A Developmental Account of Self-Regulatory Failure in Preschool and Middle Childhood

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Abstract

The present studies are intended to detail developmental differences in self-regulatory failure. Study 1 is a downward extension (4-year-old children) of the standard approach to investigating self-regulatory failure in adults. In Study 1, 4-year-old participants ($N = 61$) were administered a consecutive dual-task paradigm (Baumeister et al., 1998). While this approach has been quite fruitful in the study of adult self-regulation, results from Study 1 failed to show effects of ego depletion in young children. Individual differences in self-control overshadowed any potential evidence for self-regulatory failure in Study 1. Indeed, 4-year-old children are in the early stages of the development of self-control, and demonstrate marked differences in performance and ability to self-regulate. Study 2 utilized a modified approach to the study of self-regulatory failure, informed by the extensive individual differences seen in Study 1. Participants ages 4 ($n = 45$), 6 ($n = 55$), and 8 years ($n = 46$), were given a within-subjects, pre-post self-control task. Each participant completed a tangram task, a 5-minute direction following task, and then another tangram task. While Study 2 does replicate the null findings of Study 1 with respect to condition differences in future persistence (direction following versus neutral), Study 2 provides potential evidence for overall performance failure. Persistence on a difficult tangram after any task was significantly less than persistence before the task ($F (2, 144) = 8.76, p < .01$). This effect was consistently found in all three age groups, even though older children (6 and 8 years) were found to persist significantly longer than younger children (4 years) ($Tukey HSD = -85.07, p < .05$; $Tukey HSD = -119.29, p < .01$, respectively). These results highlight the potential early
onset of self-regulatory failure, as well as the necessity for the study of individual differences leading to differential magnitude of self-regulatory failure.
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Chapter 1: Overview

Self-regulatory failure is a commonly documented phenomenon. It is theorized to be the product of having a limited capacity for self-control and attempting to continuously draw from this capacity through self-regulation (Baumeister, Bratslavsky, Muraven, & Tice, 1998). While there is ample evidence of self-regulatory failure in adults, an important question remains: if the capacity for self-control is limited because it is still developing, then will individuals exhibit a lesser, similar, or greater magnitude of self-regulatory failure as adults? Preschool through middle childhood marks an important time for the development of self-control capacities (e.g., Zelazo, Carlson, & Kesek, 2008), presenting an opportunity to explore individuals whose self-control capacities are limited. Little research has explored children’s exhibition of self-regulatory failure, or the relation between the development of self-control and subsequent self-regulatory failure (Baumeister, Vohs, & Tice, 2007). The aim of Study 1 was to examine the competing hypotheses of self-control as depleting versus self-control as priming improved self-control in a preschool population. Four-year-old participants were administered a standard consecutive dual-task paradigm (Baumeister et al., 1998). Children were randomly assigned to receive either a self-control based direction for 5 minutes, or a neutral direction for 5 minutes. They then completed a difficult tangram task. Regulatory failure effects were assessed by persistence on the difficult tangram task as a function of the utilization of previous self-control. The aim of Study 2 was to look at the relation between age and the magnitude of self-regulatory failure, as well as account for potential individual differences (e.g., conscientiousness and effortful control). Children in Study 2 included 4-, 6-, and 8-year-olds. A subset of
the children had executive function measured utilizing the EF subsection of the NIH toolbox (i.e., Dimensional Change Card Sort Task, and Flanker Task). Individual variation in persistence behavior was assessed through a pre-post version of the task used in Study 1. Children completed a difficult tangram, then the direction task, followed by an additional difficult tangram. Self-regulatory failure was measured as the change from pre-to-post persistence. Additional individual differences were quantified through parent-report (i.e., the Children’s Behavior Questionnaire). Children’s potential exhibition of self-regulatory failure (as evidenced in the present studies), as young as 4-years-of age, has important implications for intervention and education. Namely, children would likely benefit from an increased focus on training efficient self-regulation. This efficiency would enable them to recruit self-control and attention processes for additional learning over a longer time course.
Chapter 2: General Introduction

Self-regulation is a skill set recruited in everyday life. Throughout historical thought and literature, the idea of having to regulate our actions is repeated (e.g., Plato, Aristotle). Arising from the notion that we must regulate our actions and behavior, comes the question of what happens if we continue to regulate? Do we ever lose the ability to do so? Are some people more apt to fail than others?

Aristotle was the first to posit that self-regulation was likely limited, or vulnerable to interference. He called this notion “akrasia” or “weakness of will.” While akrasia was forwarded in early philosophy, similar ideas to akrasia, or weakening self-regulation, have only recently been theorized in the study of self-regulation (e.g., Monin, 2007; Exline & Baumeister, 1999). In order to understand the weakening of self-regulation, one must first understand the development of self-regulation (also referred to herein as executive function or self-control), as well as the way that self-regulation is investigated in both children and adults.

Self-Regulation in Childhood

Executive function is frequently defined as the conscious cognitive control of thought, action, and emotion (Zelazo, Carlson, & Kesek, 2008). Alternative definitions have also been forwarded, including executive function as a set of general-purpose control mechanisms that modulate the operation of various cognitive subprocesses and thereby regulate the dynamics of human cognition (Miyake et al., 2000) or as component processes: inhibition, working memory, and cognitive flexibility (Miyake et al., 2000). Executive function is a functional construct, a set of processes, wherein level
of competence is gauged by efficient execution. Researchers in the field of executive function have performed numerous task analyses, detailing the component processes underlying effective and efficient execution, arriving at processes such as planning, working memory, attention, flexibility, and inhibition (Zelazo et al., 2008).

These subprocesses of executive function have been tested utilizing a myriad of tests such as the Stroop Task (e.g., Stroop, 1935; Luria, 1966), the Self-Ordered Pointing Task (Petrides & Milner, 1982), and the Wisconsin Card Sorting Test (Grant & Berg, 1980).

In the Stroop Task (e.g., Stroop, 1935; Luria, 1966) participants are faced with stimuli of conflicting nature (e.g., names of several colors written in ink independent in color from the color named) where participants are responsible for naming the color of the ink, not the named color. This task is largely thought to measure inhibition (Zelazo et al., 2008). The Self-Ordered Pointing task measures working memory, calling for participants to “point to a new object every time they see a group of objects.” In this task, participants are repeatedly shown the same group of objects and the physical placement of the objects is modified in subsequent presentations. After each new presentation, participants are given the task of pointing to a new object. In order to succeed, participants must keep multiple objects, as well as the direction in mind; utilize the object representation to determine which object has not been selected yet, and finally, select the new object. The Wisconsin Card Sorting Test is used to measure cognitive flexibility, working memory, and inhibition. In the task, participants are shown cards that can be sorted by a color dimension, a shape dimension, or a number dimension. They are then given feedback as they begin to sort (e.g., if the participant
puts out a card that matches the target shape, but the sorting dimension is color, the experimenter will say “no”). Participants must deduce the sorting dimensions (which change over the course of the trials), update their working model of the task, plan and inhibit their tendency for one dimension over another, all in an attempt to execute the task.

The development of executive function has been intensively researched across thousands of studies, utilizing several different methods (e.g., Carlson, 2005; Hongwanishkul et al., 2005; Munakata & Yerys, 2001; Zelazo et al., 2008). Around 1-year-of-age, the translation of parent-child co-regulation to child self-regulation begins and rudimentary self-regulatory skills can be seen. More developed executive functions such as planning, inhibition, and flexibility appear to begin radical changes between the ages of 3 and 6 years (Diamond, 2002; Zelazo et al., 2003). Moreover the development of working memory follows a similar pattern of change (Morton & Munakata, 2002). Component processes of executive function develop rapidly between the ages of 3.5 and 5 years of age and continue to develop across adolescence and into early adulthood (Zelazo, Muller, Frye, & Marcovitch, 2003; Zelazo, Anderson, Richler, Wallner-Allen, Beaumont, & Weintraub, in press).

