplemental analyses, the unique prediction from self-regulation in early childhood was weakened by regressing adjustment outcomes directly on gender, ethnicity, school readiness, and family income. In the models that accounted for the influence of background characteristics on adjustment, omitting measures of self-regulation in early childhood did not alter how well any of the adaptive or maladaptive outcomes were predicted. It is not surprising that model results did not change when early childhood self-regulation was included or not, since early childhood was unrelated to adolescent adjustment after these outcomes were regressed onto gender, ethnicity, school readiness, and family income. Any effect of early childhood self-regulation seemed to be suppressed, since accounting for the effects of background characteristics on adjustment left little variability to be explained by self-regulation.

These results are inconsistent with those reported by Moffitt and colleagues (2011) in their study of childhood self-control and various adulthood outcomes. In their longitudinal design from the Dunedin study, self-control in childhood predicted various types of maladjustment at age 32, including financial instability, substance abuse, and criminal convictions. The effect of childhood self-control held even after controlling for select background characteristics such as social class and IQ. There are several reasons why childhood self-regulation predicted adjustment even beyond background characteristics in Moffitt et al, yet not in the current study. Self-control in the Dunedin sample was a composite of variables measured between the ages of 3 and 11 years old, which is a much longer developmental span than any of the age periods in the current study. Social class was averaged from birth to 11

years, and IQ was averaged across age 7, 9, and 11 interviews. These are measured later than the background characteristics in the present study (when children were 36-54 months old). Since background characteristics were measured concurrently with early childhood self-regulation, there is likely more shared variance with self-regulation than in the Dunedin sample.

Aside from the statistical variance shared between background characteristics and early childhood self-regulation, there are theoretical reasons that could explain the conflicting results. It is possible that background characteristics influence components of self-regulation differently across development (Vandenbroucke et al., 2015). While the impact of background characteristics on executive functioning is often tested in early childhood (e.g., Bernier, Carlson, & Whipple, 2010; Lengua et al., 2014; Rhoades, Warren, Domitrovich, & Greenberg, 2011), these covariates may have a weaker influence later in childhood, and become more relevant again during the transition to adolescence (Zelazo & Carlson, 2012). Although gender and ethnicity are expected to be stable across development, other indicators such as intelligence and socioeconomic status can vary over time. The current study captures early variability that is likely to manifest in later developing self-regulation skills and functioning. Later assessments of intelligence and cognitive capacity measured – say, in adolescence – would include cognitive gains made across childhood, in contrast to early skills that continue to influence development after the transition to formal schooling. Furthermore, using family income as a proxy for SES may have a different impact in early years versus in adolescence, when teens are more independent, can be gainfully employed, earn their own money, and so on. Background characteristics that are present during the youngest years contribute to early self-regulation skills, the influence a child has on their environment, and a range of learned responses. More proximal indicators may not be able to account for these cascading effects. Thus, the effects of early

childhood self-regulation might not have been diminished if background characteristics in the current study were measured later in development.

It is important to analyze self-regulation independent of these related covariates in order to have a true understanding of the interplay between executive functioning and adjustment. Background characteristics can be confounded with one another, and with proxies of self-regulation. From a policy perspective, controlling for other influences on adjustment allows us to isolate the effect of self-regulation, and predict the efficacy of programs targeting self-regulation and how they might impact later adjustment. Based on the current findings, early childhood is not a unique developmental period for self-regulation to predict any domain of adolescent adjustment after accounting for background characteristics. While it is important to statistically hold constant the effects of background characteristics, it is also of practical use to understand results from the initial analyses.

Altogether, it is evident that self-regulation in early childhood is influential for later functioning. Effortful control of behavior in early years impacts the self-regulation skills that develop during the transition to schooling, later in childhood, and adolescence (Howse et al., 2003; McClelland et al., 2013; Ursache et al., 2013). Basic, rudimentary skills must be established before children can focus on acquiring more advanced forms of self-regulation (Eisenberg et al., 2007). This is apparent in the strong stability of rank-order self-regulation. Children who demonstrate high levels of effortful control are also likely to demonstrate high levels of cognitive executive functioning across childhood and executive control in adolescence.

