INVESTIGATING THE COGNITIVE UNDERPINNINGS OF PROCRASTINATION: AN INTERVENTION STUDY AND A LONGITUDINAL ANALYSIS

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Investigating the Cognitive Underpinnings of Procrastination: An Intervention Study and a Longitudinal Analysis Goal-Related Interventions

Thesis directed by Professor Akira Miyake

This dissertation presents two studies that examined how goal-management abilities are associated with procrastination. The first study was a two-part intervention study designed to (a) examine whether individuals could reduce their academic procrastination, and (b) examine the association between procrastination and the accomplishment of academic goals. In the second study, data from a longitudinal twin study were analyzed to (a) examine whether procrastination in adulthood could be predicted by three cognitive abilities in early childhood, and (b) further understand how procrastination is associated with intelligence.

In the first study, 221 subjects completed an experiment in which they set academic goals and identified the temptations that often cause them to procrastinate. Some subjects also completed interventions in addition to these goal-setting exercises, which focused on elaborative goal-setting (i.e., setting SMART goals) and/or prepared subjects with strategies to resist their temptations (by forming implementation intentions). Results indicated that procrastination was predictive of the success of the goals generated during the exercises, but there were no effects of either intervention on the reduction in academic procrastination (or the accomplishment of academic goals), even when examining relevant moderating variables.

In the second study, I analyzed data from 954 twins who completed measures of self-restraint, attentional control, and IQ in early childhood (ages 1-3 years) and returned for measures of procrastination, goal management, impulsivity, and IQ at age 23. Results indicated that neither self-restraint, attentional control, nor IQ in early childhood were associated with procrastination at the phenotypic or genetic levels, and that procrastination was not associated with IQ even when examining IQ in adolescence or early adulthood.

Together, these findings provided additional, albeit limited, evidence for the association between goal management abilities and procrastination, most strongly with regard to the accomplishment of academic goals. These studies were also the first to directly test the effectiveness of goal-related interventions on procrastination and examine early life correlates of procrastination. Given the lack of conclusive evidence observed here for both of these topics, further research is needed to understand what interventions are effective at reducing procrastination and identify which factors in childhood can predict later life procrastination.

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Chapter 1

Brief Introduction: Unanswered Questions Regarding the Cognitive Underpinnings of Procrastination

Procrastination – the voluntary delay of an intended course of action despite expecting to be worse off for the delay – is problematic and pervasive (Ferrari, 2010; Steel, 2007, 2010). Early research on procrastination has revealed the negative physical, psychological, and financial consequences of procrastination (Jaffe, 2013; Pychyl & Flett, 2012) and identified important personality traits associated with an individual's tendency to procrastinate, such as impulsivity, conscientiousness, and perfectionism (Schouwenburg & Lay, 1995; Steel, 2007; van Eerde, 2000). Few empirical studies have directly examined the cognitive abilities that are also associated with procrastination (Blunt & Pychyl, 2000, 2005; Gröpel & Steel, 2008; Gustavson, Miyake, Hewitt, & Friedman, 2014, 2015). However, recent theoretical perspectives on procrastination have proposed that goal-management abilities may also be highly relevant to procrastination (Krause & Freund, 2014a; Kuhl, 1994; Steel & König, 2006).

In fact, my own recent work is part of this growing body of research that has highlighted the role of goal management in procrastination (Gustavson, et al., 2014, 2015). This initial work on procrastination was motivated by an evolutionary account of procrastination, impulsivity, and goal management originally proposed by Steel (2010). Stated briefly, this evolutionary account suggested that procrastination evolved as a by-product of the more evolutionarily ancient trait, impulsivity (Steel, 2010). Essentially, humans evolved to be impulsive, needing to satisfy their basic needs quickly without focusing on long-term goals. In the modern world, we are now forced to juggle many types of long-term goals in everyday life. However, our impulsive nature causes us to ignore these goals and instead procrastinate by impulsively choosing short-term

pleasures over long term goal achievement. Therefore, according to this account, the genetic influences on procrastination are likely to be highly correlated with those on impulsivity, and these shared genetic influences overlap substantially with the ability to maintain long-term goals in everyday life.

In two studies on a large sample of more than 750 twins (Gustavson et al., 2014, 2015), I showed that the genetic influences on procrastination accounted for about half of the variation in procrastination at the latent variable level, and that these genetic influences on procrastination were identical to those for impulsivity (r_g = 1.0, Gustavson et al., 2014). Importantly, I also showed that these genetic influences highly overlapped with those that support everyday goal management (i.e., the ability to activate and maintain short- and long-term goals in everyday situations), and were associated with the genetic influences on executive functions (EFs): goal-related cognitive abilities that control and regulate behavior (Gustavson et al., 2014, 2015). Although this evolutionary account is not directly tested any further in this dissertation, the results of these studies provided further evidence that procrastination is associated with poorer goal-management abilities and began to unravel the extent to which genetic and/or environmental influences play a role in these associations.

Despite the growing body of empirical and theoretical perspectives on the role of goal-management ability in procrastination, multiple questions remain regarding which aspects of goal management are associated with procrastination. For example, although individuals who report more goal-setting in everyday life may procrastinate less (Gröpel & Steel, 2008), it is unclear whether training individuals to set better goals will help them reduce their procrastination. Similarly, although my own work has shown that procrastination is associated with goal-management abilities in everyday life, as well as those involved in EFs (Gustavson et

al., 2014, 2015), it is unclear whether these associations may be due to the fact that procrastination is associated with general cognitive abilities (e.g., intelligence), or whether procrastination is most strongly associated with cognitive abilities that primarily rely on goal management processes.

Furthermore, two important areas of research on procrastination have been neglected in the existing literature. First, it is clear that procrastination is detrimental to the well-being of the procrastinator, but few if any studies have tried to reduce procrastination directly (e.g., using between-subjects interventions). Second, many studies have examined procrastination in high-school, college, and adulthood (for review, see Steel, 2007), but no studies have directly examined the emergence of procrastination, such as identifying cognitive abilities or personality traits in early childhood that may predict procrastination later in adolescence or adulthood. Therefore, in addition to investigating some of the unanswered questions based on existing studies on goal management and procrastination, it is also important to explore these understudied areas of procrastination, which can further inform theoretical perspectives regarding the malleability of this problematic behavior, and predict which individuals will be at risk for procrastination later in life.

Goals and Organization of This Dissertation

This dissertation includes two studies that further examined the role of goal-management abilities (and other related cognitive abilities) in procrastination, and investigated these understudied areas in procrastination research. Each study focused on two distinct research questions. In the first study, described in Chapter 2, I asked: (a) Can individuals reduce their academic procrastination by performing goal-related intervention exercises?; and (b) Do individual differences in procrastination predict the accomplishment of academic goals above

and beyond other relevant personality traits (e.g., impulsivity) and/or situational factors (e.g., motivation)? To answer these questions, I conducted a two-session experimental study in which subjects generated important academic goals, completed up to two goal-related interventions, and returned to the lab about three weeks later for posttest measures of procrastination and the self-reported accomplishment of their academic goals.

In the second study, described in Chapter 3, my research questions focused on whether early self-regulatory cognitive abilities were predictive of later life procrastination, and whether procrastination was associated with IQ. Specifically, these questions were: (a) Can adult procrastination be predicted by early childhood measures of self-restraint, attentional control, or IQ?; and (b) Is adult procrastination associated with intelligence when IQ is measured at more proximal time points (adolescence and early adulthood)? These questions were addressed by analyzing data from the same set of twins described in my previous work (Gustavson et al., 2014, 2015), most of which also completed measures of self-restraint, attentional control, and IQ at multiple times in early childhood (e.g., 14, 20, 24, and 36 months), as well as measures of IQ later in adolescence and adulthood (ages 17 and 23). Additionally, because this sample of twins was genetically informative, the genetic/environmental etiology of these associations were also explored.

Although both studies broadly examined the association between procrastination and goal management, each study focused on quite different research questions. Therefore, the motivation for these research questions, and the extent to which each study can be used to draw conclusions about them, are described in detail in the individual chapters. Chapter 2 describes the intervention study on academic procrastination using undergraduate students and Chapter 3 describes the longitudinal analyses based on twins from the Colorado Longitudinal Twin Study.

Finally, Chapter 4 discusses some of the general methodological implications and limitations common to both studies. Additionally, Chapter 4 highlights some important future directions that were not discussed in Chapters 2 or 3, especially regarding future theoretical work on goal-management theories of procrastination.

Chapter 2

Reducing Academic Procrastination using Goal-Management Interventions

Recent work on procrastination has begun to highlight the role of goal-management abilities that underlie individual differences in this problematic and pervasive behavior. Theoretical accounts of procrastination have suggested that various aspects of goal management may influence procrastination, such as goal setting (Steel & König, 2006), goal focus (Krause & Freund, 2014a), and action orientation (Blunt & Pychyl, 2000; Kuhl, 1994), and some of these claims have been backed up by a small but growing set of empirical studies (Blunt & Pychyl, 2000, 2005; Gröpel & Steel, 2008; Gustavson et al., 2014, 2015). This growing body of work has represented a shift in procrastination research from focusing primarily on the personality correlates of procrastination (for review, see Steel, 2007) to understanding the cognitive mechanisms that underlie and influence this problematic behavior.

However, although it is becoming clear that goal-management abilities are important factors that underlie procrastination, intervention studies are seriously needed to assess whether goal-management abilities can actually help individuals reduce their procrastination (e.g., in an academic setting). Furthermore, self-reported measures of procrastination have been correlated with measures of accomplishment such as academic grades (Beswick, Rothblum, & Mann, 1988; Tice & Baumeister, 1997). However, surprisingly little research has examined the correlation between procrastination and the success of academic goals or tested whether this association between procrastination and goal accomplishment exists above and beyond the influence of common correlates of procrastination (e.g., impulsivity, conscientiousness).

Therefore, I focused on two key research questions that can advance understanding of the association between procrastination and goal-management abilities in an academic setting. First,

can individuals reduce their academic procrastination by performing intervention exercises designed to target aspects of goal management (i.e., goal-setting and/or resisting temptations)? Second, do individual differences in procrastination predict the accomplishment of academic goals, controlling for other personality and situational factors?

To answer these questions, I conducted a two-session study in a laboratory setting. In the first session, college students completed individual differences measures of procrastination and related traits. They also completed two goal-setting exercises designed to create important short-term academic goals that they would be accomplishing in the next few weeks and identify the anticipated temptations that would distract them from those goals. Subjects were also assigned to one of four between-subjects conditions (no intervention, SMART goal intervention, implementation intentions intervention, or both interventions). Subjects returned to the lab about three weeks later for post-test measures of procrastination and goal accomplishment. This study design allowed me to examine the effectiveness of the two goal-related interventions that either elaborated on the goal-setting aspect of the exercise (SMART goals) or encouraged subjects to develop strategies to prevent their temptations from distracting them (implementation intentions). Furthermore, I examined the association between individual differences in procrastination and the actual achievement of academic goals, controlling for other relevant individual differences variables and situational factors. The motivations for this study design are described in the order of the two primary research questions.

Goal-Related Interventions for Procrastination

Procrastination is so pervasive that recent estimates have suggested that as many as 50-80% of college students procrastinate moderately or severely (Day, Mensink, & O'Sullivan, 2000; Gallagher, Golin, & Kelleher, 1992), and that almost all individuals who procrastinate

report the desire to reduce their procrastination (Gallagher, et al., 1992). The interest in this problematic behavioral tendency has even extended to the realm of popular science, with many books written on the causes of procrastination, and/or geared for those who wish to reduce their procrastination (Burka & Yuen, 1983; Ferrari, 2010; Pychyl, 2013; Steel, 2010). Because delaying action on long-term goals in favor of short-term temptations is a central component of procrastination (Steel, 2007), it may not be surprising that these books stress identifying specific goals that need to be accomplished (Pychyl, 2013), breaking these goals down into smaller, more proximal sub-goals (Burka & Yuen, 1983; Pychyl, 2013; Steel, 2010), and following a time-defined schedule (Burka & Yuen, 1983). However, despite this wide array of goal-related advice to help individuals reduce procrastination, little empirical research has directly examined the effectiveness of these goal-related strategies in actually reducing procrastination.

One set of studies that has systematically examined goal-generation processes in procrastination are those that used the Personal Project Analysis approach (PPA; Blunt & Pychyl, 2000, 2005) developed by Little (1983). PPA involves the generation of everyday goals that are important to an individual (e.g., *study for exams*, *lose 10 pounds*), choosing some of these personal projects that are the most important in the moment, and ranking these everyday goals along many dimensions (e.g., importance, difficulty, progress, etc.). In one key study (Blunt & Pychyl, 2005), individuals chose 10 projects out of 15 generated in the initial brainstorming session and ranked them on a 0-10 scale based on 29 different dimensions (including procrastination, boredom, and frustration). Results of this study revealed that individuals who procrastinate tend to be state-oriented[1] (as opposed to action oriented), and that

[1] State-orientation vs. action-orientation is described in Kuhl's (1994) theory of action orientation, which identifies three components of action orientation. The component primarily associated with procrastination (and used as a measure of procrastination in my previous work – Gustavson et al., 2014, 2015) is described as decision-related action vs. hesitation, and best captures the intentional delay of action of procrastinators. The other scales

state-oriented individuals were more likely to experience more frustration, boredom, and uncertainty about whether the project could be completed. They also experienced less control, progress, and self-identity with their goals. Although the PPA approach has been useful in further understanding the correlates of procrastination in relation to everyday goals, research has yet to explore whether exercises like this (i.e., that identify important goals and elaborate on these representations using ratings of importance) can be used as a starting point to develop interventions to help individuals reduce their procrastination.

Here, I focused on two potential interventions that draw on goal management processes (i.e., goal setting and avoiding temptations) which may be useful in reducing academic procrastination in the context of a goal-generation exercise like PPA: (a) creating SMART goals, and (b) generating implementation intentions. The first of these interventions – SMART goals – was designed to evaluate the process of elaborative goal setting in reducing procrastination. SMART goals are Specific (S), Measurable (M), Achievable (A), Realistic (R), and Time-Defined (T; Prather, 2005; Bovend'Eerdt, Botell, & Wade, 2009)[2]. SMART goals have grown in popularity in education (O'Neill, 2000) and business domains (Prather, 2005), but have not yet been rigorously tested in the realm of psychology (Bovend'Eerdt, et al., 2009). However, the components of SMART, especially regarding the specificity, measurability, and time-defined schedule for goals, have been highlighted as important components of goal accomplishment in both popular science books (Burka & Yuen, 1983; Ferrari, 2010; Halvorson, 2010; Pychyl, 2013) and long-held theories of goal-setting in cognitive psychology (Latham & Locke, 1991; Locke &

assess performance-related action orientation vs. volatility and failure-related action orientation vs. preoccupation. In the study described here (Blunt & Pychyl, 2005), action orientation was defined by falling into the top 25th percentile on all three measures (action-oriented) vs. the bottom 25th percentile (state-oriented).

[2] Some sources use different annotation for SMART goals, such as A = Actionable or R = Relevant. In this study, my instructions focused on creating Achievable and Realistic goals because these components encouraged subjects to think about whether their goals could be achieved in the allotted time-window, and to avoid writing goals that were overly ambitious (i.e., not realistic).

Latham, 2006). Therefore, the SMART goal intervention provided a good test of whether the multiple factors comprising the SMART criteria, which have been suggested as important components of avoiding procrastination (e.g., creating specific, time-defined goals), could actually help individuals reduce their procrastination in an academic setting.

The second intervention – implementation intentions – targeted a different aspect of goal management: resisting temptations. It is clear that impulsivity is substantially correlated with procrastination (Ferrari, 1993; Gustavson et al., 2014; Steel, 2007), and that individuals often procrastinate on long-term goals in favor of short-term temptations (e.g., social media, peer groups, etc.). Therefore, although setting a good goal may be important in terms of accomplishing it on time, it may be just as important to prepare individuals for situations in which their distracting temptations arise, and give them strategies to combat these temptations and keep their long-term goals active (Halvorson, 2010). Implementation intentions are a good candidate for an intervention because they are if/then rules (or *in situation X, I will do thing Y*) that can be targeted at specific temptations They have also been proven to be highly effective for many types of goal pursuits including health and exercise (Gollwitzer & Brandstatter, 1997; Sheeran, 2002), and may be especially effective for impulsive individuals who are more prone to giving into their temptations (Pychyl, 2013).

In fact, there is some evidence that implementation intentions are successful at reducing procrastination. In one study (Owens, Bowman, & Dill, 2008), individuals completed a simple experiment where levels of procrastination were assessed. Then, subjects were shown ten timeslots during which they could return to the lab for another optional experiment. Subjects in the implementation intention condition were also told that if they commit to a time, they would be more likely to return (and then chose a time to return). The implementation intention in this

study was not targeted at a specific temptation, but the subjects in the implementation intention group were more likely to return for the optional session rather than put it off, regardless of their level of procrastination. A similar study found that implementation intentions mediated the association between intentions and behavior in searching for a job, suggesting that these factors are important in not delaying action on these long-term goals, though this effect was again not mediated by levels of procrastination (van Hooft, Born, Taris, van der Flier, & Blonk, 2005). Finally, a third study suggested that individuals who naturally use implementation intentions have a smaller intention vs. behavior gap, though procrastination itself was not correlated with self-reported implementation intention use (Howell, Watson, Powell, Buro, 2006). Therefore, although there is some conflicting evidence that implementation intentions do not affect procrastination directly, they may be useful at reducing intention-behavior gaps related to academic procrastination.