From a developmental neuroscience perspective, the ability to recruit self-control processes is dependent on the maturation of neural areas associated with self-regulation, namely the lateral prefrontal cortex, areas of the superior parietal cortex, and subcortical structures such as the basal ganglia (e.g., Bunge & Zelazo, 2006). Increased synaptogenesis in prefrontal areas begins postnatally, and continues through early and middle childhood. This is thought to lead to peak cortical thickness as late as 7.5 years.
of age in typically developing children (Shaw et al., 2007). Moreover, the experience dependent selective pruning and myelination of neural pathways associated with self-control continues throughout adolescence and into early adulthood (Bunge & Zelazo, 2006).

While self-regulation in childhood is often equated with normative development in executive function, primarily in working memory, inhibitory control, planning, cognitive flexibility, and attention, in relatively “cool” or “non-emotional” contexts, a great interest has been placed on the development of a similar top-down control process in more emotional or “hot” situations as well (e.g., Hongwanishkul et al., 2005; Mischel, Shoda, & Rodriguez, 1989; Zelazo & Carlson, in press). “Hot” executive function has traditionally been explored using tasks that require self-control in either emotionally taxing contexts (e.g., under a great deal of stress), contexts where the stimuli itself is motivationally significant (e.g., candy, chips, monetary rewards), or in the presence of stimuli that may elicit emotions (e.g., happy, sad, or neutral faces).

An example of a classic task in the study of “hot” executive function is the Delay of Gratification task (e.g., Mischel, 1958). In the Delay of Gratification task, children are shown a desirable stimuli (usually a marshmallow) and told that they can either eat the marshmallow now, or that when the experimenter returns, if the child has not eaten the marshmallow, they will receive a second marshmallow (usually 10 minutes later). Children show a great deal of variance in their ability to delay (in both time of delay and decision to delay), and this variance is predictive of teacher and parent reported self-control abilities in later adolescence, wherein children who delayed
longer in childhood (at age 4) were rated higher in self-regulatory abilities nearly 10 years later (Mischel, Shoda, & Rodriguez, 1989).

Recently, researchers have employed several measures to disentangle various aspects of “hot” executive function, including, but not limited to, the Delay Choice paradigm (e.g., Murray & Kochanska, 2002) and the Children’s Gambling Task (e.g., Kerr & Zelazo, 2004). A relatively consistent set of findings appears to be arising. First, children show great variability in their “hot” executive function performance (e.g., Kerr & Zelazo, 2004). Second, while developmental changes in “hot” executive function or affective decision-making have been shown extensively among 3-4-year-olds (e.g., Kerr & Zelazo, 2004; Carlson, 2005), considerable continuity and stability in variability is also expected beyond the preschool years (Mischel, Shoda, & Rodriguez, 1989). Finally, while systems recruited for “hot” executive function tasks likely overlap with systems recruited for “cool” executive function tasks, there are several areas additionally recruited in “hot” tasks, such as the orbitofrontal cortex, signifying either an additional “top-down” control system unique for “hot” situations (Zelazo & Carlson, in press), or an emotional “go” component recruited in “hot” contexts (Metcalf & Mischel, 1999).

**Self-Regulation in Adulthood**

In research with adults, self-control is often defined in terms similar to “hot” executive function, primarily as resistance to temptation in a particular motivationally significant confrontation (e.g., dieters exposed to ice cream or former smokers offered cigarettes) (Baumeister, Vohs, & Tice, 2007). Inhibition arises out of socially induced constraints on behavior (e.g., the refusal to eat ice cream based on the society’s value
judgment of thinness) (Gailliot et al., 2007). While most adults can and do exhibit self-control, one’s ability to do so continuously is affected by the relative size of one’s self-control capacity. This “Strength Model” of self-control is often explained with a muscle metaphor. For instance, after repeated weight lifting, muscles will become exhausted and unable to continue to lift heavy objects. The muscle fatigue becomes crippling with extended over-utilization. Similarly, the capacity for self-control is posited to be muscular in nature, becoming exhausted upon repeated use, and replenished by rest and/or nutritional energy. This strength model arises out of a series of research experiments with adults wherein participants will readily (and quite pervasively) demonstrate a marked decrease in their self-regulation after already having regulated (e.g., Baumeister et al., 1998).

The adult laboratory experiments of self-regulatory failure usually include one motivationally salient or very difficult self-control task (e.g., do or don’t direction in the presence of chocolate, suppressing thoughts) and a follow-up persistence task (e.g., unsolvable anagrams), this combination is referred to as the dual-task paradigm (Baumeister et al., 2007). For example, in one study (Muraven, Tice, & Baumeister, 1998, Study 2), participants were given Wegner’s classic thought suppression task (1987). In this task, participants were randomly assigned to one of three directions: 1) “think about a white bear as much as you can,” 2) “don’t think about a white bear,” 3) no specific direction while writing down sentences. Following the 6-minute thought suppression test, all participants were given a sheet of unsolvable anagrams and told that this was “not a test,” they were instructed to solve as many as they wanted and to ring a bell when they wanted to be finished. The results were quite dramatic,
participants who had actively suppressed thoughts persisted significantly less long, on average 563 seconds, over a 3-minute difference, than participants with no direction ($M = 758$ seconds).

Numerous studies in social psychology detail the possible environmental influences involved in the depletion of self-control, instead of the consideration of individual differences in self-control competence (Hagger, Wood, Stiff, & Chatzisarantis, 2010). Studies have dealt with small variations to the above experiment (e.g., changing the depletion task), as well as complete changes to the laboratory paradigm to be more concerned with aspects of shopping, prejudice, and many other constructs. Findings from studies of self-regulatory failure have shown, for example, that after a regulation task, participants exhibit marked reduction in management of one’s impression (Vohs, Baumeister, & Ciarocco, 2005), suppression of stereotypes and prejudice (Gordijn, Hindriks, Koomen, Dijksterhuis, & Van Knippenberg, 2004; Richeson & Shelton, 2003; Richeson & Trawalter, 2005; Richeson, Trawalter, & Shelton, 2005), coping with thoughts and fears of dying (Gailliot et al., 2006), restraining aggression (Stucke & Baumeister, 2006), and managing one’s intake of food and alcohol (Kahan et al., 2003; Muraven, Collins, & Nienhaus, 2002; Muraven, Collins, Shiffman, & Paty, 2005; Vohs & Heatherton, 2000).

The strength model of self-control is usually juxtaposed with a cognitive-mechanistic account of self-control (Baumeister et al., 2007). This cognitive mechanistic account states that self-control primes self-control, essentially, that engaging in one self-control task prepares one to continue to engage in self-control tasks (Baumeister, Gailliot, DeWall, & Oaten, 2006). While this account is argued to be
unsupported in adult studies (e.g., Baumeister et al., 2007), this cognitive-mechanistic account of self-control may explain many findings with regards to children’s self-regulation. Indeed, studies of executive function in children are focused on mechanistic accounts of the development of cognitive control across childhood.

**Self-Regulatory Failure in Children**

Kaplan and Berman (2010) contend that the “self-control” concept referred to in adult social, cognitive, and neuropsychology, and “executive function,” usually described in developmental studies with children, are either very similar, or synonymous terms. They contend that the strength of one’s executive function may be analogous to the strength of one’s self-control capacity (Kaplan & Berman, 2010). The development of one’s self control (and inferred capacity for self-control) is the central focus of Study 2, examining the age–related development of self-regulation and the magnitude of self-regulatory failure.