The cascading effects of early childhood self-regulation are also evident when assessing adolescent adjustment, particularly for domains of functioning that involve a degree of self-monitoring and control. Early childhood self-regulation skills uniquely predict adjustment that

relies on social and emotional competency in adolescence (i.e., positive attitudes towards school and aggressive and antisocial behavior), even beyond self-regulation measured at older ages. Very early indicators of self-regulation influence cognitive functioning, social adjustment, and behavior. Children with good self-regulation skills can better adapt to the new intellectual, social, and environmental challenges of a formal school setting. These children are likely to develop and maintain positive relationships with teachers and peers, which promotes higher levels of adaptive behavior, and academic engagement and motivation over time (C. Blair & Raver, 2012; Hamre & Pianta, 2001; Silva et al., 2011). Current results support this conceptual framework, as children who demonstrate better effortful control of their behavior in early childhood were likely to report positive attitudes towards school, and less maladaptive behavior in adolescence. High levels of self-regulation in early childhood promoted executive functioning in middle childhood, which then predicted academic achievement in adolescence. Thus, how well a young child can control his/her behavior is vital for later functioning.

However, individual variability in early childhood self-regulation was not more predictive of adolescent adjustment than background characteristics also measured in early years. It appears that other stable traits (i.e., gender, ethnicity), environmental factors, educational access, and resources (i.e., family income, school readiness) better inform adolescents' relative functioning and adjustment. Although self-regulation in early childhood uniquely accounted for some domains of adolescent functioning, these relations were weakened after considering how these outcomes vary by background characteristics. Altogether, early self-regulation skills and background characteristics contribute to children's successful adjustment to school. These abilities and experiences cascade onto the development of later behavioral and cognitive aspects of self-regulation, behavioral functioning, and academic success a decade later.

5.5 LIMITATIONS AND FUTURE DIRECTIONS

The current study has many methodological strengths, including a longitudinal design, objective behavioral measures of self-regulation, and sophisticated analytical techniques, yet there are several limitations to note. Results should be interpreted in light of the following considerations.

First, results may not be widely generalized to all youth. While the NICHD SECCYD sample was large, it was not nationally representative, so results are only applicable for comparable samples. Although there was relatively little missing data (74% of families completed the final interview), it is likely that those who did not complete the entire study were also those at highest risk for various negative outcomes. Prior literature suggests that those most likely to engage in risky behavior also have the highest attrition rates in longitudinal studies (Thornberry, Bjerregaard, & Miles, 1993; Zand et al., 2006). Missing data was addressed with the Full-Information Maximum Likelihood (FIML) statistical technique, which estimates missing parameters for an individual, based on what is known from individuals with available data. If the 'riskiest' youth were indeed those who dropped out of later interviews, estimates would be biased towards lower-risk youth. The current sample did show low variability in risk behavior compared to other nationally representative studies of adolescent risk-taking (Kann, Olsen, & McManus, 2015; Sadeh & Baskin-Sommers, 2016). Future research should include more at-risk youth to understand how self-regulation predicts adjustment in diverse samples.

Second, self-regulation in adolescence was based on a composite score of two performance tasks, because a latent factor of self-regulation could not be derived for this age period. The dearth of laboratory tasks that measured "hot" executive functioning, such as risk-taking propensity or sensation seeking, in adolescence limited the ability to include this domain of self-regulation during this age period. It stands to reason that latent factors of self-regulation

in childhood were more comprehensive measures of varied executive functioning, and adolescent self-regulation was restricted to only one domain (i.e., cognitive control). If more sensitive behavioral tasks were administered during the age 15 interview, we may expect one (if not two) latent factor of self-regulation to be derived in adolescence, as well as a stronger prediction from middle childhood to adolescence. It is also possible that behavioral tasks are less accurate in modeling real-world behavior in older youth as compared to younger youth, or that certain executive functions are better ascertained in a laboratory setting that is isolated from various social and environmental factors (e.g., OSPAN and Tower of Hanoi can better measure working memory and planning, but the BART may not a good method of assessing real-world risk-taking). We would expect risk-taking propensity during the BART to correlate with real-world behavior based on previous research which demonstrated moderately strong associations between performance on this task and real-world risk-taking in adolescents (Lejuez et al., 2007).

Nevertheless, using a composite score instead of a latent factor introduces methodological concerns. In SEM, composite scores and latent factors are similar in that they both represent an unmeasured quality or characteristic, but composite scores assume perfect measurement, while latent factors allow for error variance. Using a composite score versus a latent factor can undermine the predictive power of adolescent self-regulation (Mackenzie, 2001). This statistical consideration could explain the unexpected relation of higher levels of adolescent self-regulation correlating with lower levels of reported adjustment. Thus, the reader should consider these limitations when interpreting the inverse associations between self-regulation and adjustment in adolescence, and be hesitant to assign too much weight to these findings. Based on the nature of secondary analysis of an existing dataset, the present analyses are constrained by the tasks the NICHD Early Child Care Research Network investigators chose

to administer at each interview. Future research should include a more varied array of self-regulation tasks in adolescence that are developmentally appropriate, methodologically sound, and represent both "hot" and "cool" types of executive functioning. Indeed, it may be the case that adolescents' performance on laboratory tasks represent more than one latent factor of self-regulation. Based on the dual systems model of adolescent development, it may be fruitful to assess skills representative of both the "hot" and "cool" aspects of self-regulation (Steinberg, 2010). It is possible that these two separate types of tasks will tap into distinct underlying capacities, which differentially predict domains of adjustment.