Procrastination and Goal Accomplishment

As noted earlier, theoretical accounts of procrastination have begun highlighting aspects of goal management that may be highly relevant to procrastination (Krause & Freund, 2014a; Steel & König, 2006), but surprisingly little empirical work has examined the specific associations between procrastination on the accomplishment of academic or everyday goals (Gröpel & Steel, 2008; Gustavson et al., 2014, 2015). Furthermore, little is known about how strongly procrastination is associated with goal success above and beyond the many personality traits that are correlated with procrastination (Steel, 2007) or related to the ability to achieve goals in everyday life (Gustavson et al., 2014, 2015). Therefore, the second goal of this study was to better specify the association between levels of procrastination and an individual's ability to achieve his/her self-generated academic goals, while controlling for the influence of other

relevant personality traits (e.g., impulsivity and conscientiousness), and situational factors (motivation and confidence for accomplishing those goals).

The few existing empirical studies on procrastination and goal management suggest that procrastination can be used to predict goal achievement, though somewhat indirectly. For example, Gröpel and Steel (2008) showed that individuals who procrastinate tend to report less goal setting in everyday life. Similarly, my research has shown that procrastinators tend to experience more goal management failures in everyday life, such as forgetting to finish common tasks after they are started (e.g., forgetting to pick up items at the store or passing along messages; Gustavson et al., 2014, 2015). Finally, research using the PPA approach suggests that individuals who procrastinate tend to report less control over their goals, less self-identification with these goals, and less self-reported progress on personal goals (Blunt & Pychyl, 2005). However, it is still unclear how these prospective ratings (e.g., of progress) actually mapped onto later goal success, as no existing study using the PPA approach has had subjects return to the lab to reevaluate their projects weeks or months later.

Another small body of work that has examined the association between procrastination and achievement has also focused on academic grades. For example, self-reported procrastination has been associated with lower academic grades in multiple samples (Beswick, et al., 1988; Tice & Baumeister, 1997), but not always (Solomon & Rothblum, 1984). Nevertheless, these findings suggest that procrastination is likely associated with some important outcome measures, especially in academic settings. However, these findings are limited in that they do not thoroughly examine the association between procrastination and accomplishment of academic goals directly (e.g., at the assignment level rather than for overall course grades).

When examining the association between procrastination and goal accomplishment on specific academic goals (or assignments), it will also be important to consider whether this association is due to individual differences in procrastination itself (i.e., the choice to intentionally delay progress on that goal), or due to personality traits and situational factors that are associated with procrastination and are also predictive of goal success. For example, procrastination behaviors have been linked with many personality traits such as impulsivity, conscientiousness, and academic motivation, to name a few (Steel, 2007), and each of these factors may be associated with goal success above and beyond the act of procrastinating itself. Therefore, examining these associations using multiple regression procedures (to see which constructs predict goal success controlling for the others), will help isolate which of these correlated factors best predict academic outcomes.

In this study, I examined whether procrastination is predictive of goal success above and beyond some common correlates of procrastination, and relevant situational/cognitive factors. I focused on two well-studied personality correlates of procrastination (impulsivity and conscientiousness), multiple motivational factors (including trait-level academic motivation, as well as motivation and confidence for the specific goals generated in the goal-setting exercises), and two other relevant constructs: trait-level fixed vs. incremental beliefs about procrastination (i.e., beliefs about whether procrastination can be changed), and subjects' memory for their goals upon returning to the lab.

I assessed trait levels of impulsivity and conscientiousness because they are perhaps the most widely studied correlates of procrastination (Gustavson et al., 2014; Steel, 2007). They also may be highly relevant to goal accomplishment because impulsive individuals are more prone to give into their distracting temptations and avoid work (Gustavson, et al., 2014; Pychyl, 2013),

while conscientious individuals tend to be better organized and persevere until tasks are completed (Costa & McCrae, 1992). Trait-level fixed vs. incremental mindset has yet to be systematically linked with procrastination, but these types of fixed vs. incremental beliefs (e.g., regarding willpower) have been suggested as important components of the ability to achieve everyday goals (Halvorson, 2010). Individuals who believe that procrastination is fixed, for example, may be less likely to achieve their goals (even in the intervention conditions), whereas individuals who believe procrastination is malleable may be more likely to achieve their academic goals or reduce their procrastination.

Motivational factors may also be important in relation to the reduction in academic procrastination and the accomplishment of academic goals. The two trait-like aspects of motivation I examined here were (a) internal academic motivation (the drive to do well for oneself, which is negatively correlated with procrastination) and (b) external academic motivation (the drive to do well because to impress parents, teachers, or peers, which is positively correlated with procrastination). Furthermore, I examined situational aspects of motivation, including (a) motivation to achieve the goals generated during the exercises and (b) confidence ratings that subjects would achieve their goals, as these factors may more directly predict goal accomplishment (given that they are oriented towards the goals themselves). Finally, subjects' memory for their goals were assessed because individuals who cannot activate and maintain their goals may have great difficulty completing them, and these types of goal management failures have been associated with procrastination in other, nonacademic contexts (Gustavson et al., 2014, 2015).

It is possible that any (or many) of these personality factors, beliefs, situational factors, and individual differences in memory for goals could account for the association between

procrastination and goal success, especially when combined in one model. However, if procrastination predicts unique variance in goal accomplishment controlling for these traits, this would suggest that procrastination is predictive above and beyond these other constructs, and that procrastination may even mediate the associations between these constructs and goal success (e.g., if they are no longer significant predictors after controlling for procrastination).

The Current Study

The current study was the first to examine whether procrastination can be reduced in an academic setting using goal-related interventions, and one of the first to explore how strongly procrastination is predictive of the accomplishment of specific academic goals. In summary, using goal-generation exercises similar to PPA, I tested whether two goal-related interventions (SMART goals and implementation intentions) increased the likelihood that students reduced their academic procrastination across a three-week interval, and whether these intervention exercises contributed to the self-reported success of the academic goals at the end of the three-week interval. I also examined how well procrastination was predictive of the success of the goals generated during the exercises and subjects' self-reported procrastination at Session 2, and whether other individual differences variables or the interventions themselves also uniquely contributed to these outcome measures above and beyond procrastination.

The design of this two-session study is displayed Figure 2-1. First, subjects completed individual differences measures of procrastination, personality (e.g., impulsivity and conscientiousness), and beliefs (fixed vs. incremental mindset). Then, they completed the goal-generation exercises, modelled on the PPA approach. In these exercises, subjects brainstormed multiple academic goals (nine total), chose the most important academic goals (three total), and elaborated on the importance of accomplishing these goals (half of the subjects also honed their

goals into SMART goals). Afterward, they also brainstormed and identified important temptations that they would come across in weeks between sessions (and half of the subjects wrote implementation intentions for these specific temptations). Finally, subjects rewrote their goals, and completed motivation and confidence ratings for them. In the second session, which occurred about three weeks later, subjects returned to the lab to complete posttest measures of procrastination, assessments of the memory for their goals and temptations identified by the exercises in Session 1, and self-reported measures of the accomplishment of their goals.

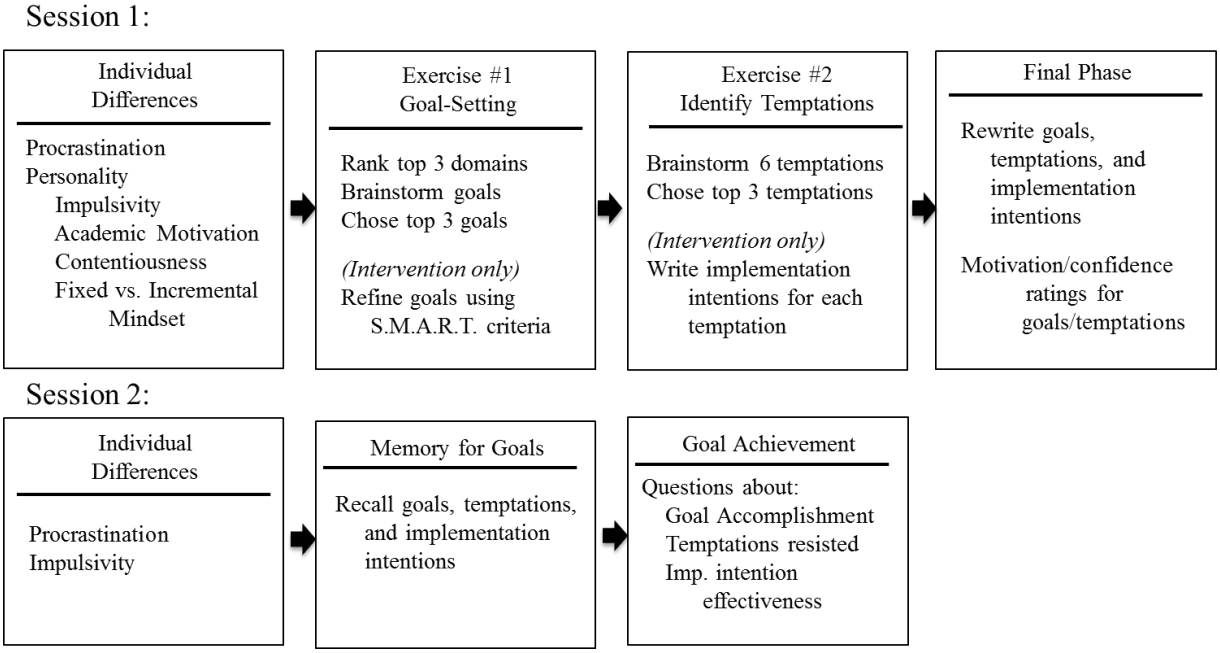

Figure 2-1: Summary of the procedure of the intervention study.

Method

Subjects

Two-hundred-eight subjects participated in this study (127 female, 81 male) for course credit. Of these 208 subjects, 177 returned for the second session (110 female, 67 male). Preliminary analysis indicated that subjects who did not return were not substantially different from those who did return (e.g., on responses to the individual differences questionnaires in

Session 1), so their Session 1 data were included in the analyses reported here where appropriate (i.e., for comparisons using Session 1 data only). Thirteen additional subjects completed the first session of the study, but their data were excluded because they did not complete the exercises by the end of session 1 (two subjects), because they completed the pilot study in a previous semester (one subject), or because at least two of three raters indicated that they did not generate at least two acceptable temptations (one subject) or implementation intentions (nine subjects).

Design and Procedure

This experiment was a two-part study with a 2 (SMART vs. control) x 2 (implementation intentions vs. control) between-subjects design. Subjects were distributed fairly evenly across each of the four between-subjects conditions (n = 48-55 per condition), even when considering only those subjects who returned for Session 2 (n = 39-47 per condition). All questionnaires, exercises, and interventions were completed on Macintosh computers using Qualtrics software (questionnaires and interventions). Additionally, some measures required paper and pencil (e.g., transcript release, recalling top three goals/temptations).

Session 1. As shown in Figure 2-1, Session 1 consisted of four stages: (a) administering individual differences measures; (b) administering the goal setting exercise ("SMART" vs. "control"); (c) administering the implementation intention exercise ("implementation intentions + temptations" or "temptations only"); and (d) a short final phase.

Individual differences measures. First, subjects completed questionnaires measuring individual differences in procrastination and other constructs. Subjects responded to all questionnaire items with how each statement was true of them "in general," except for the measures of procrastination and impulsivity, which asked about the "past three weeks." This ensured that these questionnaires were directly comparable to the post-test responses for these

same questionnaire at Session 2 (using the same instructions), and that I was measuring the change in procrastination behaviors, rather than trait-like characteristics of procrastination.

The primary measure of academic procrastination was the Procrastination Assessment Scale – Students (PASS; Solomon & Rothblum, 1984), perhaps the most widely used measure of academic procrastination. The PASS included three separate questions about each of six academic domains (see below), resulting in 18 items total. Importantly, because individuals ranked each of these domains in order of importance, this scale was further subdivided into two subscales: (a) top three academic domains and (b) bottom three academic domains. For these subscales, responses were included for only those domains that were chosen as the top or bottom three (identified in the first goal-setting exercise for each subject), and only for two of the three items relating to the degree of procrastination[3], resulting in two six-item scales (Top 3 Domains and Bottom 3 Domains). As described below, I focused primarily on the Top 3 Domains scale because subjects only completed the goal-generation interventions for these most problematic domains. Therefore, any effects of the intervention exercises were most likely to be observed when focusing on the top three domains. In contrast, the bottom three domains acted as a within-subjects control (i.e., to measure the change in academic procrastination for domains that were not intervened on), in lieu of including a "true" control group that did not perform the goal-setting exercises whatsoever.

Five other questionnaires were administered to measure individual differences in important correlates of academic procrastination. Domain-general, non-academic procrastination

[3] The third PASS item asked about how much individuals wanted to reduce their procrastination. This item was excluded from these scales because I wanted to assess the degree of procrastination in each of the top/bottom three academic domains only. Exploratory factor analyses of the PASS in this and previous samples have identified that these questions load on a different factor than those responses to the first two items about the degree of procrastination.

was measured with the 15-item Adult Inventory of Procrastination (McCown, Johnson, & Petzel, 1989). Impulsivity was measured with the 30-item Barratt Impulsivity Scale (Patton, Stanford, & Barratt, 1995). Conscientiousness was measured with the nine-item conscientiousness subscale of a short version of the Neo-Five Factor Inventory (Costa & McCrae, 1992). Academic motivation was measured with the 33-item Internal/External Motivation Scale (Lepper, Corpus, & Iyengar, 2005). Finally, fixed vs. incremental beliefs about procrastination were measured with a four-item scale assessing whether individuals believe that procrastination is changeable (adapted from the Implicit Identity Questionnaire; Rattan & Dweck, 2010)[4].

Exercise 1: Goal setting. For the first exercise (i.e., generating academic goals), subjects were assigned to one of two conditions: (a) SMART goals or (b) control.

Regardless of group, subjects were given a list of six academic domains, corresponding to the six domains asked about in the PASS, and asked to rank order (from one to six, using each number once) the domains in order of how much they typically procrastinate on them. The domains were: (a) *Writing a term paper,* (b) *Studying for exams,* (c) *Keeping up with weekly reading and homework assignments,* (d) *Academic administrative tasks,* (e) *Attendance tasks,* and (f) *School activities in general* (as described above, these responses were used to create the Top 3 and Bottom 3 Domains scales).

Afterward, all subjects were instructed to brainstorm three goals related to accomplishing something between Session 1 and 2 of the experiment for each of these top three academic domains chosen in the previous step (nine total). Then, for each domain, subjects picked their top

[4] In addition to these measures, I also assessed individual differences in working memory (the Reading and Letter-Rotation Span tasks) and levels of perfectionism (the Almost Perfect Scale). These measures were included as part of separate projects on the association between procrastination and these traits. Including these constructs in the analyses did not change the overall results, so these measures are not discussed further here.

goal (out of the three brainstormed goals) and copied it later in the survey. At the end of this step, all subjects had identified three important academic goals, one for each of their most problematic domains.

Next, for the SMART condition only, subjects were given a worksheet with an explanation of each of the SMART criteria, as well as examples of how to hone a general goal (*I want to get in shape*) into a SMART goal (*I want to lose 20 pounds by the end of January*). These examples, as well as those on the exercise survey itself, were for general health-related goals, but subjects were instructed to make sure all of their academic goals were related to their top three academic domains, and that they could be accomplished between sessions of the experiment. Appendix A displays the SMART intervention survey performed by subjects in this condition and the worksheet that explained each of the SMART criteria. The control condition skipped this step entirely (though they were told to make sure that their goals needed to be something that they could accomplish between sessions of the study).

Both groups (control and SMART) then completed a few final questions for each of their goals to ensure compliance to the instructions, and to encourage subjects to elaborate on the importance of these academic goals. These questions were:

- *"Is this a goal you plan to complete before Session 2?"* (Control Only)
- "*Does this goal comply with the five SMART criteria?"* (SMART Only)
- *"Which course(s) does this goal apply to?"* (Both conditions)
- *"Why is it important that you accomplish this goal? (1-2 sentences)"* (Both conditions)

Finally, the experimenter checked over their goals to either make sure they were related to an academic goal (control condition) or to make sure they met the SMART criteria (SMART condition). If not, the experimenter instructed the subject to continue to work, giving suggestions only if the subject still struggled to complete the exercise.

Exercise 2: Identify temptations. In the second exercise (i.e., identifying temptations), subjects were also split into one of two conditions: (a) temptations only, or (b) temptations plus implementation intentions.