A growing body of evidence may suggest an alternative to “strength”, particularly relevant to the experience-dependent development of self-regulation, that of functional efficiency (e.g., Martijn et al., 2007; Muraven, 2010). When adult participants are either primed (Martijn et al., 2007) or trained to more efficiently utilize self-control (Muraven, 2010), depletion effects appear to decrease. These training effects can also be seen in studies with children related to executive function and working memory. Intervention programs focusing on general self-control appear to have the greatest impact in children’s measured executive function abilities (Diamond & Lee, 2011). This general approach emphasizes several key aspects necessary for continued executive function: knowing when and how to self-regulate, and when self-
regulation is no longer necessary. In the present studies, measures of individual temperament, particularly effortful control, may serve as proxies for experience with self-control and will be analyzed as potential protective mechanisms against self-regulatory failure.

From these limited data, a developmental hypothesis may be advanced. When the strength model of self-control is applied to development, the expectation would be that an individual’s level of executive function would directly predict the magnitude of their self-regulatory failure. As the “self-control” muscle becomes more adult-like throughout middle childhood, children will be more apt to recruit self-control in the tasks, depleting their capacity, and resulting in greater differences in persistence/self-control in future tasks.

In addition to age-related development of executive function, Study 2 will investigate the relation between effortful control and self-regulatory failure. Temperament in infancy and early childhood reflects early, stable, personality traits (e.g., Rothbart, 2007). Rothbart and colleagues include three broad dimensions in their temperamental measures: surgency, negative affectivity, and effortful control. Effortful control is defined as the ability to suppress a dominant response to perform a subdominant response (e.g., Kochanska, Muray, & Harlan, 2000). It is usually assessed using the Children’s Behavior Questionnaire (CBQ), a parent report measure that is related to executive function (e.g., Hongwanishkul, Happaney, Lee, & Zelazo, 2005), and it provides a litmus test of self-regulation in everyday situations outside of the laboratory. Thus, effortful control is likely to provide a measure of children’s experience in exerting executive function in a variety of contexts and will predict
overall efficiency of self-regulation. Executive function will be measured directly, as it likely underlies effortful control, it is expected to also underlie susceptibility to self-regulatory failure. Executive function is expected to be a stronger predictor of self-regulatory failure than effortful control.

A common concern surrounding the assessment of self-regulatory failure is that of general fatigue. Fatigue (in terms of sleep deprivation) is unrelated to depletion effects (Vohs et al., 2011). Moreover, the contention that self-regulatory failure is in fact generalized mental fatigue is not supported by evidence. In several studies, performance on non-self-control, but still cognitive tasks remains unaffected by previous exertion of self-control (e.g., Muraven & Slessareva, 2003; Schmeichel et al., 2003). However, while the notion of generalized mental fatigue is not supported by evidence from research with adults, the present study will also investigate whether self-regulatory failure in children will be generalized to other cognitive tasks (not explicitly self-control related). Based on the adult literature, we do not expect to find significant differences in performance on a measure of relatively concrete knowledge, a vocabulary test.
Chapter 3: Study 1

The phenomenon of self-regulatory failure has been documented in hundreds of studies with adults, however, it has yet to be extended to young children, those for whom the self-control “muscle” has not completely developed. The goal of Study 1 was to compare the two potential adult self-control performance theories in children. The first theory is the strength model, predicting that, just as with adults, children who engage in self-control will be hampered in their self-control in a subsequent task (Baumeister et al., 1998). However, an alternative to this theory, the cognitive mechanistic account, suggests that children may perform better on subsequent tests requiring self-control, after having already had to recruit self-control. This is theorized to be due to a priming effect that using self-control would have, that engaging in self-control alerts the individual to continue to engage in self-control. These two hypotheses were explored in a preschool-age-sample of children utilizing a modified version of the standard dual-task paradigm (e.g., Vohs & Heatherton, 2000).

The present study used a modified paradigm employed by Vohs and Heatherton (2000), one appropriate for children. In the place of tempting food, children were faced with a table covered in toys that traditionally take two hands to use (e.g., Barbies, horses, race cars, Mr. Potato Head, and Silly Putty). Children were given instructions that either limited their play abilities with the toys (e.g., “Do keep one hand on the table, but you can play with the toys,” or “Don’t touch the table, but you can play with the toys”) or did not limit their play (i.e., “You can play with the toys.”). In the limiting case, most toys were designed to be played with on the table and to require two hands, so
children had to actively resist their pre-potent urge to either use both hands or to touch the table (depending on the direction).

For the second task, we chose a child-modified version of a common second-task, a persistence-based anagram task (e.g., Ciarocco, Sommer, & Baumeister, 2001) Instead of using anagrams, due to the necessary reading abilities inherent in anagrams, we chose tangrams, a more appropriate, non-verbal task. Our measure of continued self-control was persistence on a difficult, but not impossible tangram.

It was hypothesized that children would show decreased self-regulatory performance, primarily that those who were randomly assigned to a direction condition, and engaged in self-control during that condition would persist less on the difficult tangram than those who were assigned to the neutral condition. Additionally, it was hypothesized that children’s expected exhibition of self-regulatory failure would not generalize to other cognitive, non-self-control demanding tasks.

**Method**

**Participants.** Participants were 4-year-old children \(N = 61, M_{\text{age}} = 4.57 \text{ years, } SD = .29\). All children were recruited from the participant pool maintained by the Institute of Child Development. Children had to speak and understand English. There were no reported children with developmental delays or disabilities. Data from an additional 3 participants were excluded from analysis due to video malfunction.

**Procedure.** All parents gave informed consent for their children to participate. Children gave verbal assent. Parents were also asked to complete a brief demographics form as their children participated in the study.
All participants were tested in the Developmental Social Cognitive Neuroscience Lab at the Institute of Child Development. Children were randomly assigned to receive either a direction condition \( (n = 30) \) or a neutral condition \( (n = 31) \). Following the five-minute direction task, children engaged in the Tangram task described below, followed by the Stanford-Binet vocabulary measure.

After the study, children and their parents received compensation and were fully debriefed. Parents were paid $5 to cover travel expenses, and children received a small toy for participation.

**Parent Measure.**

**Demographic questionnaire:** The demographic questionnaire was administered to assess several aspects of the child’s socio-cultural and economic status, including gender, age, race/ethnicity, language familiarity, number of siblings, birth order, maternal and paternal education and occupation, and family income.

**Child Measures.**

**Direction Task:** The direction task was a modified version of the simple direction task given to adults (Vohs & Heatherton, 2000). In this task, children were shown a table with several desirable toys (all of which would normally require two hands). Children were randomly assigned to receive either a direction condition (i.e., “Do keep one hand on the table at all times, but you can play with any of the toys you want” or “Don’t touch the table, but you can play with any of the toys,”) or the neutral condition (i.e., “You can play with any of the toys you want.”). Children were reminded of the direction after one minute of the task. Children were videotaped for a 5-minute period of time. Direction following was coded from the videotape of the session for
both quantity of direction following out of 5 minutes and number of violations (e.g., removing hand from table in direction condition).