Third, some of the outcome measures were weak, and did not correlate with the robust latent factors of self-regulation as expected. Adolescent outcomes were primarily measured by self-report. With the exception of academic achievement, which incorporated the Passage Comprehension and Applied Problems subscales of the Woodcock-Johnson psycho-educational battery, all other indicators of adjustment were based on subjects' reports of their perceived behavior and environment. While using objective measures of self-regulation across development was seen as an advantage of this study, this could have also introduced issues around measurement. The methodological difference in laboratory tasks versus self-report surveys could partially explain why academic achievement was the only outcome significantly predicted by self-regulation (both with and without considering the influence of background characteristics). Other indicators, such as objective assessments of physical health, mental health, or observational measures of peer interactions, for example, might help paint a picture of adolescent adjustment that does not rely so heavily on self-reported behavior.

Outcomes measured by self-reported surveys could also explain why so many effects were marginal, even though strong associations were expected, especially in such a large sample.

While teens might provide the most accurate accounts of aggression and delinquency, there are also disadvantages of using self-report measures of maladaptive behavior. In a heterogeneous sample that displays more extreme antisocial behavior than the current NICHD sample, it is likely that self-regulation better predicts objective measures of maladaptive adjustment versus subject's reports of their own behavior. Additionally, positive peer environment was not associated with self-regulation at any period. Positive peer environment was comprised of positive peer group characteristics and friendship quality. In other words, high scores on this composite were indicative of having a close, high-quality relationship with friends who exhibited desirable qualities such as being academically oriented and showing moral behavior. The finding that self-regulation was not related to positive peer environments in adolescence is inconsistent with prior literature that shows youth who exhibit higher levels of self-regulation are more likely to associate with more positive peer groups (e.g., Barkley, 1997; Eccles, Early, Fraser, Belansky, & McCarthy, 1997; T. W. Gardner et al., 2008; Wills, Gibbons, Gerrard, & Brody, 2000). Thus, future research should incorporate multi-rater measures or laboratory assessments of adjustment, instead of relying solely on self-reported surveys that are inherently based on the subject's perception of their own adjustment or environment.

Finally, the amount of variance explained in two of the three adjustment outcomes that were significantly predicted by measures of self-regulation was quite modest. Models explained about 6% of adolescents' positive attitudes toward school and aggressive and antisocial behavior, respectively (varying slightly when the direct effects of background characteristics were included). Overall, predictors from early childhood through adolescence collectively explained only a small amount of variance in these adjustment domains. Models, however, accounted for more variance in academic achievement (~65%). Thus, to understand how self-regulation

predicts social and interpersonal outcomes, such as positive attitudes toward school and aggressive and antisocial behavior, it is important to look beyond the significant pathways, and consider how much variance is being explained. Based on these data, it may be premature to develop early interventions focused on self-regulation until it is clear that self-regulation in early and middle childhood is able to account for these adolescent outcomes.

Future research may consider unpacking the influence of the various background characteristics included in the present study. The supplemental models indicated that gender, ethnicity, family income, and school readiness all predict later adjustment in adolescence. When outcomes were regressed directly on this group of covariates, the impact of self-regulation was largely attenuated. Some background characteristics appear to have a stronger statistical association with select outcomes (e.g., school readiness with academic achievement and positive attitudes towards school). However, the group of background characteristics were all tested together, simultaneously. Future studies could more carefully evaluate which individual background characteristics are most clearly related to later adjustment, when in development they appear to be most important, and how they interact with other aspects of children's social, emotional, and cognitive functioning ot predict adjustment in adolescence.

5.6 CONCLUSION

In conclusion, this study contributes to our understanding of the development of self-regulation across childhood and adolescence, and implications for later adjustment. These results build on existing literature by following the same sample of youth, and testing how a range of adjustment outcomes in adolescence are explained by self-regulation laboratory task performance across

multiple points in development. Specifically, findings provide evidence of the large stability in self-regulation across childhood, and to a lesser degree, into adolescence. Individual variability in self-regulation, particularly in early childhood, is predictive of some domains of adaptive and maladaptive adjustment that rely on behavioral control and interpersonal relationships. Self-regulation exhibited at later points in childhood is indicative of outcomes related to cognitive ability (i.e., academic achievement). Although not a specific aim of this study, these results also highlight the importance of considering related background characteristics when testing the impact of early childhood self-regulation on subsequent adjustment. Altogether, this refines our understanding of how behavioral manifestations of self-regulation change over time. Ultimately, this may help identify sensitive developmental windows when children should master select self-regulation skills to best promote adaptive adjustment and functioning.