In this exercise, all subjects were asked to look again at their list of top three academic domains for which they procrastinate the most. Then, they were instructed to write down six different temptations that typically distract them from accomplishing goals related to these domains. In order to be acceptable, subjects' temptations had to actively distract them from accomplishing goals. Unacceptable temptations included boredom, general lack of interest, or anxiety. These instructions ensured that all subjects generated temptations that could be targeted with an implementation intention, regardless of condition. After writing down a list of six temptations, subjects then picked the top three temptations they thought would distract them the most in the coming weeks, and rewrote them later in the survey.

Afterward, in the implementation intentions condition only, subjects were instructed to come up with implementation intentions for each of these top three temptations. They were given a brief explanation of implementation intentions by the experimenter (which was also embedded in the survey), and two examples of good implementation intentions related to health goals (Appendix A also displays the implementation intentions survey used here). The subjects in the temptations only group skipped this step entirely.

Finally, experimenters completed a preliminary check of all responses to make sure that the temptations were acceptable (i.e., not boredom or anxiety-related), and, in the case of the implementation intentions group, the experimenter also checked to make sure that the implementation intentions were some real action that the subject could take to get back on track to their goal (e.g., rather than simply not giving in to his/her temptation). Again, the

experimenter instructed the subject to continue to work if they did not deem the temptations and/or implementation intentions acceptable (though some subjects were excluded based on rater judgements of the acceptability of these temptations and implementation intentions).

End of session 1. In the final phase of Session 1, subjects were instructed to rewrite their top three goals and temptations (and implementation intentions) from the previous two exercises. They were told that rewriting these goals and temptations would make them more likely to remember their goals over the coming weeks. Rater judgements indicated that subjects remembered their goals/temptations from the preceding exercises well, so these data are not discussed further.

Importantly, subjects then answered a question that assessed their motivation for each goal (*How motivated are you to achieve this goal?*) and confidence for each goal (*How confident are you that you will achieve it?*)[5]. Finally, subjects were given a one-page transcript release form to obtain grades for the semester that they completed this study (these grade data are not described further here). This step was entirely optional, but most subjects opted to release grades (n = 195).

Session 2. Session 2 consisted of three parts, and was completed on average about 2.5 weeks after Session 1 (*M* = 17.48 days, *SD* = 4.50, Range = 12-38). First, subjects completed individual differences measures for academic procrastination, nonacademic procrastination, and impulsivity. The instructions for these questionnaires were worded exactly the same as in Session 1 (i.e., regarding procrastination/impulsivity in the past three weeks, regardless of the actual time between sessions).

[5] After these items, subjects were asked two final items about how much they thought the exercises, in general, would help them (a) reduce their academic procrastination, and (b) resist their temptations, but these final items are not discussed further here.

Second, subjects were asked to write down their top three goals, temptations, and implementation intentions (if applicable) from Session 1 as best they could remember. As discussed in the introduction, this was done to assess how well subjects remembered their goals over the three-week interval (see rater judgements, below), to examine whether the memory for goals moderated the effect of the interventions, and was used in the multiple regression procedures in Analysis 2.

Finally, subjects were reminded of their actual responses at Session 1, and answered the four questions about the effectiveness of the goal-generation exercises (all on a 1-5 scale), three of which formed the dependent measures of goal accomplishment. For each goal, subjects were asked: *Was your goal accomplished?* For each temptation, they were asked: *On average, how much per week did this temptation arise?* and *When this temptation arose, what percent of the time did it distract you?* (the latter formed the primary measure of resisting temptations here). Finally, for each implementation intention (in that condition only), subjects were asked: *How effective was this implementation intention at helping you resist giving into your temptation?*

Data Analysis

All analyses were conducted using multiple regression procedures (using SPSS or R), using an alpha threshold of .05. The analyses of this study are described in two sections, corresponding to the primary goals of this study. After presenting the basic descriptive statistics and baseline measures, I first examined whether individuals in the SMART or implementation intentions conditions were able to reduce their academic procrastination more so than individuals in the control conditions (as well as whether these condition differences predicted the measures of goal accomplishment at Session 2). Second, I examined the post-test measures of goal accomplishment and procrastination, and explored which variables were associated most

strongly with individuals' accomplishment of their goals, abilities to resist temptations when they arose, the effectiveness of the implementation intentions, and procrastination at Session 2.

Rater judgments. In addition to the basic data coding, raters judged the compliance of responses to the exercises and subjects' memory of their goals. For compliance, raters ranked whether each goal met each of the SMART criteria (0 or 1 for each criterion), whether each temptation was a real distraction (0 or 1 for each temptation), and whether each implementation intention was a real action that they could take towards the accomplishment of one of their goals (0 or 1 for each implementation intention). Initial analyses indicated that subjects in the SMART condition met more of the SMART criteria (M = 4.25 out of 5 per goal, SD = .60) than the control group (M = 3.05, SD = .85), F (1, 202) = 204.71, $p < .001$, $\eta_p^2 = .50$, and that subjects largely complied with the instructions for the temptations (M = 2.94 out of 3 temptations were deemed acceptable, SD = .09) and implementation intentions (M = 2.61, SD = .66). Kappa reliability estimates for the individual SMART goal rankings were very high (> .91 between any two set of raters) and lower but acceptable for the ratings for temptations (.66 – .89) and implementation intentions (.64 – .74), probably due to the high rate of compliance.

For the memory judgements, raters ranked on a scale of zero-three, whether each goal was correctly recalled at the start of Session 2: A score of zero indicated that the subject wrote nothing; a score of one indicated that the subject wrote something, but his/her response was not about the same PASS domain as the goal; a score of two indicated that the subject correctly identified the PASS domain that his/her goal was written about, but did not remember any more significant details; a score of three indicated that the subject remembered both the correct domain and at least one significant detail of his/her academic goal (e.g., he/she was studying for a *calculus* exam).

All rater judgments were practiced by two raters until the grading rubric could be honed well enough to ensure consistent responses (by grading a subset of 30 subjects), but final judgments were made by three raters. Interrater correlations were very high for the averaged memory rankings at each session (*r*s between any two raters > .94), as were kappa reliability estimates for each of the three memory rankings individually (> .95). Similar memory rakings were also completed for temptations and implementation intentions, but they are not discussed further here.

Results

Descriptive Statistics and Session 1 Individual Differences

Descriptive statistics for the measures of procrastination and other individual differences variables, at both sessions, are displayed in Table 2-1. The correlations between these individual differences measures are also displayed in Table 2-2. As shown in Table 2-2, levels of academic procrastination in Session 1 were correlated with the other individual difference as expected given previous meta-analytic estimates (Steel, 2007), regardless of whether I focus on the top three academic domains, bottom three academic domains, or nonacademic procrastination. Finally, the number of times that each of the six PASS domains were chosen during the first goal-setting exercise are displayed in Appendix B.

Table 2-1. Descriptive Statistics of Individual Differences Variables and Dependent Measures

	N	Mean	SD	Range	Skewness	Kurtosis	Reliability
Individual Differences (all measured at Session 1)							
Academic Procrastination							
Top 3 Domains	208	3.06	.67	1 - 4.67	-.39	.43	.80
Bottom 3 Domains	208	2.38	.61	1 - 4	.14	-.37	.78
Everyday Procrastination	208	2.40	.56	1.2 - 4	.18	-.41	.82
Impulsivity	208	2.15	.34	1.3 - 3.53	.47	1.06	.83
Conscientiousness	208	3.72	.60	2 - 5	-.17	-.71	.78
Academic Motivation							
Internal	208	3.55	.48	2.00 - 4.82	-.39	.70	.88
External	208	3.14	.48	1.63 - 4.31	-.34	.30	.83
Fixed vs. Incremental Beliefs	208	2.42	.75	1.00 - 4.50	.10	-.28	.82
End of Session 1							
Motivation for goals	198	5.39	.91	2 - 7	-.68	1.08	.61
Confidence for goals	198	5.26	.98	1 - 7	-.54	1.12	.69
Dependent Measures (all measured at Session 2)							
Academic Procrastination							
PASS top 3	177	3.07	.59	1.67 - 5	.37	.30	.79
PASS bottom 3	177	2.38	.64	1 - 4	.05	-.41	.81
Goals Accomplished	176	3.29	.82	1 - 5	-.22	-.18	.35
Temptations Resisted	177	2.42	.73	1 - 5	.49	.13	.41
Imp. Intention Effectiveness	84	3.75	1.28	1 - 5	-.40	-.51	.57

Note: Means indicate the average response for all questionnaire items (e.g., on a 1-5 scale for academic procrastination). Reliability was estimated using Cronbach's alpha.

Table 2-2: Correlations Among Individual Differences at Session 1

	1	2	3	4	5	6	7	8	9
1. Top 3 Domains	1								
2. Bottom 3 Domains	**.46**	1							
3. Everyday Procrastination	**.49**	**.44**	1						
4. Impulsivity	**.42**	**.39**	**.45**	1					
5. Conscientiousness	**-.47**	**-.48**	**-.60**	**-.61**	1				
6. Internal Academic Motivation	**-.25**	**-.30**	**-.23**	**-.42**	**.38**	1			
7. External Academic Motivation	.09	**.21**	**.22**	**.28**	**-.23**	**-.52**	1		
8. Fixed vs. Incremental Beliefs	**.20**	**.27**	**.18**	**.30**	**-.30**	**-.24**	.16	1	
9. Motivation for goals	**-.24**	**-.17**	**-.16**	**-.24**	**.22**	**.24**	-.03	-.12	1
10. Confidence for goals	**-.37**	**-.26**	**-.24**	**-.24**	**.29**	**.29**	.03	**-.22**	**.54**

Note: Significant correlations are displayed in bold ($p < .05$).

Analysis 1: Effects of the Intervention Exercises

First, I examined whether the intervention manipulations (i.e., SMART or implementation intentions) predicted academic procrastination or goal accomplishment at Session 2. I explored these intervention effects for all five of the dependent measures listed in Table 2-1, but focused primarily on academic procrastination at Session 2 (Top 3 Domains) because this measure best captured procrastination in the academic domains for which the intervention exercises were written. The other dependent measures included procrastination in the bottom three domains (Bottom 3 Domains), and self-reported goal accomplishment, ability to resist temptations, and implementation intention effectiveness (if applicable) at Session 2.

For each dependent measure, I used multiple regression procedures to examine the main effects of the two between-subjects manipulations (SMART goals vs. control goals and implementation intentions vs. temptations only), controlling for their interaction (SMART x implementation intentions) and for levels of procrastination at Session 1. After these basic analyses, I present some follow-up regression analyses exploring potential moderating variables on the interventions.

Basic effects of the interventions. For the primary measure of academic procrastination (Top 3 Domains), baseline procrastination at Session 1 was highly predictive of Session 2 procrastination, $F(1, 172) = 97.26$, $p < .001$, $\eta_p^2 = .36$. However, there were no main effects of the SMART intervention, $F(1, 172) = .54$, $p = .462$, $\eta_p^2 = .00$, or the implementation intention intervention, $F(1, 172) = .89$, $p = .348$, $\eta_p^2 = .01$, and there was no evidence for an interaction between interventions, $F(1, 172) = .53$, $p = .467$, $\eta_p^2 = .00$, suggesting that these interventions did not help reduce procrastination in the context of this study, even when focusing specifically on the academic domains that for which subjects completed the exercises. Similar results for

both interventions were observed even if I did not control for levels of procrastination at Session 1, or dropped the interaction term between the two conditions out of the model.

These results are displayed in Table 2-3, which shows the means and standard deviations of PASS scores (Top 3 Domains and Bottom 3 Domains) for Session 1 and 2 broken down by condition. As shown in Table 2-3, there was essentially no change in Top 3 Domains scores. In fact, scores actually increased by .02 points collapsing across condition, though this difference was not statistically significant, $F(1, 172) < 1$. Further analyses revealed no evidence that individuals in any condition were able to substantially reduce their procrastination over time (in two conditions procrastination was actually slightly higher at Session 2). These results suggest that the interventions themselves did not help reduce procrastination above and beyond the control groups, and that there was no decrease in academic procrastination overall across conditions, ruling out the possibility that all groups improved regardless of condition.

Table 2-3: Condition Means for the PASS Top 3 and Bottom 3 Domains

		Top 3 Domains				Bottom 3 Domains			
		Session 1*		Session 2		Session 1*		Session 2	
	N	M	SD	M	SD	M	SD	M	SD
Control Goals									
Temp Only	47	3.00	.65	2.97	.60	2.18	.56	2.15	.65
Implementation Intention	39	2.99	.72	3.05	.60	2.45	.57	2.57	.57
SMART Goals									
Temp Only	46	3.21	.61	3.17	.62	2.40	.60	2.42	.68
Implementation Intention	45	2.99	.64	3.07	.52	2.33	.70	2.40	.59
Grand Average	177	3.05	.65	3.07	.59	2.33	.61	2.38	.64

Note: Means indicate the average response on a 1-5 scale. * indicates that Session 1 scores are reported only for subjects who returned for Session 2.

Although there was no true control condition (i.e., subjects in all conditions completed at least the goal-generation and temptation-identification aspects of the exercise), another way that

I examined whether there was a change in procrastination across all conditions was by focusing on the Bottom 3 Domains, for which no goal-setting interventions were completed regardless of condition. However, not surprisingly given the findings for the Top 3 Domains, analyses examining the Bottom 3 Domains at Session 2 also revealed no evidence for an effect of either intervention, Fs(1, 172) < 2.88, ps > .091, η_p^2s < .02, and no overall change in procrastination collapsing across conditions (again, procrastination actually slightly increased), F(1, 172) < 1. Therefore, the interventions did not result in a significant decrease in procrastination for the academic domains chosen as most important (Top 3 Domains), and there was also no change in academic procrastination in the domains that were not a focus of the exercises (Bottom 3 Domains), even when both dependent measures were collapsed across condition.

Finally, I examined whether the intervention exercises resulted in higher endorsement of the items related to the accomplishment of goals, the ability to resist temptations, and the effectiveness of implementation intentions (for those in that condition only). These results are shown in Table 2-4, which displays the mean scores on each dependent measure by condition. Again, analyses of each of these dependent measures revealed no main effects of either intervention on the self-reported measures of goal accomplishment, Fs(1, 172) < 1, or the ability to resist temptations when they arose, Fs(1, 173) < 1.43, ps > .233, η_p^2s < .01. Furthermore, there was no evidence that individuals in the SMART condition found that the implementation intentions were more effective compared to those who did not generate SMART goals, F(1, 81) = 1.56, p = .215, η_p^2 = .02. There was also no evidence for an interaction between these conditions to predict either goal accomplishment or resisting temptations (i.e., SMART x implementation intentions condition), Fs(1, 179) < 2.77, ps > .097, η_p^2s < .02.

Table 2-4: Condition Means for Self-Reported Goal Accomplishment, Ability to Resist Temptations, and Implementation Intention Effectiveness

		Goals Accomplishment		Temptations Resisted		Implementation Int. Effective	
	N	M	SD	M	SD	M	SD
Control Goals							
Temp Only	47	3.29	.79	2.38	.75	-	-
Implementation Intention	39	3.29	.75	2.42	.66	3.93	1.12
SMART Goals							
Temp Only	46	3.18	.96	2.60	.82	-	-
Implementation Intention	45	3.39	.75	2.29	.66	4.04	1.16
Grand Average	177	3.29	.82	2.42	.73	3.99	1.14

Note: Means indicate the average response on a 1-5 scale.

Potential moderating variables on intervention effectiveness. These initial analyses indicated that subjects on average did not improve their academic procrastination, even in the SMART or implementation intentions conditions, and that the interventions were not associated with goal accomplishment. However, it was important to further examine whether the interventions were effective for certain individuals (e.g., high on baseline procrastination). Therefore, exploratory moderation analyses for five potential moderators were examined[6]. These moderators included baseline procrastination (i.e., Session 1 Top 3 Domains), impulsivity (Session 1), fixed vs. incremental beliefs (Session 1), motivation for each goal (Session 1), and memory for each goal (at Session 2). These moderators were chosen because they were the only significant predictors of at least one dependent measure of goal accomplishment (or procrastination) in the multiple regression procedures discussed in Analysis 2, below (see Table 2-7).

[6] Other exploratory analyses suggested that there was no indication of moderation of the rater judgements of the number of SMART criteria met per goal, the compliance of the temptations generated in the second exercise, the number of days between sessions, or for other individual differences variables such as conscientiousness, internal/external academic motivation, or confidence for goals.

These moderation models are displayed in Table 2-5. In all regression models, I included the main effects of both conditions (SMART and implementation intentions), and their interaction. Additionally, for the moderation models of academic procrastination (Top 3 Domains or Bottom 3 Domains), I continued to control for the Session 1 scores on these measures only (Top 3 Domains or Bottom 3 Domains, respectively). Then, I included the main effect of the potential moderator (e.g., Session 1 impulsivity), and the two-way interactions between the moderator and each condition (e.g., SMART x Impulsivity). I did not include the three-way interactions in the models shown in Table 2-5 (e.g., SMART x Implementation Intentions x Impulsivity), but similar results were observed when I did include these potential three-way interactions.