_Tangram Task:_ In this task, participants were given a series of solvable tangram puzzles. In the first two tangrams, the experimenter helped and encouraged the child in solving the puzzles. Participants were told that the experimenter needed to go “do some work at the other table.” The children were then instructed that their “job” was to do the best they could to try to solve a difficult puzzle. To increase motivational significance to a 4-year-old child, children were also told that “if they could complete the puzzle by themselves, they would get to choose a toy from the special toy chest next door, not just the regular one.” They were then instructed about a bell, labeled by the experimenter as the “bring me back bell,” that the child could use to alert the researcher if they were “just too tired or didn’t want to do it (i.e., solve the puzzle) anymore.” Children were then shown a difficult house tangram and told “ready, set, go.” The experimenter then walked across the room, sat at a desk with their back to the child and timed persistence on the tangram task. Time of persistence was recorded based on time to ring the bell or children’s verbal announcement of termination. If participants persisted to 10 minutes, the experimenter returned, completed the puzzle with the child, and the child was given a maximum score of 600 seconds (10 minutes) for persistence.

_Vocabulary Task:_ This task was taken from the Stanford-Binet Version 5. In this task, children were asked a series of questions regarding vocabulary such as, “What is an apple?” Responses were recorded and raw scores were calculated for all participants.
Quantification of Measures

**Direction Following.** Direction following/degree of self-control use was coded from videotapes of the session. The objective measures were the number of violations of the rule that occurred and the quantity of time out of 5-minutes exerting self-control (following direction). Participants in the neutral condition were not included in analyses of violations or time spent regulating, as they could not violate a direction nor did they have a direction to follow for the 5-minute period.

**Tangram Persistence.** Latency to bell ringing/giving up was used as the outcome variable in tangram persistence. Latency to giving up was recorded based off of time to bell ring, or verbal declaration of cessation.

**Vocabulary.** Raw scores were generated from the vocabulary subscales of the Stanford-Binet Version 5. For analyses, age in years (with two decimal places included) was used as a covariate and vocabulary raw score was used as the dependent variable.

**Results**

**Self-Regulatory Failure.** Contrary to our hypotheses and expectations regarding a downward extension and replication of the findings of self-regulatory failure in adults, a 3-way between-subjects Analysis of Variance (ANOVA) failed to find significant differences on tangram persistence between children who were assigned to the two direction conditions, or the neutral condition ($F(2, 58) = .08, n.s.$)(See Figure 1). Additionally, since no differences were seen between the “Do” and “Don’t” direction conditions on overall tangram persistence ($t(28) = .495, n.s.$), the groups were combined for analyses as the “Direction group.” A planned comparison of tangram
persistence for those receiving a direction ("Direction group") versus those receiving the “you can play with the toys” prompt also failed to find significant differences on tangram persistence ($t (59) = .058, n.s.$)(See Figure 2). (Insert Figures 1 and 2 here).

Consistent with our hypotheses, there were no significant differences between direction and neutral groups on Stanford-Binet vocabulary raw scores, using age in years as a covariate ($F (2, 57) = 2.18, n.s.$).

To examine potential individual differences in self-control ability, the relation between rule-following behavior in the direction task and persistence on the tangram task was analyzed. Only participants who had received a direction (those in the “Do” and “Don’t” conditions) were included in this analysis. Both time on direction ($r = .421, p < .05$) and number of violations of the rule ($r = -.390, p < .05$) were significantly related to persistence on the tangram task, suggesting that those who engaged in the direction task, and followed the direction to a greater degree, persisted longer on the tangram task.

**Discussion**

Contrary to our hypotheses, 4-year-old children did not show evidence of self-regulatory failure. As with all null results, we cannot conclude that children do not experience self-regulatory failure, rather, we can conclude that this may be the case, or that several aspects of the testing methodology may be masking potential self-regulatory effects. Evidence from correlational analyses also suggests that children who engage in self-control may actually persist longer in future self-control situations.

Of particular note concerning these data is the extensive variance seen in children across all direction conditions on tangram persistence. Indeed, individual
variation in persistence may have eliminated any potential demonstrations of self-regulatory failure. Anecdotal evidence from these sessions suggests a potential depleting role of the laboratory, wherein 5 minutes of ANY laboratory task may in and of itself be overly depleting for some children. Taken together, these findings lead one to question the efficacy of the standard dual task paradigm, commonly used in adult studies of self-regulation, for use in studies with populations whose self-control abilities are limited and/or highly diverse.

Outside of potential issues with testing, exploratory correlational analyses suggest a very different picture for young children. In both number of violations and amount of direction-following behavior (as coded from videos of the direction task), significant correlations were seen with tangram persistence, however, the correlations were in the opposite direction of what would have been predicted given a limited resource model of self-control. Our predictions would have been that those who engaged in a greater degree of self-control in the direction-task should have experienced greater self-regulatory failure, and thus failed to persist on the tangram far more quickly. These data suggest that in fact children who violated the rule less often and followed the direction for more time out of the 5 minutes persisted longer on the tangram task. These unexpected results may be explained utilizing cognitive priming account of self-regulation (e.g., Schacter, Dobbins, & Schnyer, 2004). In this account, engaging in self-regulation primes the brain for self-control, thus increasing the likelihood that one will continue to self-regulate in future exercises of self-control. In children, there is the potential that in the early development of self-regulation, when one engages in self-control, one will continue to engage, rather than fail to continue. These
exploratory findings highlight the need for a developmental study of self-regulatory failure, looking at the continuity and discontinuity of self-regulation and self-regulatory failure with age.

This study has several limitations, which have been suggested through the discussion section. The primary limitation is one of methodology, wherein the dual-task paradigm may not be the most appropriate approach for assessing self-regulatory failure in children. Recent studies have begun to introduce a within-subjects, pre-post approach to the study of self-regulatory failure that may account for more individual differences and could be useful for the study of self-regulatory failure in children. Moreover, these results did not allow for the differentiation of self-control abilities (e.g., executive function) in relation to self-regulatory failure. Future studies would benefit from including measures of individual self-control abilities, such as executive function, or more temperamental measures (e.g., effortful control).
Chapter 4: Study 2

While preliminary results from Study 1 suggest a non-replication of the adult findings of self-regulatory failure, the individual differences in persistence abilities, regardless of direction condition, have led to the modified methodological approach used in Study 2. Study 2 was designed to investigate the developmental and individual differences associated with self-regulatory failure. In Study 2, the potential role of the development of executive function was examined in predicting or protecting against self-regulatory failure. Additionally, measures of individual differences (such as temperament/personality) that are related in some populations to susceptibility to depletion effects were examined in children (for a full review, see Baumeister et al., 2006). Adhering to a strength model of self-control, the prediction was that the development of one’s self-control capacity would lead to the recruitment of self-control in the appropriate situations, leading to a greater depletion effect in future self-control situations (as compared to the situation where children likely do not have well-developed self-control and are unlikely to have a high degree of recruitment). It was hypothesized that there would be age-related changes in the magnitude of self-regulatory failure, in that 4-year-olds would likely show the least effect due to their relatively less developed executive function, 6-year-olds would likely show a larger magnitude effect given that they have better development of executive function, and 8-year-old children who have the most well-developed executive function, would show the largest effects of depletion on their follow-up persistence, akin to those reported in previous studies with adults.
It was also expected that measures of individual temperament (CBQ), primarily the effortful control subscale, would predict the magnitude of self-regulatory effects. Predictions related to individual temperament were similar to those suggested by developing executive function. Namely, with increased effortful control, individuals would engage in greater self-control, and would subsequently become depleted. On the other hand, training studies aimed to overcome the effects of self-regulatory failure (e.g., Muraven et al., 2010), suggest that there may be ways to overcome self-regulatory failure. In reference to temperament, specifically effortful control, the more controlled one is in everyday life, the more experience one may have with control-based situations, leading to a certain efficiency (defined as needing less effort to reach the same behavior outcome) in self-regulation, and yielding less depletion effects.