These findings also address the conceptual and methodological need to include laboratory self-regulation tasks that capture the full spectrum of relevant skills at each developmental period. This need is reflected in the robust latent self-regulation factors derived during childhood periods, as well as the poor cohesion of tasks during the adolescent period. Generally, this raises the question if, as a field, we define self-regulation too broadly. By including many diverse capacities under the umbrella construct of 'self-regulation,' we may be overlooking important nuances. Future research might consider divorcing self-regulation into distinct skillsets (e.g., hot versus cool executive functions), as some types of self-regulation may have different associations with be more related to some domains of functioning over others.

Children are active agents in their own development, and understanding 'where they start out' has implications for where they 'end up.' Based on these findings, researchers and practitioners should consider a child's relative ability to self-regulate when they are in early

childhood, in addition to background characteristics. Collectively, these early indicators influence how a child is likely to adjust to new transitions, and how they will continue to practice and acquire new self-regulation skills, which are key for later academic, interpersonal, and behavioral functioning.

APPENDIX A

DESCRIPTIVE INFORMATION FOR SELF-REGULATION PERFORMANCE TASKS ACROSS CHILDHOOD AND ADOLESCENCE

Table 14. Descriptive information for self-regulation performance tasks across childhood and adolescence

Age	Task	Measure/ Variable	Construct	Description	*n*	*Mean*	Range	Skewness	Kurtosis
36 Month									
	Forbidden Toy Task	Latency to first *active* or *minimal* engagement (in seconds)	Delay of Gratification	Latency to minimum engagement or latency to active engagement – minimum of two times – with an attractive toy	1,093	80 *sec*	0 – 151 *sec*	-.041	-1.874
54 Month									
	Tempting Snack Task	Amount of time waited to eat snack (in minutes)	Delay of Gratification	Minutes waited to eat desired snack in "waiting game"	961	4.48 *min*	0 – 7 *min*	-.494	-1.6
	Day/Night Stroop	Percent correct trials	Impulse Control	Percent of non-missing trials in which a correct response was given (proportional weighting)	838	74.66 *percent*	12.5 – 100 *percent*	-.822	.113

Table 14 (continued)

Age	Task	Measure/ Variable	Construct	Description	*n*	*Mean*	Range	Skewness	Kurtosis
	Woodcock-Johnson Memory for Sentences	WJ Memory for Sentences Standard Score	Short-term working memory	Standardized score of ability to recall words/phrases within provided sentences (32 items)	1,054	91.75	17 – 142	-.151	-.439
	CPT sustained attention	Accurate responses in critical trials minus inaccurate responses in non-critical trials (com-mission)	Sustained Attention	CPT Commission Errors subtracted from Correct Responses to Critical Trials	1,002	18.42	-115.87 – 44	-2.014	4.939
1st Grade									
	Woodcock-Johnson Memory for Sentences	WJ Memory for Sentences Standard Score	Short-term working memory	Standardized score of ability to recall words/phrases within provided sentences (32 items)	1,018	98.51	2 – 154	-.091	2.607

Table 14 (continued)

Age	Task	Measure/ Variable	Construct	Description	*n*	*Mean*	Range	Skewness	Kurtosis
	Woodcock-Johnson Memory for Names	WJ Memory for Names Standard Score	Long-Term Memory Retrieval	Standardized score of ability to recall names of newly introduced space creatures	1,020	101.54	43 – 161	.032	1.631
	CPT sustained attention	Accurate responses in critical trials minus inaccurate responses in non-critical trials (com-mission)	Sustained Attention	CPT Commission Errors subtracted from Correct Responses to Critical Trials	996	51.19	-60 – 60	-3.749	18.618
	Tower of Hanoi Planning Efficiency Score	Total Planning Efficiency Score of 6 Trials in Tower of Hanoi	Planning/ Problem Solving/ Future orientation	Sum of number of trials required to successfully complete tasks 1 through 6	998	14.379	0 – 34	.42	-.349
3rd Grade									
	Woodcock-Johnson Memory for Sentences	WJ Memory for Sentences Standard Score	Short-term working memory	Standardized score of ability to recall words/phrases within provided sentences (32 items)	1,013	101.93	29 – 155	.377	.897

Table 14 (continued)