The results of these moderation analyses revealed little evidence for moderation, though two potential moderation effects were significant. First, as shown in Table 2-5, there was an interaction between Session 1 procrastination (Top 3 Domains) and the implementation intention intervention to predict the self-reported ability to resist temptations. This interaction suggested that the implementation intentions condition resulted in higher self-reported ability to resist temptations, but only for individuals who had high levels of procrastination at Session 1. Second, I observed a significant interaction between subjects' memory for goals and the SMART goal condition predicting academic procrastination at Session 2. Further analysis of this interaction suggested that better memory for goals was more associated with less procrastination in the control condition, $F(1,80) = 4.69$, $p = .033$, but not in the SMART goal condition, $F(1,83) = .60$, $p = .443$.

Table 2-5: Moderation Analyses of Intervention Exercises on the Main Dependent Measures of the Study

	Top 3 Domains		Bottom 3 Domains		Goals Accomplished		Temptations Resisted		II Effectiveness	
	F	*P*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*
Procrastination (Top 3 Domains - Session 1)	df = (1, 171)		df = (1, 171)[a]		df = (1, 170)		df = (1, 171)		df = (1, 80)	
SMART Condition x Top 3 Domains	.42	.518	3.12	.079	1.30	.256	.01	.939	.96	.330
Imp Int Condition x Top 3 Domains	.61	.438	1.65	.201	.01	.933	**3.94**	**.049**	-	-
Impulsivity (Session 1)	df = (1, 170)		df = (1, 170)		df = (1, 170)		df = (1, 171)		df = (1, 80)	
SMART Condition x Impulsivity	.97	.327	1.11	.293	.04	.845	.13	.719	.82	.368
Imp Int Condition x Impulsivity	< .01	.996	.17	.677	.28	.600	2.15	.145	-	-
Fixed vs. Incremental Beliefs (Session 1)	df = (1, 170)		df = (1, 170)		df = (1, 170)		df = (1, 171)		df = (1, 80)	
SMART Condition x Beliefs	.85	.358	.06	.809	.15	.694	.77	.381	.28	.601
Imp Int Condition x Beliefs	.10	.750	.61	.438	2.26	.135	.35	.557	-	-
Motivation for goals - Session 1	df = (1, 163)		df = (1, 163)		df = (1, 163)		df = (1, 164)		df = (1, 76)	
SMART Condition x Motivation	.29	.592	1.99	.161	.93	.337	.56	.454	.30	.587
Imp Int Condition x Motivation	.24	.626	.11	.742	.16	.214	3.49	.064	-	-
Memory for Goals - Session 2	df = (1, 166)		df = (1, 166)		df = (1, 166)		df = (1, 167)		df = (1, 77)	
SMART Condition x Memory	**4.77**	**.030**	2.21	.139	.01	.922	.03	.871	.65	.422
Imp Int Condition x Memory	3.76	.054	.27	.606	.67	.413	.09	.770	-	-

Note: Significant interactions between moderating variables and the intervention conditions are displayed in bold ($p < .05$). Degrees of freedom change in each model due to some missing observations for some variables (e.g., goal accomplishment, motivation, and memory for goals), or because only half of the sample was included for Implementation Intention Effectiveness (only those subjects who completed implementation intentions).

[a] indicates that the moderator in this analysis was the Bottom 3 Domains (Session 1) rather than Top 3 Domains, but results were very similar if the Top 3 Domains were used instead.

These moderation effects suggest that implementation intentions may have been somewhat effective for those high in procrastination, and that memory for goals may play a larger role in the goals generated in the control condition compared to the SMART condition. However, it is also likely that both of these association were due to the large number of statistical tests conducted in this exploratory moderation analysis (e.g., 45 statistical tests are presented in Table 2-5, so I would expect about two significant associations due to chance). Therefore, there was little evidence that the interventions, as implemented here, were effective at reducing academic procrastination as measured by the PASS.

Analysis 2: Procrastination and Goal Success

Next, I examined which individual differences variables, especially procrastination, uniquely predicted each of the five dependent measures described in Table 2-1. Because the second goal of this study primarily concerned the association between procrastination and goal success (controlling for other factors), I focus on the dependent measures for self-reported goal accomplishment, but also discuss the associations with the other dependent measures as well. In these analyses, I no longer examined the effects of the SMART or implementation intentions intervention, as Analysis 1 revealed that these interventions had little if any effect on the dependent measures assessed here.

First, I examined the simple correlations between five dependent measures, levels of academic procrastination (Top 3 Domains and Bottom 3 Domains from Session 1), and the individual differences variables motivated in the introduction. Namely, I focused on the three personality traits correlated with procrastination (impulsivity, conscientiousness, and internal/external academic motivation), and the four other factors that may be associated with both procrastination and goal success (fixed vs. incremental beliefs about procrastination,

motivation for goals, confidence for goals, and memory for goals). Finally, I also included nonacademic procrastination (AIP) in these analyses, as these aspects of procrastination were moderately correlated with academic procrastination (see Table 2-2).

Table 2-6 displays the bivariate correlations between the five outcome measures and these individual differences variables. Importantly, levels of procrastination at Session 1 (e.g., Top 3 Domains) were moderately correlated with all three measures of success at Session 2 (goals accomplished, temptations resisted, and implementation intention effectiveness). Procrastinators tended to report that they were less able to accomplish their goals, had more difficulty resisting temptations when they arose, and did not find the implementation intentions as effective. Many of the other individual differences measures in this study were also good predictors of the success of the self-generated academic goals (e.g., impulsivity, motivation for goals), and in the expected direction. However, it was important to examine these associations using multiple regression procedures to reveal which of these factors uniquely predicted goal success before heavily discussing these effects.

Table 2-6: Correlates of the Main Dependent Measures of the Study

	Session 1 Variables										Session 2 Variables			
	PASS Top 3	PASS Bot 3	AIP	BIS	CON	IMS	EMS	IIQ	Motiv for Goals	Confid for Goals	Memory for Goals	Goals Accomp	Temp Resisted	II Effective
Top 3 Domains	**.60**	**.36**	**.48**	**.43**	**-.43**	**-.19**	.13	**.34**	**-.25**	**-.31**	**-**.04	**-.34**	**-.30**	**-.38**
Bottom 3 Domains	**.32**	**.58**	**.54**	**.37**	**-.41**	**-**.13	.12	**.29**	**-.21**	**-.26**	**-**.04	**-.19**	**-.22**	**-.39**
Goals Accomplished	**-.32**	**-.22**	**-.23**	**-.20**	**.23**	**.20**	**-**.02	**-.20**	**.31**	**.32**	.11	1		
Temptations Resisted	**-.18**	**-.19**	**-.21**	**-.29**	**.28**	**.20**	**-**.14	**-.16**	**.31**	**.16**	.00	.09	1	
II Effectiveness	**-.35**	**-.37**	**-.38**	**-.33**	**.40**	.17	**-**.01	**-.31**	**.52**	**.44**	.03	**.44**	**.24**	1

Note: Significant correlations are displayed in bold ($p < .05$). PASS = Procrastination Assessment Scale – Students, AIP = Adult Inventory of Procrastination, BIS = Barratt Impulsivity Scale, CON = Conscientiousness, IMS/EMS = Internal/External Motivation Scale, IIQ = Fixed vs. Incremental Beliefs About Procrastination, Motiv = Motivation for accomplishing goals, Confid = Confidence for accomplishing goals.

Regression analysis. Four final regression models were conducted to examine which individual differences factors were unique predictors of goal achievement and procrastination in Session 2 (Top 3 Domains). In each of these regression models, I included all of the measures from Table 2-5. Overlapping constructs from Session 2 (i.e., procrastination and impulsivity) that are not shown in Table 2-5 were excluded in these analyses as well (because of their high correlations with those same measures from Session 1), but similar results were observed if these Session 2 measures were included instead of Session 1. The last dependent measure (Bottom 3 Domains at Session 2) was excluded here because similar results were observed for the Top 3 Domains, and this dependent measure was primarily included as a within-subjects control for Analysis 1.

These regression models are displayed in Table 2-7. For goal accomplishment, two variables emerged as significant predictors of the success of academic goals, controlling for the other factors: Session 1 procrastination was associated with less goal accomplishment, and subjects' memory for their goals was associated with more goal accomplishment. For the ability to resist temptations when they arose, however, the only significant predictor was motivation to accomplish their goals. Similarly, motivation for goals was the only significant predictor of the self-reported effectiveness of the implementation intentions. These results suggest that procrastination predicted goal accomplishment above and beyond the effect of the other individual differences variables, and that these factors largely did not contribute to goal success after accounting for procrastination and memory for goals. However, they also suggest procrastination did not uniquely predict the ability to resist temptations, or the effectiveness of implementation intentions, controlling for motivational factors.

Table 2-7: Multiple Regression Models for the Main Dependent Measures of the Study

	Top 3 Domains		Goals Accomplished		Temptations Resisted		II Effectiveness	
	β	*p*	β	*p*	β	*p*	β	*p*
Procrastination								
Academic (Top 3 – Session 1)	**.44**	**< .001**	**-.20**	**.040**	.02	.810	-.05	.739
Academic (Bottom 3 – Session 1)	-.06	.400	.07	.450	-.05	.576	-.12	.357
Nonacademic	**.19**	**.016**	-.11	.227	-.02	.800	-.10	.425
Impulsivity	**.17**	**.036**	-.02	.808	-.11	.296	-.13	.299
Conscientiousness	.02	.842	.02	.845	.09	.446	.11	.425
Internal Academic Motivation	.09	.250	.03	.754	.05	.569	-.12	.367
External Academic Motivation	.00	.973	.09	.318	.00	.997	.11	.405
Fixed vs. Incremental Beliefs	**.18**	**.006**	-.11	.157	-.07	.396	-.17	.137
Motivation (for goals)	-.04	.605	.12	.156	**.28**	**.002**	**.34**	**.014**
Confidence (for goals)	-.03	.703	.09	.376	-.10	.351	.04	.777
Memory for goals (Session 2)	-.04	.494	**.15**	**.049**	-.03	.698	-.02	.846
Total R^2 of model (Adjusted R^2)	.47 (.44)		.20 (.15)		.16 (.10)		.40 (.29)	

Note: Standardized beta coefficients (β) and significance values (*p*) for regression models of outcome measures at Session 2. Significant predictors are displayed in bold ($p < .05$). II Effectiveness = Effectiveness of implementation intentions

Table 2-7 also displays the regression model predicting Session 2 procrastination (Top 3 Domains). Given the lack of strong effects of the interventions discussed in the previous section, this final model helps reveal which factors do predict procrastination at Session 2, controlling for one another. Interestingly, other than procrastination at Session 1 in those same domains (not surprisingly, the largest predictor of procrastination at Session 2), Session 2 procrastination was primarily predicted by nonacademic procrastination (β = .19), impulsivity (β = .17), and fixed vs. incremental beliefs about procrastination (β = .18). These results suggested that individuals who reported the most procrastination between Session 1 and Session 2 were those who procrastinated the most in the previous three weeks (both academically and in everyday life), were more impulsive, and were more likely to endorse the belief that procrastination is changeable. This final result is perhaps the most interesting, as this is likely the first study to

show (somewhat surprisingly) that individuals who procrastinated the most tended to endorse the belief that procrastination is a malleable trait.

In summary, procrastination (in the weeks preceding Session 1) was uniquely predictive of the self-reported accomplishment of academic goals and procrastination at Session 2, controlling for many other individual differences variables, most of which were correlated with these outcome measures, but not after controlling for procrastination and each other. Procrastination was not uniquely predictive of the ability to resist temptation or the effectiveness of the implementation intentions, which were primarily explained by motivational factors specific to the academic goals generated during the exercises (and not the trait-like aspects of academic motivation measured by internal/external academic motivation).

Discussion

The first goal of this study was to provide an initial empirical test of whether goal-setting interventions (SMART and implementation intentions) could be used to help students reduce their procrastination and achieve their personal academic goals. There was little evidence that either the SMART or implementations intentions interventions helped reduce academic procrastination (at least in the context of the current study), or resulted in better ability to achieve goals, even when examining potential moderating variables such as baseline levels of procrastination and impulsivity (though there were two potential moderation effects that may be further examined in the future).

The second goal of this study was to directly examine the association between procrastination and the accomplishment of specific academic goals, especially in the context of multiple regression (i.e., to identify which factors uniquely predicted the dependent measures). Levels of procrastination at Session 1 were a strong predictor of goal success and procrastination

in Session 2, controlling for other factors such as impulsivity, conscientiousness, and motivation for goals, which did not show strong effects on goal accomplishment or procrastination, controlling for the other variables. Therefore, although this initial study on goal-related interventions did not reveal strong effects for student's ability to reduce their procrastination, this research provided more evidence for a link between procrastination and the success of academic goals.

Limitations

Before discussing the primary theoretical and methodological implications for this study, I point out two limitations of this work, and why they may have contributed to the lack of evidence for effects of the goal-setting interventions at reducing procrastination.

Most importantly, the dependent measure of the academic procrastination used in this study may not have been sensitive to changes in procrastination over time. The PASS has been widely used as a trait-like measure of academic procrastination since its development (Solomon & Rothblum, 1984), but few if any studies have examined change in procrastination over time using this measure. PASS scores in this sample were correlated with other individual differences as expected, and were one of the only unique predictors of goal accomplishment at Session 2, but may not be sensitive to change in levels of procrastination over time. For example, there are only five response options for each item, and if individuals did not feel that they significantly reduced their procrastination, they may not have reported any change (even if they did reduce their procrastination a little). Future studies that examine changes in procrastination over time could benefit from more directly asking students if they felt that their procrastination tendency was reduced in weeks subsequent to interventions, or by developing behavioral measures of procrastination that are more objective and potentially more sensitive to change.

A second major limitation of this research was the lack of a true control group in this study. All subjects regardless of condition completed the goal-generation exercise and identified temptations that would get in the way of these goals. Even though the control goals (vs. SMART goals) and temptations only (vs. implementation intention) conditions provided a good active control to the intervention groups, it was impossible to examine whether these control exercises alone were effective at helping reduce procrastination.

I tried to address this limitation in two ways: (a) by examining whether there was an overall decrease in procrastination between Session 1 and Session 2, and (b) by examining similar change scores for the bottom three domains that the interventions were not completed for (a within-subjects control). Neither of these methods revealed any changes in procrastination across any group (there were only small and non-significant changes in procrastination across all subjects, and for both Top 3 and Bottom 3 Domains). However, aside from the previous limitations regarding the sensitivity of the measure, it is still possible that subjects in this study had less procrastination than similar students who did not complete this experiment. For example, procrastination may steadily rise throughout the semester, and this lack of a change in procrastination may actually be an improvement over the baseline (in fact, procrastination in the Top 3 Domains at Session 1 was positively correlated with the days since the start of the semester, $r = .11$, $p = .103$, though this correlation was not statistically significant). Therefore, even though there was little evidence that the interventions were effective, comparing these interventions with a true control group will be necessary to rule out such alternative interpretations.

Implications for Procrastination Interventions

The first goal of this study was to provide an initial attempt at examining whether individuals could reduce their academic procrastination, especially when pairing a simple goal-generation exercise (like that used by PPA) with interventions that target effective goal-setting (SMART goals) and/or resisting temptations (by forming implementation intentions). However, not only was there no evidence that either intervention resulted in more reduction in academic procrastination, there was also no reduction in procrastination collapsing across group membership, at least as implemented in the current study. These results suggest that even though procrastination is associated with goal accomplishment, reducing academic procrastination may not be as simple as identifying the important goals that need to be accomplished, making sure those goals are specific, measureable, and time-defined, and/or planning how to react when distracting temptations arise.

Of course, this is only one study, so the lack of clear findings that individuals could reduce their procrastination does not necessarily mean that these goal-related interventions show no effects. Rather, in line with some of the claims described in popular science books regarding how to help reduce procrastination (Burka & Yuen, 1983; Ferrari, 2010; Halvorson, 2010; Pychyl, 2013), these goal-setting exercises may not have been enough to observe a strong reduction in procrastination. Instead, these manipulations may need to be combined with other potential factors that may be important in successfully reducing procrastination.

For example, researchers have suggested that prevention-focused goals (e.g., avoiding a negative outcome) are necessary to help avoid procrastination, compared to promotion-oriented goals that highlight what is to be gained (Halvorson, 2010). Similarly, a focus on process (how to accomplish a goal) vs. outcome (why achieving a goal is important) could be necessary at

reducing procrastination depending on the individual and/or situation (Krause & Freund, 2014a). In this study, I did not force subjects to write goals in one way or the other (i.e., promotion or prevention-oriented), or tell subjects to focus on process vs. outcome depending on their individual characteristics or situations. If factors like SMART goal-setting and implementation intentions had strong effects alone, I should have observed at least a small effect of these interventions. Nevertheless, it is possible that SMART goal and implementation intentions may be helpful when combined with other approaches, such as ensuring goals are also prevention-oriented (Halvorson, 2010), focusing on process or outcome depending on the situation (Krause & Freund, 2014a) or breaking down goals into sub-goals (Pychyl, 2013; Steel, 2010).