Method

Participants. Participants were 4-, 6-, and 8-year-old children \((N = 146)\) (For a breakdown of age group by gender see Table 1). Participants were Caucasian (89.9%), African-American (2.7%), Hispanic (2.7%) or Asian (2%). Participants were recruited from the participant pool maintained by the Institute of Child Development. Children spoke and understood English. No children were excluded for parent-reported developmental disabilities or delays. (Insert Table 1 here).

Procedure. All parents gave informed consent for their children to participate. Children also gave verbal assent. Parents were asked to complete the Children’s Behavior Questionnaire and a brief demographics form while their children participated in the study.
All participants were tested in the Developmental Social Cognitive Neuroscience Lab at the Institute of Child Development. All participants completed the pre-post tangram task, the direction task used in Study 1, and the Stanford-Binet Vocabulary assessment. A subset of the 4-year-olds \((n = 14)\), 6-year-olds \((n = 14)\), and 8-year-olds \((n = 23)\) completed additional executive function measures. Participants in this subgroup completed the two computer-based measures of executive function at the onset of testing. These assessments were given in fixed order (i.e., DCCS, Flanker) so as to best examine individual differences in these tasks. Following the executive function battery, children completed the first tangram persistence task, then the direction task, and then the follow-up tangram persistence task. After completion of the final persistence task, participants completed the vocabulary section of the Stanford-Binet Version 5. (For a breakdown of the procedure, see Figure 3). (Insert Figure 3 here).

Following the study, children and their parents received compensation and were debriefed. Parents were paid $10 to cover travel expenses, and children received a small toy and a DSCN lab t-shirt.

**Child Measures.**

*Flanker Task* (Rueda et al., 2004). In the Flanker task, children were shown a line of fish and told to point to the direction the middle fish was pointing. In incongruent trials, the flanking fish were pointing in the opposite direction of the middle fish. In congruent trials, flanking fish were pointing in the same direction as the middle fish. If children passed (75 % accuracy) 20 fish based trials, arrows replaced the fish
and children were asked “which direction the middle arrow was pointing,” this continued for 20 additional trials.

*Dimensional Change Card Sort Task (DCCS; Zelazo et al., 2003; Zelazo et al., in press).* In the computerized version of the Dimensional Change Card Sort task, children were shown a series of stimuli that could be sorted according to two dimensions (i.e., shape and color). First, children were told to sort a series of stimuli (e.g., red rabbits and blue boats) by one dimension (i.e., shape or color). After a series of five trials on the pre-switch dimension, children were instructed that they “were now playing a new game, the color game (or shape game if color was the first dimension).” In the color game, children sorted the stimuli by their color, rather than their shape dimension. If children completed the series of five trials post-switch phase with 80% percent accuracy, they moved on to a mixed block, wherein the direction for sorting cards (i.e., shape or color) was constantly changing, participants had a total of 30 mixed trials.

*Tangram Persistence.* Participants were given a series of solvable tangram puzzles. In the first two puzzles, the experimenter helped the child in solving the puzzles. Participants were then instructed to complete the “house” puzzle by themselves. As in Study 1, the time of persistence was the outcome measure, and the previously described “bring me back bell,” was used. However, unlike Study 1, after completing the direction task, participants again returned to the tangrams and had to solve a difficult hammer puzzle. Time of persistence was the outcome measure for follow-up persistence (again, using the bell ring or verbal termination as the latency measure). Difference scores were calculated by subtracting the post-persistence time
from the pre-persistence time. Individual variation in time of persistence, regardless of direction condition, was accounted for, by dividing the difference score by the time of persistence-pre score.

Direction Task. For a full description of the Direction task, refer to Study 1. The only difference to note is that children were randomly assigned to receive either a do direction condition (i.e., “Do keep one hand on the table at all times, but you can play with any of the toys you want.”) or the neutral condition (i.e., “You can play with any of the toys you want.”). The don’t direction condition was not used.

Parent Report Measures.

Demographic questionnaire. The demographic questionnaire was administered to assess several aspects of the child’s socio-cultural and economic status, including gender, age, race/ethnicity, English language familiarity, number of siblings, birth order, maternal and paternal education and occupation, and family income.

Children’s Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001). The Children’s Behavior Questionnaire measures the temperament of children between the ages of 3 and 7. Aspects that can be attained from the CBQ-VSF include Effortful Control, Surgency, and Negative Affect. Effortful control is usually related to executive function, but the two constructs are not entirely overlapping. Effortful control is considered to be a measure of inhibition and self-regulation in life, particularly in the home. Parents were asked how true certain behaviors (1-7 scale) were of their child in the last six months.

Quantification of Measures
Executive Function Battery. The computerized executive function tasks record both time and accuracy. In order to address the accuracy-speed tradeoff in the development of executive function, scores for individual measures (i.e., Flanker, DCCS) were calculated by integrating accuracy information, as well as reaction time information (For a full review of calculations, see Zelazo et al., *in press*).

For the DCCS, each trial (out of 40) accounted for a score of .125. When combined, the DCCS accuracy composite was a total of 0-5 points (reflecting accuracy and total trials completed). Additionally, in order to integrate reaction time aspects, for individuals scoring above 80% accuracy (a 4 out of 5 on the accuracy composite), a mean reaction time was calculated and scaled using a logarithmic function. When combined with the accuracy composite, each participant received a score of 0-10 capturing accuracy, level of task completion, and reaction time.

Similar to the DCCS calculations, the Flanker task had 40 trials per participant. Each correct trial received a score of .125 and the sum equaled an accuracy composite of 0-5. Reaction time calculations used the same method as for the DCCS. Flanker composite scores reflected both reaction time and accuracy and were scored from 0-10.

Additionally, although the DCCS and Flanker are thought to capture distinct aspects of executive function, a composite score was calculated by averaging the composite score of the DCCS and the composite score of the Flanker in order to approximate overall executive function level.

Vocabulary. Raw scores were generated from the vocabulary subscales of the Stanford-Binet Version 5. The raw score was used in these analyses, with age in months as a covariate.
Children’s Behavior Questionnaire. The CBQ-VSF consists of 36 questions, which can be used to calculate scores for three dimensions of temperament. The authors of the CBQ (Rothbart and colleagues) suggest calculating scores for Effortful Control (from Low-Intensity Pleasure, Inhibitory Control, Perceptual Sensitivity, and Attentional Focusing type questions), Surgency scores (from Impulsivity, Approach, High-Intensity Pleasure, Smiling/Laughter, Shyness, and Activity Level type questions), and Negative Affect (from Discomfort, Fear, Anger/Frustration, Soothability, and Sadness type questions).

Persistence. Persistence was calculated in two ways. First, delta scores were calculated by subtracting the persistence following the direction task from persistence preceding the direction task. These difference scores are referred to as the magnitude of the self-regulatory failure. Additionally, in order to account for individual differences in persistence, these differences scores were also divided by the pre-persistence in order to create a scaled magnitude of self-regulatory failure.

Results

Condition Effects. Replicating the results from Study 1, an ANOVA failed to show differences between the direction conditions (“Do direction” or “neutral direction”) on the change in persistence from pre-to-post on the tangram task (referred to as the magnitude of self-regulatory failure)\(t(142) = -0.809, n.s.\)(See Figure 3), or on the scaled change in persistence (pre-post)/pre, (referred to as the scaled magnitude of self-regulatory failure)\(t(142) = 0.332, n.s.\)(See Figure 4). For the purpose of analyses, this between-subjects variable was collapsed and all future results report only within-subject differences (pre-post persistence), without reference to condition.
**Self-Regulatory Failure Effects.** Using a pre-post design, children ages 4, 6, and 8 demonstrated performance decrements due to time. Results from a repeated measures ANOVA reveal significant differences between persistence on the pre-tangram puzzle and persistence on the post-tangram puzzle that followed a 5-minute period of any activity (the direction task)($F(2, 144) = 8.76, p < .005$)(See Figure 5).