Age	Task	Measure/ Variable	Construct	Description	*n*	*Mean*	Range	Skewness	Kurtosis
	Woodcock-Johnson Memory for Names	WJ Memory for Names Standard Score	Long-Term Memory Retrieval	Standardized score of ability to recall names of newly introduced space creatures	1,015	109.5	62 – 165	.509	1.079
	Tower of Hanoi Planning Efficiency Score	Total Planning Efficiency Score of 6 Trials in Tower of Hanoi	Planning/ Problem Solving/ Future orientation	Sum of number of trials required to successfully complete tasks 2 through 7	1,011	17.18	0 – 35	-.171	-.785
4th Grade									
	CPT sustained attention	Accurate responses in critical trials minus inaccurate responses in non-critical trials (com-mission)	Sustained Attention	CPT Commission Errors subtracted from Correct Responses to Critical Trials	928	77.26	-70 – 90	-3.73	22.475
5th Grade									
	Tower of Hanoi Planning Efficiency Score	Total Planning Efficiency Score of 6 Trials in Tower of Hanoi	Planning/ Problem Solving/ Future orientation	Sum of number of trials required to successfully complete tasks 2 through 7	1,002	22.87	0 – 36	-.717	.115

Table 14 (continued)

Age	Task	Measure/ Variable	Construct	Description	*n*	*Mean*	Range	Skewness	Kurtosis
15 Years									
	Balloon Analogue Riskiness Task (BART)	Index of Riskiness (all trials; reversed)	Impulse Control	Average number of balloon "pumps" that were not exploded	955	41.66	0 – 73.5	.501	-.032
	Operation Span (OSPAN) numbers and letters task	Total Span Score across all trials	Working Memory	Number of letters recalled in correct order	913	32.39	0 – 75	.205	-.636
	Tower of London	Average time to 1st move in all trials	Planning	Time (in seconds) to make first move, averaged across all test trials	932	7 *sec*	2.4 – 31.74	2.37	7.757

APPENDIX B

CORRELATIONS BETWEEN SELF-REGULATION PERFORMANCE TASKS ACROSS CHILDHOOD AND ADOLESCENCE

Table 15. Correlations between self-regulation performance tasks across childhood and adolescence

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1. DoG, 36M	-															
2. DoG, 54M	.197**	-														
3. Impls Cntrl, 54M	.065	.117**	-													
4. ST WM, 54M	.197**	.290**	.083*	-												
5. Sust Attn, 54M	.278**	.346**	.169**	.250**	-											
6. ST WM, 1G	.206**	.290**	.082*	.574**	.200**	-										
7. LT WM, 1G	.063	.182**	.118**	.188**	.074*	.311**	-									
8. Sust Attn, 1G	.189**	.193**	.096**	.182**	.293**	.157**	.129**	-								
9. Plan, 1G	.146**	.238**	.037	.222**	.252**	.175**	.120**	.167**	-							
10. ST WM, 3G	.208**	.302**	.076*	.559**	.221**	.774**	.286**	.209**	.173**	-						
11. LT WM, 3G	.082*	.126**	.110**	.232**	.079*	.311**	.628**	.139**	.136**	.332**	-					
12. Plan, 3G	.126**	.238**	.053	.238**	.203**	.227**	.142**	.218**	.377**	.251**	.231**	-				
13. Sust Attn, 4G	.152**	.163**	.156**	.187**	.275**	.209**	.082**	.449**	.186**	.215**	.143**	.254**	-			
14. Plan, 5G	.148**	.156**	.068	.230**	.241**	.262**	.188**	.229**	.356**	.298**	.223**	.494**	.237**	-		
15. Impls Cntrl, 15Y	-.111**	-.072*	-.026	-.056	.010	-.085*	-.034	.092**	-.044	-.085*	-.087*	-.058	.028	-.086**	-	
16. Plan, 15Y	.019	.158**	.113**	.170**	.119**	.197**	.162**	.100**	.168**	.220**	.183**	.208**	.119**	.246**	-.008	-
17. WM, 15Y	.099**	.130**	.106**	.337**	.163**	.430**	.223**	.129**	.197**	.451**	.287**	.213**	.164**	.268**	-.050	.193**

***p < .01; *p < .05; DoG* = Delay of Gratification; *Impls Cntrl* = Impulse Control; *ST WM* = Short-Term Working Memory; *LT WM* = Long-Term Working Memory; *Sust Attn* = Sustained Attention; *Plan* = Planning and Problem Solving; *WM* = Working Memory; *M* = Month; *G* = Grade; *Y* = Year