Finally, although implementation intentions have been successful in many other domains including health and exercise (for review, see Sheeran, 2002), it is unclear why they did not work in the context of this study. As discussed in the introduction, recent research on implementation intentions has suggested that they may be successful at preventing individuals from procrastinating in certain situations (Howell et al., 2006; Owens et al., 2008). However, these existing studies have not shown that implementation intentions are more successful for individuals who procrastinate more, even when these effects were directly tested (Owens et al., 2008; van Hooft et al., 2004).

The implementation intentions in this study did differ slightly from their traditional use (Gollwitzer & Brandstatter, 1997; Sheeran, 2002). Namely, the implementation intentions tested here were directed at specific temptations, but implementation intentions can be broader, simply including a plan for future action. In fact, most (or all) subjects in the SMART goal condition were writing implementation intentions in this more classic sense (e.g., *I will study for two hours every weeknight* is the same as *If it is a weekday evening, I will study for two hours*). Even using

this more widely used definition of implementation intentions, however, there was little evidence that they were effective at reducing procrastination in the context of this study (i.e., there were no effects of the SMART intervention, and no evidence that subjects were able to reduce their procrastination across all conditions).

Implications for Procrastination and Goal Striving

Although I did not observe any direct effects of the exercises themselves, or of the SMART/implementation intention interventions, on the reduction in procrastination, a primary contribution of this study was that it provided more direct evidence that procrastination is predictive of the success of self-generated goals. In this study, levels of academic procrastination were moderately correlated with the self-reported accomplishment of academic goals, ability to resist temptations when they arose, and effectiveness of implementation intentions at reducing distraction by these temptations.

Importantly, I was also able to show that the association between procrastination and goal accomplishment was independent of other factors and correlates of procrastination, such as impulsivity, conscientiousness, beliefs about procrastination, and motivation for goals. These results suggest that the effects of procrastination were not simply due to its correlates, at least for goal accomplishment. Similarly, because almost none of these other individual differences factors (besides memory for goals) contributed to goal accomplishment controlling for procrastination, these results suggest that procrastination may mediate the associations of these personality traits (e.g., impulsivity and conscientiousness) and the ability to accomplish goals in everyday life.

Interestingly, this association between procrastination on goal accomplishment did not generalize to the other dependent measures of success, as procrastination was not a significant

predictor of the ability to resist temptations or the effectiveness of the implementation intentions, controlling for the other individual differences variables. In fact, the only construct that significantly predicted these two measures of success was the motivation to accomplish goals at the end of Session 1 (specifically, the motivation for the specific goals set in the exercises). Even trait-level motivational factors such as internal academic motivation (to do well for oneself) or external motivation (to do well because you think you have to, or to impress others) were not predictive above and beyond these specific motivational factors.

I also examined which factors uniquely contributed to Session 2 procrastination. It was not surprising that the procrastination at Session 2 (Top 3 Domains) was predicted by Session 1 scores (Top 3 Domains), as well as nonacademic procrastination and impulsivity. Interestingly, however, individuals who tended to report that procrastination was malleable (vs. fixed) in Session 1 ended up procrastinating even more in Session 2. This was the first study to use this measure of implicit beliefs on procrastination, and this result has some interesting implications for future research on procrastination, mindset, and beliefs (Halverson, 2010; Rattan & Dweck, 2010). Namely, these findings suggest that the (unrealistic) belief in the malleability of procrastination may lead to the thought that an individual can stop procrastinating at any time, but this thought ironically leads to more procrastination (at least, in the short-term).

Finally, it is important to briefly discuss the effects of memory (for goals) observed here. Aside from procrastination, the only other predictor of the success of the academic goals was subjects' memory for their goals at the start of Session 2. Additionally, memory for goals was one of the only candidate moderators in Analysis 1, suggesting that memory for goals was important only in the conditions where subjects did not write SMART goals. Both of these results must be interpreted with caution (the former because this association was not observed at

the basic correlational level, but only in the multiple regression, and the latter because of the large number of statistical tests conducted in the moderation analyses). However, they do suggest that remembering the specific goals one has set may play a role in goal accomplishment, either directly or indirectly. Future research on the association between procrastination and goal accomplishment (or similar intervention studies) should carefully consider the role of memory for goals, or implement procedures to ensure that all subject's memories for their goals are equivalent (e.g., by sending out reminders throughout the intervention).

Methodological Implications and Future Directions

There are a few methodological implications of this study that can be used to inform future research on procrastination and goal accomplishment. First, the two-session design of this study allowed for some other tests of the association between procrastination and goal management. For example, goal accomplishment three weeks after the exercise was predicted by levels of procrastination at Session 1, controlling for other relevant factors. In fact, because most subject's released their end-of-semester grades as part of Session 1, future analyses on this same sample will allow me to examine the role of procrastination, the goal-setting exercises, and the accomplishment of goals at Session 2 to predict even later outcomes such as the academic grades for introduction to psychology, or GPA for that semester. The multiple-outcome nature of this study may be important in future research on procrastination and goal management to help tease apart associations between these constructs, and to provide further evidence for the association between procrastination and course/semester grades (Beswick, et al, 1988; Tice & Baumeister, 1997).

Further analyses of this same dataset may also reveal that the success of the goal-setting exercises or interventions may greatly depend on the types of goals being set. For example, as

described in the results, individuals chose some domains much more frequently than others (e.g., writing papers), and each of the six domains were chosen fairly frequently (see Appendix B). Setting SMART goals or identifying implementation intentions may be more effective when targeting specific academic domains compared to others. For example, less well-defined academic tasks (e.g., writing papers) likely have less clear goals from the start, whereas some tasks like attending classes or office hours do not require SMART goals as strongly (e.g., a goal of not missing any classes is already specific, measurable, and time-defined). Analyses of these data focusing on the academic domains that goals were written for may reveal positive effects of the interventions on some domains, and even possibly harmful effects on others (e.g., over-whelming individuals with too high standards such that when they do not meet them, they give up), but these effects will likely have to be confirmed with another sample before strong conclusions are drawn.

Chapter 3

Examining Early Life Predictors of Procrastination and the Association between Procrastination and Intelligence

Individual differences in many cognitive abilities and personality traits persist across the lifespan. For example, individual differences in intelligence (IQ) remain remarkably stable over decades (Deary, Pattie, & Starr, 2013; Schwartzman, Gold, Andres, Arbuckle, & Chaikelson, 1987), as do individual differences in personality traits such as those assessed by the NEO Personality Inventory (McCrae & Costa, 1994). Furthermore, early life measures of these constructs not only predict individual differences in the same constructs later in life, but can also predict important life outcomes. Childhood IQ, for example, is predictive of many adult outcomes such as the likelihood of developing mental disorders (Koenen et al., 2009), obesity (Chandola, Deary, Blane, & Batty, 2006), and even mortality (Gottfredson & Deary, 2004). These findings suggest that it may be important to monitor such cognitive and personality variables in childhood, as they may help parents/children better plan for their future.

In contrast to these traits that can be measured in early childhood and predict outcomes throughout the lifespan, some constructs may not emerge until adolescence or adulthood. Procrastination, for example, does not necessarily exist in early childhood. By definition, individuals cannot procrastinate until they understand how to prioritize some actions over others and can knowingly choose to delay action on an important long-term goal despite expecting to be worse off for that delay (Steel, 2007, 2010). Although the demographic and personality variables associated with procrastination in adolescence and adulthood are becoming better understood (Steel, 2007; Steel & Ferrari, 2013), little is known about when procrastination arises or whether individual differences in adult procrastination can be predicted by other stable and predictive

traits that emerge early in childhood such as self-restraint, attentional control, or IQ. Furthermore, it is unclear how strongly procrastination is associated with general intelligence in adulthood, as the cognitive abilities underlying procrastination have only recently begun to be investigated (Gustavson et al., 2015).

In this study, I analyzed data from the ongoing Colorado Longitudinal Twin Study from which I have modeled the genetic relations among procrastination, goal management, impulsivity, and EF in early adulthood (Gustavson et al., 2014, 2015). Most of the twins who completed measures of procrastination (and IQ) in adulthood also completed observed or behavioral measures of self-restraint, attentional control, and/or IQ in early childhood (ages 14 – 36 months). This study focused on two key research questions: (a) Can adult procrastination (as well as two related constructs: goal management failures and impulsivity) be predicted by early childhood self-restraint, attentional control, or intelligence?; and (b) What is the association between procrastination and IQ in early adulthood? Because this sample is genetically informative, I also examined the etiology of these relationships where relevant, as any observed associations may be due to shared genetic/environmental factors, or both.

Early Childhood Predictors of Procrastination

The first goal of this study was to explore the early cognitive abilities that may act as indicators of procrastination later in life. Multiple goal-related cognitive abilities that emerge in early childhood have been identified, such as the delay of gratification and/or early executive functions (EFs; Garon, Bryson, & Smith; 2008; Hongwanishkul, Happaney, Lee, & Zelazo; 2005; Munakata, Snyder, & Chatham, 2012), and these abilities may predict important outcomes later in life (Caspi & Silva, 1995; Friedman, Miyake, Robinson, & Hewitt, 2011; Mischel et al., 2011). However, studies have yet to systematically explore whether individual differences in the

development of goal-related abilities in childhood predict procrastination in adulthood. Here, I focused on three potential early cognitive correlates of later life procrastination: self-restraint, attentional control, and IQ.

Self-restraint. The first cognitive ability in early childhood that may relate to the development of procrastination in adulthood is self-restraint. Self-restraint is defined here as the ability to exert control over one's actions (especially prohibitory control), such as through the ability to comply with "do" and "don't" commands (Kochanska, Coy, & Murray, 2001). Self-restraint in early childhood is also associated with the ability to delay gratification (Mischel, Shoda, & Rodriguez, 1989), and with the development of early EFs (Posner & Rothbart, 2009). Therefore, these self-restraint abilities may predict procrastination later in life, given procrastination's association with goal management, EFs, and self-regulation in adulthood (Gustavson et al., 2015).

In fact, recent work has shown that children with better self-restraint in early childhood had better EF abilities about 15 years later in adolescence (Friedman et al., 2011). In this study, a sample of about 950 twins (actually, the same sample described here) completed the prohibition task, a measure of self-restraint, four times in early childhood (ages 14 – 36 months). In this task, the experimenter showed a child an attractive toy (i.e., a glitter wand) and *prohibited* the child from touching it for 30 seconds. Many of these children returned at age 17 and completed a battery of nine frequently studied EF tasks. Two groups of individuals were identified based on their performance on the prohibition tasks in childhood using a latent class growth model, and those children who had better self-restraint in early childhood also had significantly better Common EF, a latent factor explaining variation in all nine EF tasks, in adolescence (Friedman et al., 2011).

These findings are important because they suggest that self-restraint in childhood may draw on the same goal-management abilities thought to support EFs later in life (Miyake & Friedman, 2012). In fact, these same EF abilities are also associated with individual differences in procrastination in adulthood (Gustavson et al., 2015). Namely, a recent study on this same sample of twins revealed that individual differences in the same Common EF factor (this time based on measures taken at age 23) were correlated with both procrastination (r = –.15) and everyday goal management failures at age 23 (r = –.32) at the phenotypic level, suggesting that individuals with better Common EF tend to procrastinate less and experience fewer goal management failures in everyday life (Gustavson et al., 2015). Because both childhood self-restraint and adult procrastination are linked with the component of EF hypothesized to underlie general goal-related processes (Miyake & Friedman, 2012), it is reasonable to expect that childhood self-restraint may also be predictive of adult procrastination.

Attentional control. A second construct in childhood that may predict adult procrastination is attentional control. Attentional control is an aspect of temperament that has been studied as part of the more broad temperament construct of effortful control (Rothbart, 2007). Specifically, attentional control refers primarily to persistence and attention span, whereas effortful control includes other abilities such as suppressing prepotent behaviors, slowing motor activity, and planning and selecting actions based on the environment (Kochanska, Murray, & Harlan, 2000; Rothbart, 2007). In this study, I focused primarily on attentional control, because these specific abilities involved in attentional control have been suggested to be a precursor to the broader construct of effortful control (Kochanska & Knaack, 2003), and also because attentional control is thought to aid in the development of self-regulation (Kochanska & Knaack, 2003; Kochanska et al., 2000), an overarching term used to described procrastination and other

abilities in adulthood (Gustavson et al., 2014; Steel, 2007). Attentional control in early childhood is also associated with self-restraint (Smith Watts, 2014), and may be protective for developing behavioral problems (Rothbart, Ellis, Rueda, & Posner, 2003).

Based on this prior research on attentional control as an early indicator of self-regulation (Kochanska et al., 2000; Posner & Rothbart, 2009), it may be a strong candidate to be an early predictor of procrastination. Specifically, procrastination is closely linked to self-regulation and related traits like self-control and impulsivity in both college students and adults (Gustavson et al., 2014; Klassen, Krawchuk, & Rajani, 2008; Senecal, Koestner, & Vallerand, 1995; Steel, 2007), so the early self-regulatory abilities involved in attentional control may predict procrastination and these other aspects of self-regulation in adulthood. Temperament constructs in early childhood are precursors of personality (Rothbart, Ahadi, & Evans, 2000; Rowe & Plomin, 1977), and personality traits are highly stable over the lifespan (McCrae & Costa, 1994), so it is possible that these associations will be observed even 20 years later.

Intelligence in early childhood. A final construct in childhood that may predict adult procrastination is IQ. The motivation for an association between procrastination and IQ is discussed further in the next section, but there are reasons to expect that IQ will be a good predictor of procrastination even when focusing on early childhood measures. For example, individual differences in IQ are highly stable over decades (Deary et al., 2013; Schwartzman et al., 1987; Tucker-Drob & Briley, 2014), and IQ in childhood is predictive of many outcomes including the likelihood of developing mental disorders, obesity, and mortality (Chandola, et al., 2006; Gottfredson & Deary, 2004; Koenen et al., 2009). Finally, IQ is associated with both self-restraint and attentional control in early childhood (Smith Watts, 2014), suggesting that to the extent that these abilities are associated with procrastination, IQ may be predictive as well.

Procrastination and General Intelligence

The second goal of this study was to examine the association between procrastination and IQ in more detail. Another benefit of the longitudinal sample used in this study is that IQ was measured at two other time points in addition to early childhood: at age 17 and at age 23. Therefore, the association between procrastination and IQ can be examined at these later ages as well, as this provides more information about the strength of the association between procrastination and IQ at more proximal time points.

In addition to the reasons discussed briefly in the previous section, another reason to examine the association between procrastination and IQ is to provide more information about the types of cognitive abilities that underlie procrastination in adulthood. My previous research, for example, has highlighted the role of goal management in procrastination, both in the context of everyday settings (e.g., everyday goal failures) and for those specific goal-management abilities that support performance on behavioral measures of EF (i.e., Common EF; Gustavson et al., 2015). However, in this previous work, an alternative interpretation for the association between procrastination, goal failures, and EF was that procrastination is simply associated with general cognitive abilities, such as those measured by IQ, rather than abilities specific to goal management processes. Therefore, further examining the association between procrastination and IQ can inform whether the cognitive abilities impaired in those who procrastinate are limited to the goal-management abilities already identified, or if they represent a larger association between procrastination and IQ.

Like self-restraint, another reason to suspect a link between procrastination and IQ is that both are associated with EF, especially at the genetic level (Friedman et al., 2008; Gustavson et al., 2015). For example, Friedman et al. (2008) showed that higher IQ at age 17, as measured by

the Wechsler Adult Intelligence Scale (WAIS), was associated with better Common EF ability at the phenotypic (r = .53) and genetic levels (r_g = .57). As discussed earlier, my own research has shown that at age 23 Common EF was the component of EF most closely associated with procrastination at the phenotypic (r = –.15) and genetic levels (r_g = –.19; Gustavson et al., 2015). Therefore, these findings suggest that procrastination may be at least weakly associated with lower IQ.

However, if IQ is only associated with procrastination because of Common EF, this relationship will likely be weak at best. Procrastination is only weakly related to Common EF at the phenotypic level, and Common EF accounts for only about 25% of the phenotypic variation in IQ (i.e., in adolescence; Friedman et al., 2008). Furthermore, another 25% of individual differences in IQ can be accounted for by the Updating-Specific EF (Friedman et al., 2008), which is not associated with procrastination at the phenotypic level (r = -.01; Gustavson et al., 2015). Therefore, the remaining half of the variation in IQ cannot be accounted for by EF and likely reflects a number of other cognitive abilities. Thus, if I observe a moderate or strong correlations between procrastination and IQ, this would suggest that other cognitive abilities predict procrastination above and beyond those that support Common EF (e.g., visual discrimination, language, and problem solving, to name a few). However, if this correlation is weak, it is likely that this association is driven by Common EF, especially when both constructs are assessed at the same age.

The few existing studies that have examined procrastination and IQ suggest that procrastination may only be weakly related to intelligence (Di Fabio & Palazzeschi, 2012; Ferrari, 1991). In one study, individuals selected based on extreme scores for high and low procrastination did not differ in their verbal or abstract intelligence as measured by the Shipley

Institute of Living Scale (Ferrari, 1991). In another study, self-reported procrastination was associated with worse performance on the Raven's Advanced Progressive Matrices, a more common measure of intelligence (r = -.22; Di Fabio & Palazzeschi, 2012).