Surprisingly, and contrary to hypothesis, a 3 (age group) x 2 (Pre-Post) repeated measures ANOVA revealed failed to find significant effects of age in the magnitude of self-regulatory failure ($F(2, 142) = .211, n.s.$). Descriptive statistics for pre-and post-persistence (with variance) in all age groups can be found in Table 2. As expected, and suggestive of development in self-regulatory/persistence abilities, there was a significant main effect of age on persistence level ($F(2, 142) = 6.46, p < .005$). Post-hoc Tukey tests revealed that 4-year-olds’ average persistence score was less than 6- and 8-year-olds’ ($HSD = -85.07, p < .05$, $HSD = -119.28, p < .01$, respectively).

**Executive Function Measures.** An overall EF composite score was calculated by averaging the Flanker toolbox score and the DCCS toolbox score. For the subset of children who received the executive function battery, executive function performance was not related to the magnitude of self-regulatory failure ($r = -.069, n.s.$), or the scaled magnitude of self-regulatory failure ($r = .121, n.s.$).

Data from each of the executive function measures were analyzed separately to explore if individual measures contributed to either the magnitude of self-regulatory failure or the scaled magnitude of self-regulatory failure.
The Flanker toolbox score was not related to the magnitude of self-regulatory failure \( (r = -.131, \text{n.s.}) \). The Flanker score was also not related to the scaled magnitude of self-regulatory failure \( (r = -.014, \text{n.s.}) \).

The Dimensional Change Card Sort (DCCS) toolbox score was also not related to the magnitude of self-regulatory failure \( (r = -.017, \text{n.s.}) \) or to the scaled magnitude of self-regulatory failure \( (r = .168, \text{n.s.}) \).

**Temperament Measures.** In addition to Executive Function differences assessed in the children utilizing the EF battery, children’s temperament was assessed utilizing the Children’s Behavior Questionnaire, VSF (Rothbart et al., 2001). From the 36-questions, scores for Effortful Control, Negative Affect, and Surgency were calculated. The range of scores for Effortful Control, Negative Affect, and Surgency seen across age groups can be found in Table 4. Effortful Control and Surgency were not related to differences in the magnitude of self-regulatory failure \( (r = -.057, \text{n.s., } r = -.029, \text{n.s.,} \text{ respectively}) \). However, negative affect was significantly related to the magnitude of self-regulatory failure \( (r = -.318, p < .05) \) wherein children with greater levels of negative affect, characterized by irritability and frustrated temperaments, had less change in their pre-to-post tangram persistence.

**Socio-demographic Measures.** A full breakdown of early social contextual differences in children can be seen in Table 3. This includes socio-economic variables such as family income and maternal education, as well as variables about birth order and number of siblings. A series of exploratory correlational analyses revealed that family income was not related to the magnitude of self-regulatory failure, or the scaled magnitude of self-regulatory failure \( (r = -.048, \text{n.s., } r = .038, \text{n.s.,} \text{ respectively}) \).
However, birth order was related to the magnitude of self-regulatory failure ($r = -0.197, p < 0.05$), children who were later born (second, third, fourth) exhibited less decrement in their pre-post tangram persistence.

**Vocabulary Measure.** As hypothesized, a 2-way (condition) between-subjects ANCOVA failed to show significant differences in Stanford-Binet Version 5 raw vocabulary score using age in months as the covariate ($F(1, 142) = 0.013, n.s.$).

**Discussion**

As was the case with Study 1, the traditional dual-task paradigm approach to the study of self-regulatory failure did not reveal significant differences in persistence for children who had to self-regulate in a previous task versus children who did not. Given that nearly all laboratory tasks require some degree of self-regulation (e.g., Baumeister, 2002) children may be self-regulating in any condition of the direction task. In light of this interpretation, a within-subjects approach may allow for the manifestation of self-regulatory failure.

Significant differences in continued self-regulation, by utilizing a pre-post persistence design suggests that, as is the case with adults, engaging in any amount of self-control hinders children’s future engagement in self-control. Consistent with our hypothesis, children across all ages displayed performance deficits in a self-regulation task from pre-to-post, however, contrary to our hypotheses, the magnitude of self-regulatory behavior (change from pre-post) was not related to age, executive function, or most aspects of individual temperament.
We expected age-related changes in the magnitude of self-regulatory failure. There is neural evidence indicating late maturation of prefrontal areas responsible for self-regulation (Shaw et al., 2007). Additionally, extensive findings from developmental studies of executive function reveal significant changes in self-regulatory abilities, particularly changing between the ages of three and eight (e.g., Zelazo, Carlson, & Kesek, 2008). Consistent with these behavioral results, a significant main effect of age was present for average persistence (overall persistence level). 8-year-olds and 6-year-olds persisted significantly longer on the difficult puzzles than 4-year-olds. The difference between pre- and post-persistence in the tangram task was not significantly different between age groups (there were no interaction effects of age x time). Taken together, the lack of age-related changes in the magnitude of self-regulatory failure, while concurrently displaying increased ability to engage in persistence, indicates a potential continuity in self-regulatory failure. These data demonstrate no significant differences between age groups in the magnitude of performance decline in self-regulatory failure.

The notion that self-regulatory failure is not influenced by age-related changes in self-control ability is further supported by a lack of significant correlations between all aspects and measures of executive function and the magnitude of self-regulatory failure in a subset of the population. Regardless of relative level of executive function, children display nearly identical patterns and magnitude of self-regulatory failure.

Previous studies have shown that individual differences in personality may influence the magnitude of self-regulatory failure (Baumeister et al., 2006), however, outside of a single significant correlation between Negative Affect (CBQ) and the
magnitude of self-regulatory failure, these results do not speak to individual differences in self-regulatory failure.

While analyses using the standard dual-task paradigms do not reveal significant self-regulatory performance decreases in children of any age, these results provide several important contributions to the literature. First, within-subjects analyses reveal that children do show evidence of a performance decrease in a task requiring self-regulation. Second, the relatively novel methodology for the study of self-regulatory failure, a pre-post, within-subjects design, provides a method for studying populations whose self-control abilities are quite varied. The standard dual task paradigm works quite well in populations that are relatively homogeneous in general self-regulatory ability (e.g., college students), however, in order to find the effects of self-regulatory failure in a heterogeneous group, a within-subjects design may be necessary. Finally, the magnitude of self-regulatory failure across development is potentially continuous given the lack of findings relating the level of executive function and age-related differences.

A limitation of the current study is the inability to distinguish between self-regulatory failure and general cognitive decline/fatigue. Given that all ages and conditions in Study 2 demonstrate marked failure in persistence following a self-control task, one may contend that what is being captured is simply general cognitive decline, subjective fatigue, or mental fatigue, wherein participants’ behavior in most laboratory tasks decline with time (e.g., Ackerman & Kanfer, 2009). This concept has been documented in several previous studies over the last 100 years with both adults and children (e.g., Ebbinghaus, 1896, Carmichael, Kennedy, & Mead, 1949) To disentangle
general cognitive decline from specific decline in self-regulatory performance, future studies would benefit from the inclusion of pre-post tests that are not expected to be dependent on self-control abilities (e.g., Stanford-Binet vocabulary). As this study did not include such a measure, we can only comment that self-regulatory performance declined significantly after exerting self-control, not that this failure or declination is specific to executive function/self-control.
Chapter 5: General Discussion

The goals of the present studies were trifold: 1) to investigate if self-regulatory failure, as documented with adults, is also present in children, when self-regulatory abilities are relatively underdeveloped, 2) to detail potential developmental changes in the magnitude of self-regulatory failure, and 3) to examine individual differences in temperament, self-regulation, and socio-demographics that may lead to differences in self-regulatory failure.