APPENDIX C

HYPOTHETICAL MODEL OF DEVELOPMENTAL SELF-REGULATION PREDICTING ADAPTIVE ADOLESCENT ADJUSTMENT

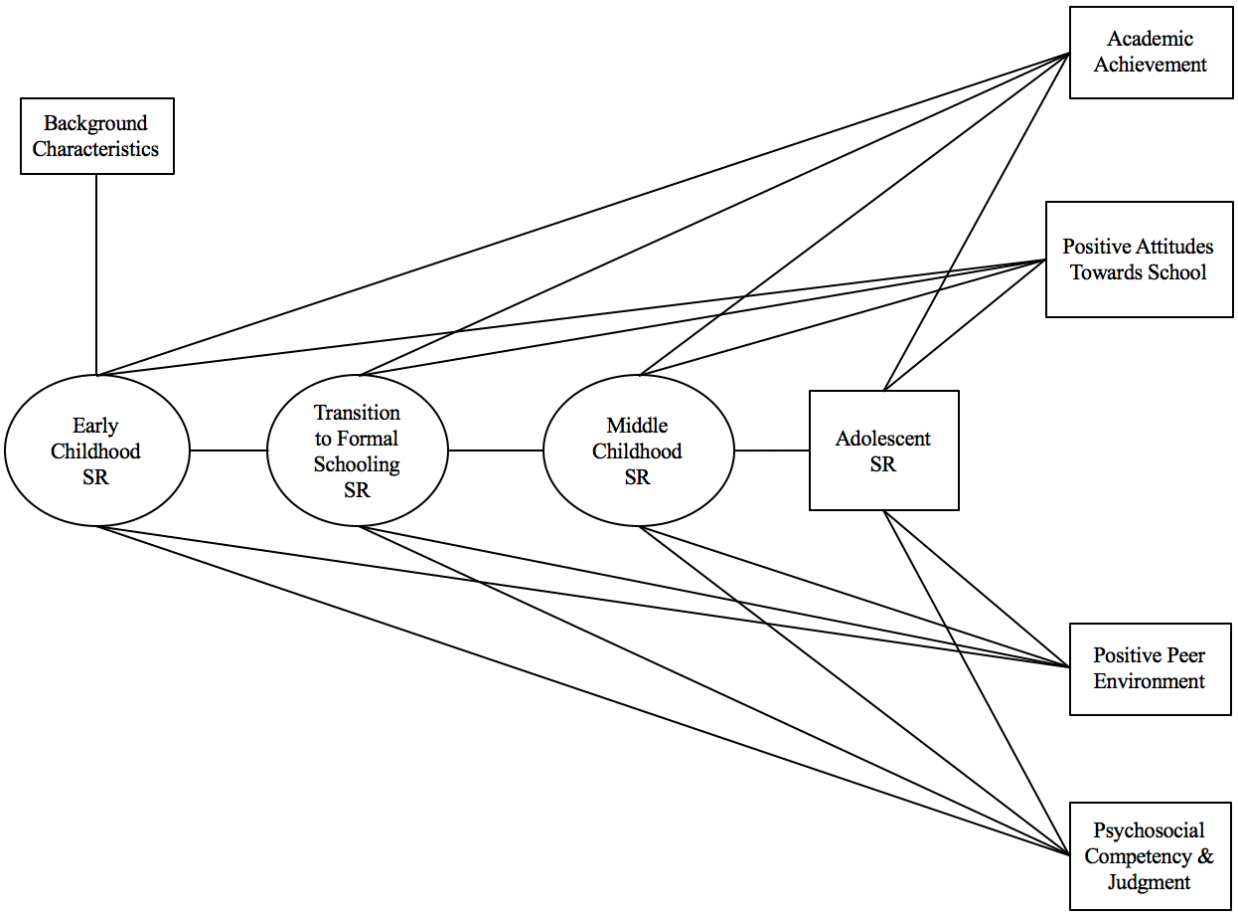

Figure 15. Hypothetical model of developmental self-regulation predicting adapative adolescent adjustment