Based on these initial findings on college students, it is likely that the association between procrastination and IQ is rather small (and is therefore primarily due to the goal-management abilities involved in Common EF). However, it will be important to quantify this association in a large sample of individuals from the general population, and by examining procrastination at the latent construct level (which will reduce the influence of measurement error). Furthermore, because the sample described here is genetically informative, the association between procrastination and IQ can be examined at the genetic/environmental level. Previous work has suggested that the associations between procrastination and other cognitive abilities are primarily genetic in origin (Gustavson et al., 2014, 2015), so decomposing these associations into their genetic/environmental components may reveal a stronger association between procrastination and IQ (at the genetic level).

The Current Study

In the current study, I analyzed data from the Colorado Longitudinal Twin Study to test whether individual differences in early childhood self-restraint, attentional control, and IQ predicted of adult procrastination about 20 years later. I also explored the association between procrastination and IQ with later measures of IQ (in adolescence and adulthood) to examine whether individuals who procrastinate more have lower IQs when both constructs were measured at more proximal time points. This sample is comprised of about 950 twins who completed measures of procrastination, goal failures, impulsivity, and IQ in adulthood, and/or participated in the study in early childhood (ages 14 – 36 months) and completed behavioral or observed

measures of prohibition, temperament, and IQ (IQ was also assessed in adolescence). The twins in this study are representative of the normal population of Colorado (Rhea, Gross, Haberstick, & Corley, 2013).

I conducted all analyses in this study controlling for social desirability as I have done in previous research on this sample (Gustavson et al., 2015). My previous work suggested that a substantial portion of the variation in the self-reported measures of procrastination, goal failures, and impulsivity analyzed here may be due to social desirability factors (i.e., simply responding based on what is socially acceptable, rather than reporting their true levels of procrastination). Controlling for social desirability by creating residualized scores for each questionnaire after regressing out variation shared with responses to the Marlow-Crowne Social Desirability Scale (Crowne & Marlowe, 1960) revealed stronger associations between the latent variables for procrastination and EF, as well as for goal management and EF. Therefore, in this study I controlled for social desirability in the measures of procrastination, goal failures, and impulsivity in the same way as my previous work (Gustavson et al., 2015). Although impulsivity was not included in this previous study, preliminary analyses indicated that both indicators of impulsivity used here were moderately correlated with social desirability (*r*s = .45 – .56) in a similar way as those measures of procrastination (*r*s = .40 – .49) and goal failures (*r*s = .40 – .42), justifying the use of this procedure for the indicators of impulsivity.

Method

Subjects

These analyses were based on a total of 954 individuals (482 females, 472 males) from 478 same-sex twin pairs (263 monozygotic [MZ], 214 dizygotic [DZ], and one family with unknown zygosity). Most twins completed measures at both early childhood and young

adulthood (for N at each time for each measures, see Table 3-1 and 3-2), but data were included for all twins who completed measures at any time point.

Measures in Early Childhood (Ages 14 – 36 Months)

The early childhood measures of self-restraint, attentional control, and IQ were described in earlier work on these constructs (Friedman et al., 2011; Smith Watts, 2014). However, as one of these studies was a dissertation that has yet to be published (Smith Watts, 2014), each measure is described in some detail here.

Self-restraint (age 14 – 36 months). Self-restraint was assessed at four time points using the prohibition task: 14 months, 20 months, 24 months, and 36 months, inside the children's homes. In each session, the subject was seated at a table or high chair next to the experimenter and his or her parent (who was instructed to remain neutral). First, the experimenter showed the child an attractive toy (a glitter wand) and made eye contact with the child. Next, the experimenter placed the toy on the table, said "Now, [child's name], don't touch," and looked away. After the child touched the toy or 30 s elapsed, the experimenter said "It's okay, you can touch it now." At each time point, the dependent measure was the latency at which the child touched the toy, binned into three bins due to the non-normality of the data: 0-10 s, 11-29 s, and 30 s or more. Compared to transformations, this categorical data analysis has been shown to produce more unbiased estimates in twin models (Derks, Dolan, & Boomsma, 2004).

This self-restraint task has been modelled in different way in the past, such as with a latent class growth model (Friedman, et al., 2011) or an intercept/slope model (Smith-Watts, 2014). In these analyses, however, a single latent factor explaining variation in all four time-points was fit to the data (e.g., like all of the other latent variables described here). This model was chosen because it most similar to the intercept factor in the intercept/slope model presented

most recently (Smith-Watts, 2014), which primarily accounted for the correlations with other latent factors observed in that study (e.g., attentional control, behavioral inhibition, negative emotionality, and IQ). Furthermore, it may be more powerful than the latent class growth model presented in Friedman et al. (2011) because it does not split subjects into categories or groups.

Attentional control (ages 14 – 24 months). Attentional control (i.e., persistence and attention span) was assessed in three of the four sessions in which self-restraint was assessed (14, 20, and 24 months). Although this sample has both experimenter observed and parent-report measures of attentional control, only the observed data are reported here (though results were similar if the parent report measures were used instead). Observed attentional control was measured with the Infant Behavior Records (Matheny, 1980), an examiner-based assessment of child's behavior that is assessed during the administration of the Bayley Scales of Infant Development (Bayley, 1969) and for the examiners aggregate impressions during all other procedures in the session of testing. The dependent measure at each age was the average of the toddler's persistence and attention span scores for both measures on a 1-9 scale, with higher scores indicating better attentional control (Smith Watts, 2014).

IQ (ages 14 – 36 months). In early childhood, IQ was assessed using four measures: the intelligence quotient score on the Stanford-Binet Intelligence Test (Terman & Merrill, 1973) at age 36 months, and the Mental Development Index of the Bayley Scales of Infant Development at ages 14, 20, and 24 months (Bayley, 1969).

Measures in Adolescence and Adulthood (Ages 17 and 23 years)

The assessments of procrastination, goal failures, and impulsivity have also been described in previous work on this same sample (Gustavson et al., 2014, 2015). These measures

are also briefly described here, but more detailed information including sample items can be found in Gustavson et al. (2014, 2015).

Procrastination (age 23). Procrastination was assessed with three questionnaires: (a) the 20-item General Procrastination Scale (GPS; Lay, 1986); (b) the average of the external control, goal neglect, and effort avoidance (7-items each) subscales of the Volitional Components Inventory (VCI; Kuhl & Fuhrmann, 1988); and (c) the 12-item prospective and decision-related action orientation versus hesitation subscale of the Action Control Scale (ACS; Kuhl, 1994).

Goal failures (age 23). Goal management failures were measured with two questionnaires: (a) the total score of the 25-item Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982); and (b) the log-transformed average of the short-term (14-items), long-term (14-items), and internally cued (10-items) subscales of the Prospective Memory Questionnaire (PMQ; Hannon, Adams, Harrington, Fries-Dias, & Gipson, 1995).

Impulsivity (age 23). Impulsivity was assessed with two questionnaires: (a) the average of the negative urgency, positive urgency, and lack of premeditation (22 items total) subscales of the UPPS-P Impulsive Behavior Scale (Lynam et al., 2006); and (b) the average of 20 (out of 36) items of the Self-Control Scale (SCS; Tangey, Baumeister, & Boone, 2004). As presented in previous work (Gustavson et al., 2014), these SCS items were chosen to most closely assess the urgency and lack of premeditation aspects of impulsivity, and to avoid using items from these scales that indirectly measure procrastination.

IQ (ages 17 and 23). In young adulthood (age 23), IQ was assessed using a timed short form of the Raven's Advanced Progressive Matrices (Raven, 1960), in the same session that the measures of procrastination, goal failures, and impulsivity were completed. IQ was also

measured in adolescence (age 17; M=17.25, SD=.65) using the Wechsler Adult Intelligence Scale (WAIS; Friedman et al., 2008; Wechsler, 1997).

Data analysis

All analyses were conducted using Mplus software (Version 7.2; Muthén & Muthén, 2010). Model fit for these structural equation models was evaluated with chi-square tests (χ^2), the root-mean-square error of approximation (RMSEA), and the Comparative Fit Index (CFI). Models with χ^2 values less than two times the degrees of freedom, RMSEA values < .06, and CFI values > .95 were classified as having good fit (Byrne, 1989; Hu & Bentler, 1998). Furthermore, the significance of model parameters was evaluated with χ^2 difference tests (χ^2_{diff}). Estimation used full-information maximum likelihood (for all models that did not include prohibition), or weighted least squares, mean and variance adjusted (for all models that included prohibition tasks, because of the binned nature of these measures). Finally, for phenotypic analyses only, standard errors and χ^2 were adjusted to account for the clustering in the data (i.e., within-families) using the "type = complex" command and corresponding scaling factors in the Mplus output (Satorra & Bentler, 2001).

In the genetic analyses described here, variation in each construct (and covariation between constructs) was decomposed into three sources: genetic influences (*A*), shared environmental influences (*C*), and nonshared environmental influences (*E*). These models are based on the assumption that genetic influences were correlated at 1.0 in MZ twin pairs and 0.5 in DZ twin pairs (because they share 100% and 50% of their segregating alleles identical by descent, respectively). Additionally, shared environmental influences were correlated at 1.0 (because twins were reared together) and nonshared environmental influences were set to no correlation (by definition).

For both the latent variables and residual variances (i.e., of the individual indicators) of procrastination, goal failures, and impulsivity, the shared environmental influences (and shared environmental covariances) were not estimated in any of the analyses because previous research has suggested that these influences account for little to no variation these constructs/measures (Gustavson et al., 2014, 2015). Furthermore, shared environmental influences on the latent variable for attentional control were also removed because univariate analyses revealed no evidence for shared environmental influences on this factor. In these analyses, twins were assigned randomly to twin 1 vs. twin 2, using the same assignment used by Friedman et al. (2008, 2011).

Results

Descriptive statistics for all of the variables used in this study, and the twin 1 vs. twin 2 correlations (for both MZ and DZ twins) are displayed in Table 3-1. For the self-restraint measures only, the *n* per bin and twin 1 with twin 2 correlations (for each time point) are displayed in Table 3-2.

Table 3-1: Descriptive Statistics for the Measures Used in the Longitudinal Analysis

	N	Mean	SD	Range	Skewness	Kurtotsis	*r*MZ	*r*DZ
Age 14 – 36 months								
Attentional Control								
14 mo	790	5.26	1.02	2 - 8.25	-.28	.23	.06	.07
20 mo	709	5.78	.95	2.5 - 9	-.37	.77	**.30**	.07
24 mo	708	5.94	.93	3 - 8.75	-.23	.12	**.30**	.08
IQ								
Binet	667	103.13	17.70	57 - 180	-.03	.11	**.69**	**.52**
Bayley 14 mo	783	112.43	5.50	81 - 129	-.52	2.21	**.55**	**.41**
Bayley 20 mo	690	136.06	8.54	110 - 160	.03	-.19	**.80**	**.65**
Bayley 24 mo	696	148.78	8.30	119 - 162	-.08	.31	**.83**	**.59**
Age 17 years								
WAIS (IQ)	812	102.17	11.41	70 - 142	.21	.24	**.83**	**.52**
Age 23 years								
Procrastination								
GPS	751	2.59	.57	1.05 - 4.60	.04	-.03	**.51**	.09
VCI	750	3.03	.85	1.05 - 6.19	.35	.03	**.41**	**.19**
ACS	747	7.90	2.90	0 - 12	-.47	-.58	**.31**	.05
Goal Failures								
CFQ	750	1.39	.45	.12 - 3.20	.30	.54	**.49**	**.24**
PMQ	736	.63	.29	0 - 1.7	.47	.08	**.46**	.13
Impulsivity								
UPPS	746	1.96	.42	1.05 - 3.59	.33	.11	**.46**	.03
SCS	749	3.42	.61	1.40 - 4.85	-.36	.14	**.43**	**.17**
IQ								
Raven's	745	.62	.19	.11 - 1	-.39	-.44	**.60**	**.37**

Note: Significant twin 1 – twin 2 correlations (r_{MZ} and r_{DZ}) are displayed in bold ($p < .05$). WAIS = Wechsler Adult Intelligence Scale, GPS = General Procrastination Scale, VCI = Volitional Components Inventory, ACS = Action Control Scale, CFQ = Cognitive Failures Questionnaire, PMQ = Prospective Memory Questionnaire, UPPS = UPPS impulsivity, SCS = Self Control Scale, Raven's = Raven's Advanced Progressive Matrices

Table 3-2: N in Each Bin for the Prohibition Task

	14 mo	20 mo	24 mo	36 mo
Bin 1 (0 - 10 s)	557	345	223	146
Bin 2 (11 - 29 s)	116	104	74	87
Bin 3 (> 29 s)	87	227	374	425
Total N	760	676	671	658
r_{MZ}	.50	.38	.25	.53
r_{DZ}	.33	.32	.29	.33

Note: All twin 1 – twin 2 correlations (r_{MZ} and r_{DZ}) were statistically significant ($p < .05$).

Description of the Basic Phenotypic Model

The primary results are described in order of the two key research questions. However, the phenotypic associations between all of the constructs in this study were first simultaneously estimated in one correlational model. This model is briefly described here, but the results are described in the sections relevant to each primary aim (with additional analyses relevant to that research question).

This correlational model is displayed in Table 3-3 and included all of the measures taken in early childhood (prohibition, attentional control, and IQ), adolescence (one IQ assessment), and adulthood (procrastination, goal management failures, impulsivity, and IQ), $\chi^2(141) = 199.97$, $p = .001$, RMSEA = .021, CFI = .973. In this correlational model, all constructs were examined at the level of latent variables except for IQ at ages 17 and 23, which were assessed using only one measure at each time point. The factor loadings for these latent variables are displayed in Appendix C, alongside the full correlation matrix between all of the individual measures. Further analyses revealed no systematic differences compared to models of each

association individually (e.g., procrastination and self-restraint alone), so the results of the full model are presented here[7].

In Table 3-3, the latent variable correlations between all of the key constructs in the study are presented below the diagonal. Above the diagonal (and italicized), the same latent variable correlations are displayed in a similar model in which social desirability is not regressed out of the indicators of procrastination, goal failures, and impulsivity. This model also had an acceptable fit to the data, $\chi^2(141) = 187.03$, $p = .001$, RMSEA = .018, CFI = .981, but these results (without accounting for social desirability) are not discussed further.

Table 3-3: Phenotypic Correlations Between all Measures in the Longitudinal Analysis

		1	2	3	4	5	6	7	8
1. Self-Restraint	(14 – 36 mo)	1	*.45*	*.52*	*.22*	*.20*	*.04*	*.04*	*.00*
2. Attentional Control	(14 – 36 mo)	**.45**	1	*.55*	*.32*	*.21*	*.09*	*.02*	*.12*
3. IQ – childhood	(14 – 36 mo)	**.51**	**.54**	1	*.48*	*.33*	*.06*	*-.02*	*.06*
4. IQ – WAIS	(17 yr)	**.21**	**.32**	**.47**	1	*.58*	*.07*	*-.02*	*.04*
5. IQ – Raven's	(23 yr)	**.20**	**.21**	**.32**	**.58**	1	*.03*	*-.08*	*-.04*
6. Procrastination	(23 yr)	-.07	.04	-.03	-.02	-.01	1	*.65*	*.76*
7. Impulsivity	(23 yr)	-.07	-.06	**-.13**	**-.14**	**-.15**	**.47**	1	*.68*
8. Goal Failures	(23 yr)	-.09	.07	-.01	-.06	-.09	**.66**	**.54**	1

Note: Latent variable correlations model social desirability removed from measures of procrastination, impulsivity, and goal failures (below the diagonal). The corresponding correlations without social desirability removed from these measures are presented above the diagonal (and italicized). Significant correlations are displayed in bold only for correlations below the diagonal ($p < .05$).

[7] In this correlational model (and all other phenotypic models described here) I included three additional residual correlations between individual measures: a correlation between the Bayley Scales at 14 months and 20 months (both were indicators of IQ), a correlation between the measures of attentional control at 14 months and IQ at 14 months, and a correlation between those same measures at 20 months. All residual correlations were significant, $\chi^2_{diffs}(1) > 24.29$, *p*s < .001. The latter two residual correlations (between indicators of attentional control and IQ) and were justified because both measures were based on performance on the Bayley Scales (i.e., attentional control was partially based on experimenter observations during administration of the Bayley Scales and IQ was based on actual performance). The same residual correlation at 24 months was not needed, $\chi^2_{diff}(1) = 1.34$, $p = .246$, so it was not included in any models described here. Finally, no other residual correlations were estimated between the Bayley Scales in the intelligence factor (e.g., between scores at 14 and 24 months, or 20 and 24 months).

Aim 1: Early Childhood Indicators of Procrastination

The first goal of this study was to examine whether adult procrastination could be predicted by self-restraint, attentional control, or IQ in early childhood. However, the results of the basic correlational model described above suggest that procrastination was not associated with any of these constructs. As shown in Table 3-3, neither self-restraint, attentional control, nor IQ were significantly correlated with levels of procrastination in adulthood, $r = –.07$, $\chi^2_{diff}(1) = .88$, $p = .348$ for self-restraint, $r = .04$, $\chi^2_{diff}(1) = .48$, $p = .488$ for attentional control, $r = –.03$, $\chi^2_{diff}(1) = .33$, $p = .565$ for early IQ.