In reference to the first goal, it was hypothesized children as young as age four would show evidence of self-regulatory failure. At first glance, results from Study 1 and Study 2 provide little evidence that children exhibit self-regulatory failure in a standard dual-task paradigm. However, it may be argued that using a pre-post, within-subjects design, children as young as four years of age, at the very early end of self-regulatory skills, exhibit marked decreases in their self-regulation after having used any self-control (even the limited self-control necessary for the neutral condition). These results, largely due to our modified methodology, may provide initial evidence of self-regulatory failure in children. Additionally, this modified paradigm establishes a potential resource for investigating self-regulatory failure in relatively heterogeneous groups with regards to self-regulatory skills.

The standard dual task paradigm does not appear to work with children. A recent study by Dahm and colleagues (2011) investigating self-regulatory failure in an aging population (40-65 years) also failed to show significant differences using the standard dual-task paradigm. Our analyses failed to find significant differences in self-regulation following previous utilization or non-utilization of self-regulation, using the standard
paradigm in Study 1 and Study 2. Several reasons for this lack of findings may exist. First and foremost, children may to treat any laboratory situation as a goal-directed direction following condition. Given the striking decrease in self-regulatory performance in Study 2 from pre-persistence to post-persistence, regardless of direction condition, children are likely over-regulating in all conditions. Moreover, following this line of reasoning, there is also the potential that the effects of explicit (direction condition) versus more implicit (neutral condition) have a long-term time course, rather than short-term, as is the case with adults. In this case, if children had to perform additional self-regulatory tasks over a longer period of time, in the direction versus neutral condition may begin to show differences (indicating long-term efficiency in self-regulation). However, the present study, taken together with the Dahm and colleagues findings, only serve to caution that the dual task paradigm may not be as effective in situations where participants are highly variable in their persistence abilities.

It was also hypothesized that with the age-related development of self-regulatory abilities, children should exhibit larger self-regulatory failure. These data provide relatively little support for this hypothesis. In Study 2, there were non-significant differences in magnitude of self-regulatory failure with increase in age. Moreover, there were no significant relations between executive function abilities, or effortful control aspects of temperament in predicting the magnitude of self-regulatory failure. Taken together, there is surprisingly little evidence for developmental change in the magnitude of self-regulatory failure, either due to differences in self-control abilities, or to other age-related improvements.
Finally, it was hypothesized that individual differences in temperament, particularly effortful control, as well as increased executive function abilities should be correlated with magnitude of self-regulatory failure. These results do not support this hypothesis. Effortful control, as measured by the CBQ-VSF, as well as level of executive function did not predict individual differences in the magnitude of self-regulatory failure. A potential reason for may be due to the fact that only a subset of the population received all of the measures. Other aspects were still significant, namely that greater negative affectivity predicted less self-regulatory failure in the subset of the population. Most of the measures of socio-demographic status were also not related to the magnitude of self-regulatory failure, with the lone exception of birth order, in which later born children showed less magnitude of self-regulatory failure. This anomalous finding provides interesting questions for future research regarding the role of the early environment in influencing the efficiency of self-regulation and the susceptibility to self-regulatory failure.

**Implications for Education**

This evidence of performance decreases in self-regulatory tasks has striking implications for early childhood education. Given that children begin to exert less persistence after 5 minutes of any type of direction-following task, which is often the crux of educational curriculum, children’s goal directed behavior is likely hindered in classroom learning situations. Returning to evidence from training programs concerned with adults, several suggestions may be made (e.g., Muraven et al., 2010). Primary amongst these suggestions is the argument that school-training may provide a rudimentary “weight training” for self-regulation, essentially, as children’s self-
regulation is constantly called upon and exhausted, they may learn efficiency in their self-regulation. Ideally, after some training, children will show a decrease in the magnitude of self-regulatory failure. However, this assertion is not necessarily supported by the present data. If this were the case, we would expect to see that children who have been engaged in several years of extensive classroom training (8-year-olds) should show greater self-regulatory failure. This is not necessarily the case in the present study, there were not significant differences between age groups on magnitude of self-regulatory failure.

A second potential suggestion from training studies may be the necessity of explicit instruction in self-regulatory efficiency. If children were explicitly taught methods for efficient self-regulation, their magnitude of self-regulatory failure may be far less. Future research into explicitly training efficiency in self-regulation in children could inform our understanding of early childhood education, potentially reframing the most beneficial techniques and approaches to be covered.

**Limitations**

While these results provide marked evidence that children as young as 4-years of age fail to continue to control their behavior after having previously controlled their behavior (in any laboratory situation), an important question remains, is it the case that children *cannot* continue to control their behavior, or is it the case that children *will not* continue to control their behavior? The former contention is what is widely held by those who espouse the strength model of self-control. According to the strength model, there is a limited resource from which self-control can be supported and depleting this resource through continued exertion of self-control will lead to an “empty” tank,
eventually ending in self-regulatory failure. The argument arises from evidence that after adults engage in self-control, their continued engagement in self-control appears to be limited (e.g., adults do not exhibit high levels of self-control after having self-regulated for a period of time).

An alternative explanation that can explain many of these striking results: is that it is not the case that adults cannot continue to exert self-control, rather, they choose not to continue to exert self-control. This contention has been raised often (for a full review see Hagger et al., 2010). Theorists have argued that self-regulatory failure findings are likely the result of a careful interplay between resource control depletion and motivational depletion (Baumeister & Muraven, 2000). Recently, empirical data have supported the notion that motivational differences can ameliorate mild effects of self-regulatory failure (e.g., Vohs, Baumeister, & Schmeichel, 2012). The individual differences in children’s motivation may make this argument all the more plausible in children. Future studies would benefit from a disentangling of motivational depletion and self-regulatory resource depletion.

As mentioned briefly in the discussion of Study 2, another question for future research is in regards to the specificity of self-regulatory failure. Cognitive or mental fatigue, as documented in adults, appears to have similar effects to self-regulatory failure, and is relatively widespread in nature (e.g., Ackerman & Kanter, 2009). This plausible alternative is not a limitation of the study of self-regulatory failure, instead, it is a call for additional research that could specify the domains that these decreases in performance can be observed in, particularly in children. The present findings lend support to the argument that self-regulation decreases for children who have already
used self-control, however, while we know this effect happens in self-regulation, we do not know how specific the decrease in performance is. To address this issue the inclusion of a pre-, post-cognitive, but not explicitly a self-regulatory demanding task, such as tests of short term memory, would need to be administered.