APPENDIX D

HYPOTHETICAL MODEL OF DEVELOPMENTAL SELF-REGULATION PREDICTING MALADAPTIVE ADOLESCENT ADJUSTMENT

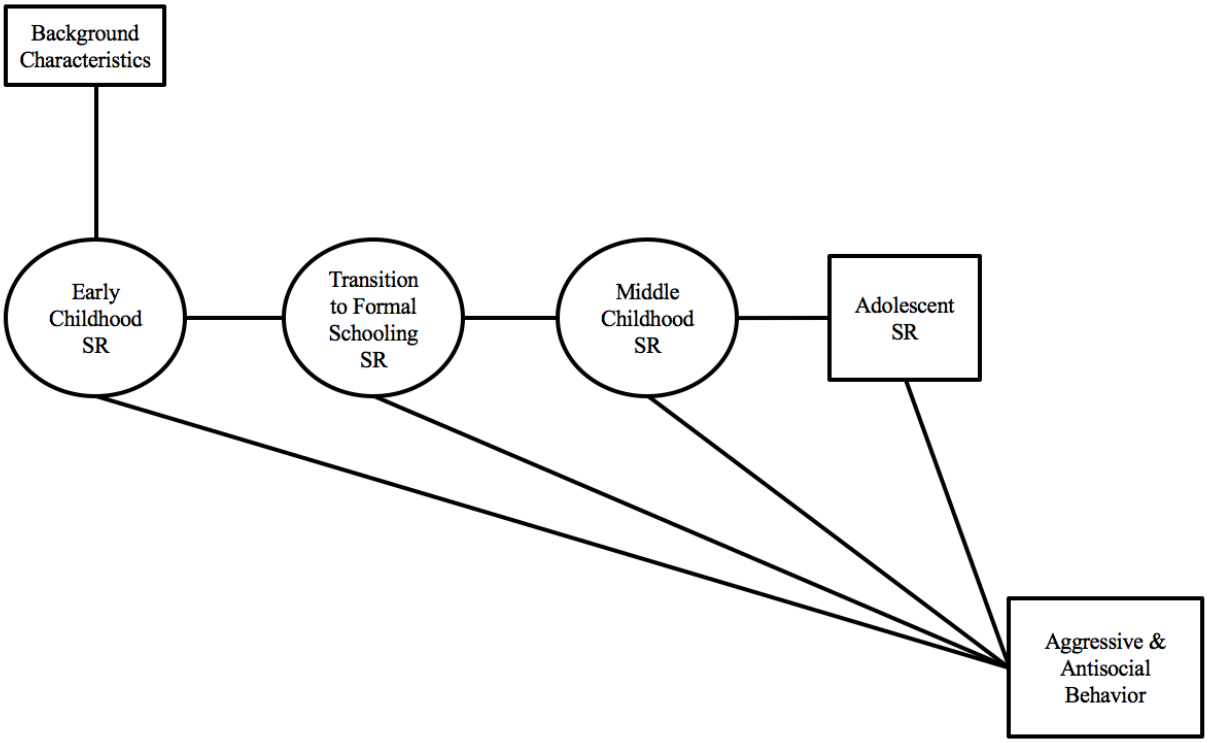

Figure 16. Hypothetical model of developmental self-regulation predicting maladaptive adolescent adjustment

APPENDIX E

HYPOTHETICAL MODEL OF ADAPTIVE ADOLESCENT ADJUSTMENT OUTCOMES REGRESSED ON BACKGROUND CHARACTERISTICS AND DEVELOPMENTAL SELF-REGULATION