Similar results were observed for levels of goal failures and impulsivity. Neither self-restraint nor attentional control were significantly correlated with either of these constructs. However, lower levels of IQ in early childhood were significantly correlated with greater self-reported impulsivity in adulthood, $r = -.13$, $\chi^2_{diff}(1) = 5.89$, $p = .015$. Although this correlation was weak, it suggests that IQ does predict this common correlate of procrastination as early as 20 years earlier. Finally, it is also important to note that all three of the cognitive abilities in childhood were moderately correlated with one another (*r*s = .45 to .51), consistent with previous research on these constructs using this sample (Smith Watts, 2014).

Structural models. I also examined the associations between the early indicators of cognitive ability and the measures of self-regulation in adulthood using two structural equation models. In the first model, displayed in Figure 3-1, $\chi^2(130) = 184.17$, $p < .001$, RMSEA = .021, CFI = .973, the three constructs in childhood (self-restraint, attentional control, and IQ) directly predict each of the constructs in adulthood (procrastination, goal failures, impulsivity, and IQ), with additional correlations between constructs measured at the same age (e.g., procrastination

and impulsivity). In this model, IQ at age 17 was excluded because it was not measured at the same time as either of the other sets of constructs (early childhood or young adulthood).

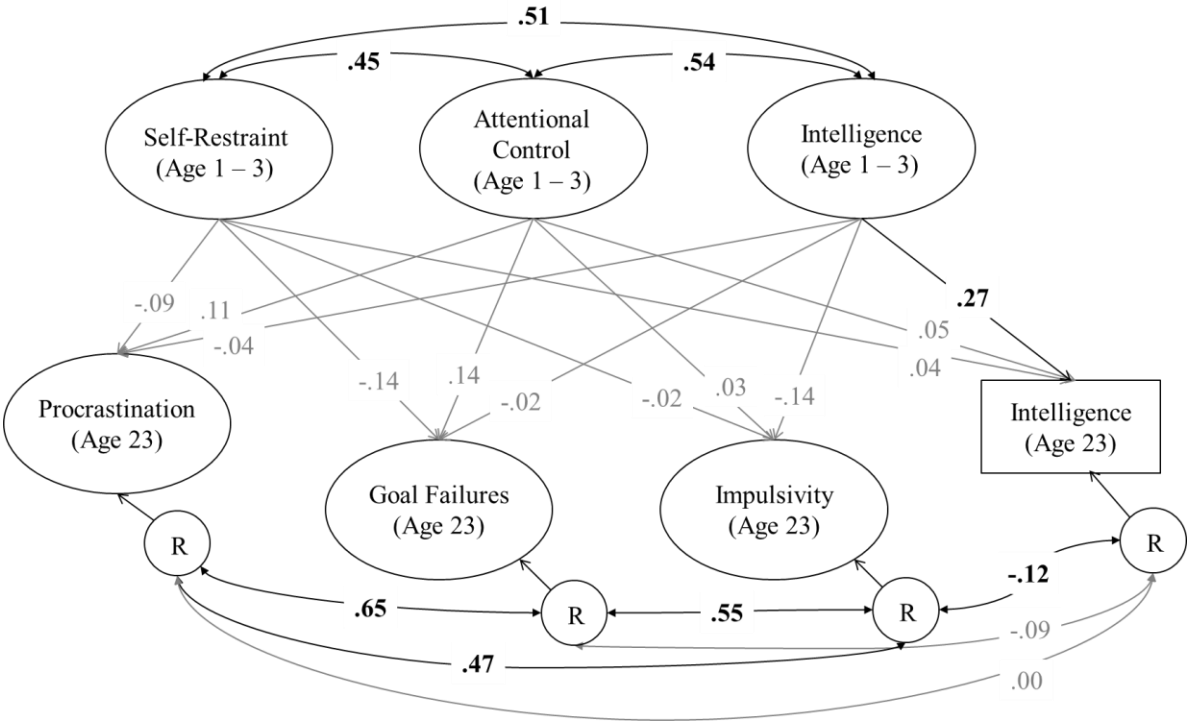

Figure 3-1. Structural model of all of the constructs examined in this study (except IQ at age 17). Self-restraint, attentional control, and IQ in early childhood predict procrastination, goal failures, impulsivity, and IQ in young adulthood (controlling for the associations with the other childhood indicators). IQ at age 23 was allowed to correlate with the other self-regulatory constructs at age 23, and they were allowed to correlate with one another. R = Residual variances on the dependent measures.

This model is interpreted slightly differently from the correlational model, but is similar to that of a multiple regression (with multiple dependent measures). Essentially, the associations between early childhood and young adulthood are shown controlling for the other constructs in early childhood. However, even in this structural model, none of the associations between procrastination and the early childhood constructs were significant (*r*s = –.14 to .14). Furthermore, the correlation between early IQ and impulsivity was no longer statistically significant in this model, $r = –.14$, $\chi^2_{diff}(1) = 2.95$, $p = .086$.

Finally, a second structural model was fit to the data, to examine whether any of the early childhood measures were predictive of the common variance between procrastination, goal failures, and impulsivity (e.g., a tendency to report self-regulatory failures in general), as these constructs share substantial phenotypic variance (Gustavson et al., 2014). This second structural model is presented in Figure 3-2, $\chi^2(135) = 180.94$, $p = .005$, RMSEA = .019, CFI = .977. This model is similar to the previous model, in which the early childhood measures predicted variation in the young adult measures, controlling for the effects of one another. However, in this model, rather than examining procrastination, goal failures, and impulsivity separately, a higher-order latent factor was fit to these measures (termed Self-Regulation), explaining variation in all three of these everyday self-regulation constructs in young adulthood. This model did not fit significantly worse than the previous model, $\chi^2_{diff}(5) = 1.63$, $p = .898$, suggesting that this was an appropriate way of examining the association between the early childhood measures and the tendency to report more self-regulatory failures in general (i.e., more procrastination, goal failures, and impulsivity in adulthood).

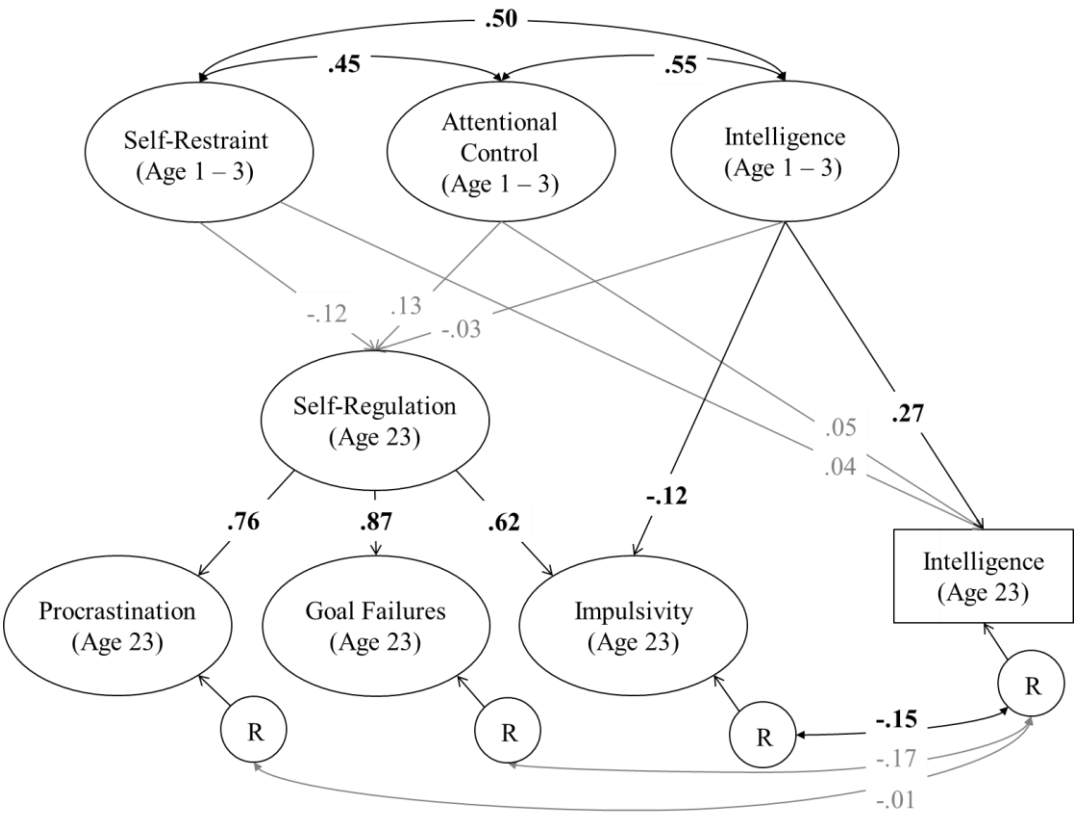

Figure 3-2: Second structural model of all of the constructs examined in this study (except IQ at age 17). Self-restraint, attentional control, and IQ in childhood predict a higher-order self-regulation latent variable that accounts for common variation across procrastination, goal failures, and impulsivity (with one residual association between IQ at age 3 and impulsivity at age 23). Early childhood constructs also predicts IQ at age 23 (controlling for one another), and IQ at age 23 was allowed to correlate with the other self-regulatory constructs at age 23. R = Residual variances on the dependent measures.

Like the other analyses, neither levels of self-restraint, attentional control, nor IQ were not associated with self-regulation in adulthood, even when examined at the level of the higher-order latent factor. However, in this model there was a significant direct path between IQ at age three and impulsivity at age 23, suggesting that these constructs are associated above and beyond the association between early IQ and the higher-order self-regulation latent factor, $\chi^2_{diff}(1) = 5.78$, $p = .016$. Further analyses indicated that there were no other direct effects of the early childhood constructs on procrastination, goal failures, or impulsivity, above and beyond their association

with self-regulation factor, $\chi^2_{diffs}(1) < .37$, ps > .541, suggesting that the self-regulation factor entirely accounted for the associations between the early childhood constructs and procrastination or goal failures (as well as the associations between impulsivity and self-restraint or attentional control). Therefore, although there was some indication that the correlation between impulsivity and IQ was not significant in the first structural model (Figure 3-1), these analyses provide more evidence for this association (Figure 3-2). However, there was little evidence that procrastination could be predicted by any early childhood constructs, even when examining variation shared between the other aspects of self-regulation in adulthood.

Genetic analyses. Because this sample is genetically informative, it was also important to examine these associations at the genetic/environmental level. There were no strong associations between the early cognitive abilities and adult procrastination, so I did not do extensive modelling of these data. However, Appendix D displays some exploratory genetic analyses that were conducted between each pair of constructs individually (e.g., procrastination and self-restraint only). These models decomposed the phenotypic associations described in Table 3-3 into their genetic and non-shared environmental components (shared environmental correlations were also estimated for some comparisons, but only when both constructs were explained by shared environmental factors). Due to the large number of models fit and statistical tests conducted in these exploratory analyses, the results must be interpreted with caution. However, they can further inform the etiology of the correlations presented in Table 3-3.

There are two important findings revealed by these genetic analyses. First, there was some suggestion that the correlation between IQ in early childhood and impulsivity in adulthood was primarily genetic ($r_g = –.25$), rather than due to nonshared environmental influences common to both constructs ($r_e = –.07$). However, this genetic correlation it was only marginally

significant, $\chi^2_{diff}(1) = 3.02$, $p = .082$, suggesting that I cannot be sure whether these influences are truly due to genetic or environmental factors (though the significant genetic correlations between impulsivity and IQ at age 17 and 23 described in the following section provide more support that this association was also primarily genetic). Second, these analyses revealed that the significant phenotypic correlations between the three constructs in early childhood were also primarily due to shared genetic influences (though even some of these large genetic correlations with self-restraint were not significant due to the fact that the genetic influences on self-restraint were not significant in the univariate model).

Aim 2: Procrastination and Intelligence

The second goal of this study was to further examine the association between procrastination and IQ, focusing on measures of IQ measured closer in time (age 17 and age 23) to the assessment of procrastination in young adulthood (at age 23). As shown in Table 3-3, however, procrastination was not associated with levels of IQ at age 17, $r = –.02$, $\chi^2_{diff}(1) = .14$, $p = .710$, or age 23, $r = –.01$, $\chi^2_{diff}(1) = .04$, $p = .843$.

Like procrastination, IQ was also not significantly associated with goal failures regardless of the age of assessment of IQ. However, IQ at age 17 and age 23 were significantly associated with impulsivity at age 23 (r = –.14 and –.15, respectfully), and the association between impulsivity and IQ at age 23 was observed above and beyond the direct influence of IQ at age three on impulsivity (as noted by the significant correlations between the residual variances of IQ at age 23 and impulsivity in Figures 3-1 and 3-2). These results suggest that higher intelligence in early life was associated with less impulsivity in adulthood, and that new variance in IQ in young adulthood was also associated with impulsivity above and beyond this early association.

Although I did not observe any associations between IQ at age 17 or 23 and procrastination, I examined this association further using a genetic model. Additionally, the associations between impulsivity and IQ at these time points were also analyzed with a genetic model, to decompose the phenotypic association between these constructs as well. The bivariate correlations between procrastination and IQ, and impulsivity and IQ, are displayed in Figure 3-3, which are reproduced from the corresponding analyses from Appendix D.

As shown in Figure 3-3a and 3-3b, the genetic influences on procrastination were negatively associated with the genetic influences on IQ, but these associations were not significant, even at age 23, $r_g = -.18$, $\chi^2_{diff}(1) = 1.48$, $p = .224$. In contrast, the genetic influences on impulsivity were negatively correlated with the genetic influences on IQ at both age 17, $r_g = -.30$, $\chi^2_{diff}(1) = 7.72$, $p = .005$, and age 23, $r_g = -.34$, $\chi^2_{diff}(1) = 6.66$, $p = .010$. There was no evidence for an association between the nonshared environmental influences on procrastination and IQ, or between the nonshared environmental influences on impulsivity and IQ, suggesting that the phenotypic associations described in Table 3-3 were primarily due to shared genetic influences, rather than environmental influences.

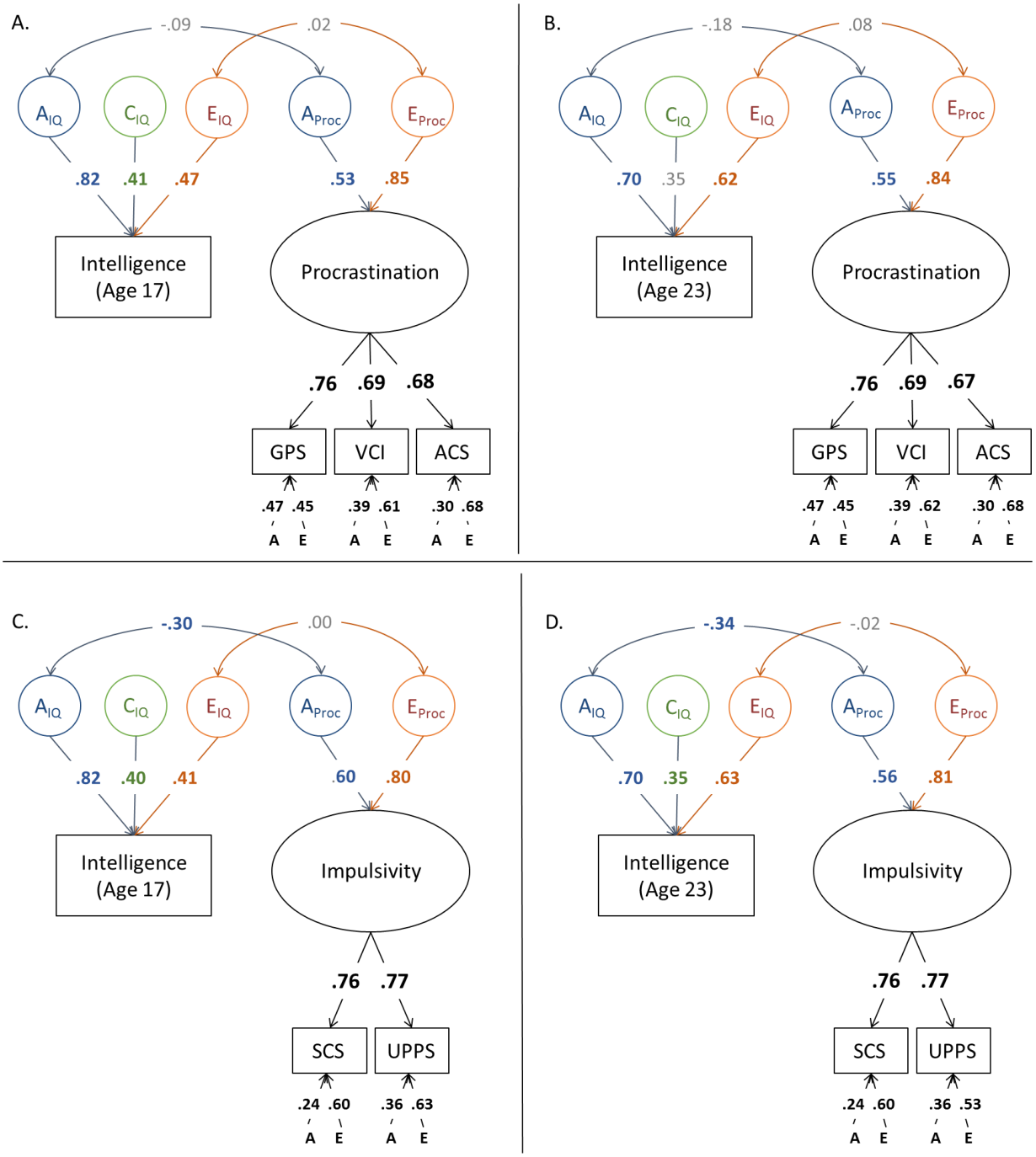

Figure 3-3: Bivariate genetic/environmental correlations between procrastination and IQ (A and B) and impulsivity and IQ (C and D). Significant factor loadings and correlations are displayed in bold, and nonsignificant factor loadings and correlations are displayed in grey.