Conclusions

These results provide important insight into the early nature of self-regulatory failure, namely, that children as young as four-years of age exhibit a marked decrease in their self-regulation (as measured by persistence) following a task with either an explicit self-control direction, or a relatively neutral direction. While the findings of self-regulatory failure in adults have been documented in hundreds of studies, across a myriad of applications of self-regulation (for a full review see Haggar et al., 2010), no evidence regarding the early onset of self-regulatory failure in children has been reported. Moreover, the surprising developmental continuity in magnitude of self-regulatory failure leads to many possible questions regarding the strength model/limited resource model of self-control. Primary amongst those questions is the role of cognitive development in influencing individual differences in self-regulatory failure. In the present study, little evidence was found for relations between the development of executive function or individual differences in temperament and the magnitude of self-regulatory failure. Evidence from the more social and contextual differences (e.g., the correlation between birth order and magnitude of self-regulatory failure) may lead to the hypothesis that aspects of the social environment might influence the magnitude of self-regulatory failure. This potentially fruitful exploration should be researched in the future.
Finally, while questions remain regarding the specificity and mechanisms underlying self-regulatory failure, they do not render the findings impotent. Children do show a marked decrease in their persistence (self-regulation) after a direction-following task. Whether children can’t or won’t persist is an important question for future research, but the fact remains that on a performance level, they don’t.
References


Appendix A

Table 1. Distribution of gender and age in months across developmental groups in Study 2

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Gender</th>
<th>n</th>
<th>Mean Age in Months (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year-olds</td>
<td>Male</td>
<td>21</td>
<td>55.86 (4.39)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>22</td>
<td>54.82 (3.89)</td>
</tr>
<tr>
<td>6-year-olds</td>
<td>Male</td>
<td>25</td>
<td>78.64 (2.89)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>28</td>
<td>78.14 (3.31)</td>
</tr>
<tr>
<td>8-year-olds</td>
<td>Male</td>
<td>21</td>
<td>102.48 (3.15)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>24</td>
<td>101.58 (3.06)</td>
</tr>
</tbody>
</table>
Table 2. Distribution of gender and age in experimental groups in Study 2

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Gender</th>
<th>Direction condition</th>
<th>N</th>
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</thead>
<tbody>
<tr>
<td>4-year-olds</td>
<td>Male</td>
<td>Self-control</td>
<td>12</td>
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<td>8-year-olds</td>
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<td></td>
<td></td>
<td>Neutral</td>
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</tbody>
</table>

Note. The experimental group (self-control) received an explicit direction during the 5-minute self-control task, “Do keep one hand on the table at all times, but you can play with any of the toys.” The control group participants (neutral) were told “You can play with any of the toys.”
Table 3. Demographic means by age group for birth order, number of siblings, maternal education, and family income in Study 2

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Birth Order (SD)</th>
<th>Number of Siblings (SD)</th>
<th>Maternal Education</th>
<th>Family Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year-olds</td>
<td>1.77 (.87)</td>
<td>2.44 (.85)</td>
<td>Some Graduate School</td>
<td>$75,000-$100,000</td>
</tr>
<tr>
<td>6-year-olds</td>
<td>1.52 (.70)</td>
<td>2.60 (.88)</td>
<td>Some Graduate School</td>
<td>$75,000-$100,000</td>
</tr>
<tr>
<td>8-year-olds</td>
<td>1.49 (.69)</td>
<td>2.56 (.72)</td>
<td>Baccalaureate Degree</td>
<td>$75,000-$100,000</td>
</tr>
</tbody>
</table>
Table 4. Children’s Behavior Questionnaire Means for Surgency, Negative Affect, and Effortful Control by Age Group in Study 2

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Variable</th>
<th>Mean (SD)</th>
<th>Range (Min-Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year-olds</td>
<td>Surgency</td>
<td>4.20 (1.06)</td>
<td>2.25 - 5.92</td>
</tr>
<tr>
<td></td>
<td>Negative Affect</td>
<td>4.40 (.75)</td>
<td>2.92 - 5.67</td>
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<tr>
<td></td>
<td>Effortful Control</td>
<td>5.38 (.73)</td>
<td>4.20 - 6.67</td>
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<tr>
<td>6-year-olds</td>
<td>Surgency</td>
<td>4.63 (.93)</td>
<td>2.83 - 6.08</td>
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<tr>
<td></td>
<td>Negative Affect</td>
<td>4.11 (.82)</td>
<td>2.83 - 5.58</td>
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<tr>
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<td>Effortful Control</td>
<td>5.19 (.88)</td>
<td>3.75 - 6.83</td>
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<tr>
<td>8-year-olds</td>
<td>Surgency</td>
<td>4.82 (1.06)</td>
<td>2.83 - 6.83</td>
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<tr>
<td></td>
<td>Negative Affect</td>
<td>4.08 (.93)</td>
<td>2.33 - 5.83</td>
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<tr>
<td></td>
<td>Effortful Control</td>
<td>5.28 (.89)</td>
<td>3.82 - 5.29</td>
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</tbody>
</table>

Note. Surgency, Negative Affect, and Effortful Control composite variables are calculated from a series of questions on the Children’s Behavior Questionnaire. All are based off the 1-7 range of scores.
Table 5. Tangram Persistence (Pre/Post) by age group in Study 2

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Time (Pre/Post)</th>
<th>Mean Persistence in seconds (SD)</th>
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</thead>
<tbody>
<tr>
<td>4-year-olds</td>
<td>Pre</td>
<td>173.11 (156.49)</td>
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<td></td>
<td>Post</td>
<td>140.64 (131.86)</td>
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<tr>
<td></td>
<td>Difference</td>
<td>32.45 (105.32)</td>
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<tr>
<td></td>
<td>Standard Diff.</td>
<td>-.06 (.81)</td>
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<tr>
<td>6-year-olds</td>
<td>Pre</td>
<td>250.76 (195.85)</td>
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<tr>
<td></td>
<td>Post</td>
<td>228.27 (177.83)</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>22.50 (111.59)</td>
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<tr>
<td></td>
<td>Standard Diff.</td>
<td>-.09 (.62)</td>
</tr>
<tr>
<td>8-year-olds</td>
<td>Pre</td>
<td>292.58 (185.40)</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>254.87 (178.47)</td>
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<td>Difference</td>
<td>37.72 (144.09)</td>
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<tr>
<td></td>
<td>Standard Diff.</td>
<td>.04 (.48)</td>
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Note. Difference scores are calculated by subtracting post-persistence from pre-persistence. Standardized difference scores are calculated by dividing the difference score by the pre-persistence.
Table 6. Bivariate correlations for variables included in Study 2.

<table>
<thead>
<tr>
<th>Variable 1</th>
<th>Variable 2</th>
<th>Correlation Coefficient</th>
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<tbody>
<tr>
<td>EF Compre</td>
<td>EF Planner</td>
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<td>EF DCs</td>
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<td>EF Control</td>
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<tr>
<td>EF Compre</td>
<td>EF Alert</td>
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<td>EF Compre</td>
<td>EF Sherry</td>
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<td>EF Compre</td>
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<td>EF Material</td>
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<tr>
<td>EF Compre</td>
<td>EF Vocab</td>
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<td>EF Compre</td>
<td>EF Age (mo)</td>
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<td>EF Compre</td>
<td>EF SRP</td>
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</tr>
<tr>
<td>EF Compre</td>
<td>EF Pres</td>
<td>0.25</td>
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Note: Values denote two-tailed correlation coefficients. All correlations were performed on the complete sample with demographically adjusted values.
Table 7. Partial correlations for variables included in Study 2, using age in months as a covariate.

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Note: All partial correlations were performed on complete sample with age data reported (N = 138) except for the DBO variables.
Appendix B

Figure 1. Persistence on the Tangram Task by Conditions in Study 1

Note. Bars represent standard error. Children were randomly assigned to the Do ($n = 14$), Don’t ($n = 16$), and No Direction/Neutral ($n = 30$)
Figure 2. Persistence on the Tangram Task by Direction in Study 1

Note. Bars represent standard error. Children were randomly assigned to the Direction ($n = 30$) or No Direction ($n = 31$) conditions.
Figure 3. Structure of Study 2 for participants randomly assigned to the direction condition (top) and the neutral condition (bottom)
Figure 4. Difference scores of Pre-Persistence minus Post-Persistence for all age groups in Direction (Do) and Neutral conditions in Study 2

Note. Bars represent standard error.
Figure 5. Scaled Difference Pre-Post Persistence Scores for all age groups by condition in Study 2

Note. Bars represent standard error.
Figure 6. Difference between pre and post for all age groups with conditions collapsed in Study 2

Note. Bars represent standard error.