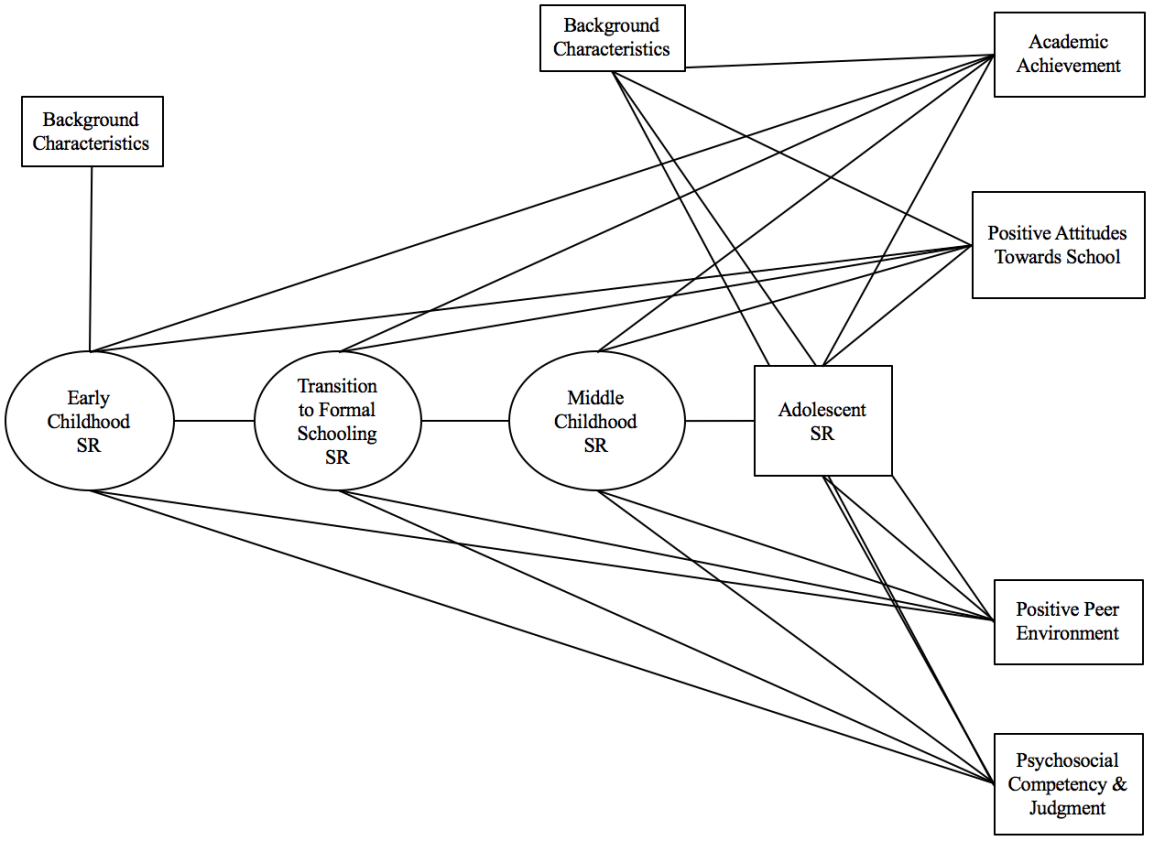

Figure 17. Hypothetical model of adaptive adolescent adjustment outcomes regressed on background characteristics and developmental self-regulation

APPENDIX F

HYPOTHETICAL MODEL OF MALADAPTIVE ADOLESCENT ADJUSTMENT OUTCOMES REGRESSED ON BACKGROUND CHARACTERISTICS AND DEVELOPMENTAL SELF-REGULATION

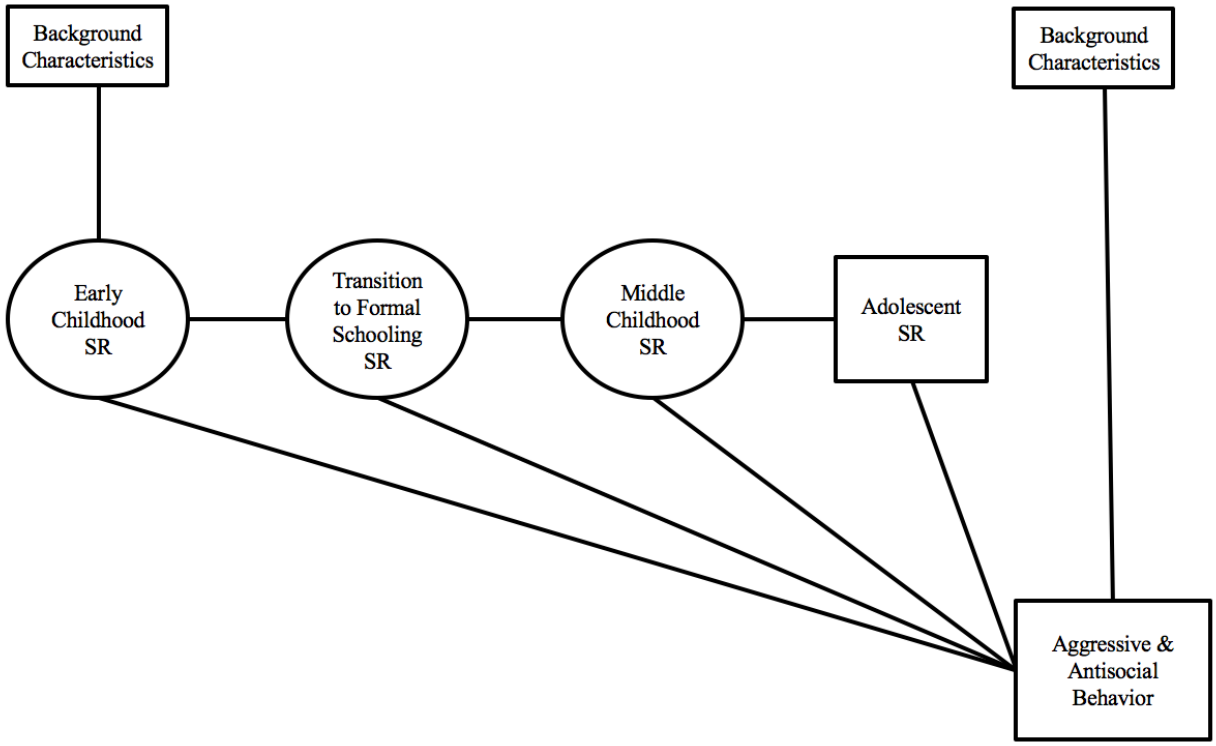

Figure 18. Hypothetical model of maladaptive adolescent adjustment outcomes regressed on background characteristics covariates and developmental self-regulation

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