However, there was limited power to detect these genetic/environmental correlations even with this large sample. For example, the 95% confidence interval of the correlation described in Figure 3-3b (between procrastination and IQ at age 23), was quite large (–.62 to .08), and the estimate of the genetic correlation between impulsivity and IQ at age 23 (r_g = –.34) was well within that estimate. Conversely, the estimate for procrastination was also within the confidence interval for impulsivity (–.59 to –.12). These results suggest that although the only correlation to reach statistical significant was for impulsivity and IQ, this genetic correlation was not substantially different from that estimated for procrastination and IQ (which share near-identical genetic influences; Gustavson et al., 2014).

In summary, these analyses revealed little evidence for an association between procrastination and IQ, or between goal failures and IQ. However, there was some evidence for a small negative correlation between impulsivity and IQ, regardless of the age of IQ assessment, and that these correlations were primarily due to shared genetic influences.

Discussion

The main goals of this study were to examine whether adult procrastination could be predicted by three goal-related constructs in early childhood (self-restraint, attentional control, and IQ), and to further examine the association between procrastination and IQ in adulthood. The phenotypic models revealed that procrastination was not significantly associated with any of the cognitive constructs in early childhood, nor were the three constructs predictive of individual differences in goal failures or impulsivity in adulthood (though impulsivity was associated with early childhood IQ). However, all three of these cognitive abilities assessed in childhood were moderately correlated with one another, and predictive of IQ at ages 17 and 23, suggesting that they capture cognitive abilities in early life that influence intelligence as late as 20 years later

(though these associations between self-restraint or attentional control and age 23 IQ did not remain significant controlling for their association with IQ in early childhood). The findings of this study are discussed in the order of the two main goals of the study.

Implications for Early Indicators of Procrastination

A primary contribution of this study was that it provided a first look at some candidate constructs in childhood that may predict later life procrastination, though I did not observe a significant association between procrastination and self-restraint, attentional control, or IQ in this study. These results may be (somewhat) surprising, given that constructs like attentional control and self-restraint are thought to support early self-regulation (Kochanska et al., 2001; Posner & Rothbart, 2009) and all three of the constructs in adulthood are thought to represent failures of self-regulation in everyday life (Gustavson et al., 2014; Klassen et al., 2008; Senecal et al., 1995). Furthermore, early IQ is predictive of other life outcomes (Chandola, et al., 2006; Gottfredson & Deary, 2004; Koenen et al., 2009), so it is interesting that procrastination and goal failures may be unrelated to this predictive construct. However, these results do not necessarily mean that these constructs are truly unrelated to procrastination, or that procrastination cannot be predicted by other cognitive abilities in early life.

For example, one potential limitation of this approach was that procrastination, goal failures, and impulsivity were measured with self-reported measures, while self-restraint, attentional control, and IQ were measured with observed measures or behavioral tasks. Previous research has suggested that self-reported and behavioral measures do not correlate with one another as strongly as expected, especially with regard to the various traits and behaviors linked to self-regulation (Duckworth & Kern, 2011). As discussed more thoroughly in the general discussion (Chapter 4), future research on the cognitive abilities underlying procrastination may

substantially benefit from examining these association using behavioral measures of procrastination, as cognitive tasks are more frequently assessed using such measures, and they may be less likely influenced by biases in self-reported measures (e.g., social desirability).

I did attempt to account for some of the potential problems of self-reported vs. behavioral measures in this study by creating residualized scores for procrastination, goal failures, and impulsivity, after removing variation shared with social desirability. This procedure allowed me to more clearly examine the association between procrastination and EF in previous work (Gustavson et al., 2015), and may have helped somewhat in this study as well. For example, compared to the non-residualized scores, the correlations between procrastination and self-restraint or early IQ were more consistent with the expectations that these associations would be negative (see Table 3-3). Furthermore, the correlation between impulsivity and IQ at all ages was not significant without accounting for social desirability, suggesting that removing social desirability helped reveal this association. However, even accounting for these factors, and modelling associations at the latent variable level, I did not observe a significant association between procrastination and the candidate measures here.

This study was (somewhat) ambitious in that I tried to predict procrastination with childhood self-restraint, attentional control, and IQ measured at least 20 years earlier. Given these results, it may be fruitful to examine cognitive abilities later in childhood. For example, it may be important to explore delay of gratification and/or early EFs in mid-late childhood (4 to 10 years), which are also well-studied (Garon, et al., 2008; Hongwanishkul, et al., 2005; Munakata, et al., 2012) and may be more directly relevant to the goal-management abilities associated with procrastination than the earlier cognitive constructs investigated here.

Nevertheless, the associations described here provided an informative first look at some potential early correlates of procrastination.

Implications for Procrastination and IQ

A second contribution of this study was to further understand the relationship between procrastination and IQ in adulthood. I did not find any associations between procrastination and IQ in this study. These findings are consistent with one previous study on procrastination and IQ (Ferrari, 1991), though a second study did identify a small negative association between these constructs (Di Fabio & Palazzeschi, 2012). Although these data cannot rule out the possibility that procrastination is related to IQ when measured in adolescence or adulthood, they are consistent with recent theoretical perspectives suggesting that the most important cognitive abilities associated with procrastination are those associated with goal management processes, rather than more general cognitive abilities such as intelligence (Gustavson, et al., 2015).

For example, previous work on this same sample (as well as analyses presented here) have suggested that procrastination is highly correlated with the ability to activate and maintain goal representation in everyday life (i.e., goal failures) and procrastination is at least weakly correlated with the short-term goal-management abilities thought to be a primary component of Common EF ability (Gustavson et al., 2015; Miyake & Friedman, 2012). However, even in this previous research, I did not observe a significant correlation between the cognitive abilities that support the Shifting-Specific or Updating-Specific EFs (Gustavson et al., 2015), the latter of these abilities of which is moderately correlated with one of the measures of intelligence described here (WAIS; Friedman et al., 2008). This work provided some preliminary evidence that procrastination was only selectively associated with those cognitive abilities that more

heavily rely on goal-management, rather than other higher-level EF processes that selectively support set-shifting (Shiting-Specific) or working memory updating (Updating-Specific).

The findings of this study extend this suggestion further by ruling out the possibility that those associations between procrastination and goal failures and/or Common EF observed in earlier studies (Gustavson et al., 2015) were due to IQ. If these previous effects were due to IQ, both of the latent variables for procrastination and goal failures should have been at least weakly associated with the IQ assessment at age 23, if not also with earlier assessments as well. Similarly, these results also suggest that the weak association observed between procrastination and IQ in a previous samples could have been driven by the component of IQ associated with Common EF (Di Fabio & Palazzeschi, 2012), though further work would be needed to test this hypothesis. Nevertheless, these findings suggest that future research on the cognitive abilities that underlie procrastination (or early precursors of procrastination) should focus on those cognitive abilities that rely heavily on goal-related processes, as these abilities are likely the most relevant for procrastination.

Finally, IQ was associated with impulsivity in adulthood regardless of the age of assessment of IQ. Although genetic analyses of this association at age three could not easily confirm that these associations were genetic, further analyses of this association with later measures of IQ revealed that these phenotypic correlations were primarily due to shared genetic influences on IQ that are associated with less impulsivity. Given my previous research suggesting that procrastination and impulsivity are genetically identical (Gustavson et al., 2014), it was surprising that the genetic influences on impulsivity and IQ were significant, but not those between procrastination and IQ. However, further analyses revealed that these genetic correlations were within the confidence intervals of one another. Moreover, controlling for social

desirability may have identified some genetic influences that were unique to impulsivity (r_g = .94 between procrastination and impulsivity – Appendix D), which may be more strongly related to IQ than those genes unique to procrastination (though this genetic correlation was still very high and within the original confidence interval of the estimate of r_g = 1.0 in Gustavson et al., 2014).

Chapter 4

General Discussion

This dissertation presented two studies designed to further examine the cognitive underpinnings of procrastination. These studies were motivated in particular by my previous work on the associations between procrastination, impulsivity, goal management, and EF (Gustasvon et al., 2014, 2015). These studies were also unique in that they were the first to empirically test whether procrastination could be reduced as a function of the goal-setting interventions (Chapter 2) or be predicted by measures taken almost two decades earlier (Chapter 3). Therefore, they are informative for future research on these under-studied aspects of procrastination.

Because these studies examined very different research questions, the primary implications specific to each study were discussed in detail in the individual chapters. However, there are some theoretical and methodological implications that unite the two studies in terms of the way they inform future work. Therefore, in this chapter, I first summarize the major contributions of these studies with regard to the association between procrastination and goal management. Second, I discuss some of the most important methodological implications raised by both studies. Finally, I discuss some other future directions of this work that were not already described in Chapter 2 or 3. Specifically, I describe how these findings inform empirical work on procrastination interventions, how they inform future studies on the emergence of procrastination, and how they contribute to the development of goal management theories of procrastination.

Major Contributions of the Studies

A primary motivation for this research was based on a small but growing body of empirical research and theoretical frameworks that have focused on the role of goal management in procrastination (Blunt & Pychyl, 2005; Gröpel & Steel, 2008; Gustavson et al., 2014, 2015; Krause & Freund, 2014a). Although some of my hypotheses regarding goal management and procrastination were not supported here (e.g., procrastination could be reduced by using goal-related interventions), it is still clear that goal-management abilities are crucial in explaining individual differences in procrastination.

First, the intervention study described in Chapter 2 revealed that academic procrastination was one of only two individual differences variables that significantly predicted the accomplishment of the academic goals generated in Session 1 (the other being memory for goals), controlling for the other predictors (about ten in total). These findings suggest that procrastination is not only important in predicting the accomplishment of goals, but also that procrastination may mediate the associations between other constructs and goal achievement. For example, impulsivity and conscientiousness were correlated with outcome measures of goal success, but these associations disappeared after controlling for procrastination, suggesting that these constructs do not substantially predict goal management after accounting for their correlation with procrastination.

Similarly, although I did not observe an association between IQ and procrastination in the longitudinal analysis described in Chapter 3, these results indirectly support the notion I proposed earlier (Gustavson et al., 2014, 2015) that goal management is a central cognitive ability involved in procrastination. If levels of procrastination were strongly correlated with IQ, it would have been possible that the previously observed associations between goal management

and procrastination may have been due to this association with IQ. Of course, strong conclusions should not be drawn from null results, but these results suggest that at the very least IQ could not account for the strong association between procrastination and everyday goal management failures observed in this sample (Gustavson et al., 2014, 2015). Therefore, it is possible that procrastination is selectively associated with processes related to goal management, rather than impairments spanning many aspects of cognition.

Methodological Implications

The most important methodological implication of this work concerns the measurement of procrastination, and the need for future research on procrastination to focus on behavioral measures of procrastination. In both studies, procrastination was measured with self-reported questionnaires, as has been done in the vast majority of existing work on procrastination. However, as pointed out in each of these studies, these self-reported measures had a number of potential limitations (e.g., using a trait-like measures to examine changes in procrastination, controlling for social desirability could have removed real variation in procrastination, impulsivity, or goal failures).

Given these limitations, one of the most necessary innovations in future research will be to develop and examine behavioral measures of procrastination. Some behavioral measure of procrastination have been proposed, such as the difference between planned and actual study hours (DeWitte & Schouwenburg, 2002), or the difference between the date an exam was available on the internet and when it was actually performed (Moon & Illingworth, 2005). However, little work has been done thus far to validate such measures or examine how strongly they are associated with self-reported procrastination (Krause & Freund, 2014b). Nevertheless, quantifying procrastination using performance-based measures that do not rely on self-report will

help ensure that effects are not due to factors such as social desirability, and may strengthen correlations with other constructs that are often measures with behavioral measures rather than self-reported measures (Duckwork & Kern, 2011).

A related methodological issue concerns the measures of goal management and goal accomplishment. A strength of the intervention study, for example, was the ability to link procrastination with actual performance on self-generated goals. However, even though significant effects of procrastination were observed, the dependent measures of goal accomplishment were also limited (e.g., the average of three responses to the item *Was this goal accomplished*?), and had quite low reliability ($\alpha = .35 – .57$). I examined multiple factors related to goal success here (i.e., goal accomplishment, the ability to resist temptations, and the effectiveness of the implementation intentions), but future research on procrastination and goal-striving can more thoroughly explore this association between procrastination and goal accomplishment using measures that better quantify which aspects of goal-striving are the most difficult for procrastinators (e.g., setting aside enough time to work on goals, working for shorter durations, or an inability to break down complex goals into smaller, more manageable chunks).

A final methodological issue concerns the causal inferences generated by studies like these. In Chapter 3, for example, levels of IQ throughout early life were correlated with impulsivity in adulthood. However, even though poor early IQ could cause impulsivity later in life, this association could be driven by a third variable underlying both phenotypes (e.g., development of early EFs). Intervention studies, such as those described in Chapter 2, can be used to more strongly identify casual associations, so they may be especially useful in the future at isolating factors that influence procrastination. Even then, however, these

experimental/intervention data must also be interpreted with caution, as differences between groups could be due to multiple aspects of the intervention.

Future Directions for Empirical Research and Theoretical Development

Many of the specific future directions based on the findings of these studies were discussed in their individual chapters. However, I briefly elaborate on three areas of future research motivated by the studies presented here: (a) future empirical experiments on potential interventions for procrastination, (b) future empirical studies on the emergence and developmental course of procrastination, and (c) future directions for developing theories of procrastination that more strongly focus on the role of goal management in procrastination.

Empirical Research on Procrastination Interventions

The findings of the intervention study (Chapter 2) suggest that many more studies are needed to understand whether and how procrastination can be reduced through interventions. As discussed in Chapter 2, this dissertation examined only two possible goal-related interventions (and only implemented these interventions in the context of a single study/situation), but there are many ways that procrastination could be targeted with goal-related processes that should be tested before ruling out the possibility that these interventions are effective. Future studies could incorporate interventions that focus on breaking down goals into smaller, more proximal subgoals (Pychyl, 2013; Steel, 2010), examining promotion vs. prevention goals (Halvorson, 2010), or emphasizing goal orientations, such as a focus on process vs. outcome orientations (Krause & Kreund, 2014a). These strategies may be especially effective when combined with one another or with the interventions tested here.

In future intervention studies, it will also be important to connect these findings to real-world outcomes. Information about academic grades, or the outcomes of specific assignments,

may be especially useful in examining the association between procrastination and goal management. Goal-related interventions should also have direct effects on the actual assignments or courses for which they are generated, while the effects of these interventions on procrastination may be delayed (or indirect) compared to those on goal management. For example, individuals in a goal-setting intervention may perform better on their actual assignments or courses (even if they did not report less procrastination), reducing feelings of averseness to future assignments and/or similar courses, and possibly reducing procrastination on these later assignments/courses. Therefore, examining outcomes such as grades or GPA in future studies on procrastination interventions may help identify whether these interventions are successful, especially if paired with longitudinal methods that may shed light on the potential long-term effects of goal-related interventions on later procrastination.

Finally, intervention studies on academic procrastination may need to carefully consider the specific academic domain or type of course where an individual is procrastinating, as certain interventions may be effective only in some situations. For example, classes involving math or statistics constantly build on material presented in previous lectures or chapters, so procrastination early in the semester can have serious consequences on later coursework. In contrast, other types of classes such as introductory courses in psychology typically involve the memorization of different terms and concepts that do not necessarily hinge on previous material, so procrastination may not be as problematic in these courses. Similar situational effects may exists for some types of academic domains (e.g., term papers) compared to others (e.g., weekly quizzes). If procrastination is only strongly associated with coursework outcomes in some situations, goal-related interventions may only be effective for these types of courses (or domains) for which procrastination is especially problematic or consequential.

Empirical Research for the Development of Procrastination

As briefly discussed in Chapter 3, there are many potential early precursors of procrastination that were not examined here, but seem promising. For example, early school experiences (e.g., teaching styles, early homework habits) may be predict procrastination later in high-school, college, and the workplace. Two additional future directions may be especially relevant in examining the early correlates of procrastination and the association between procrastination and other negative health outcomes.

First, it will be important to examine the association between procrastination and externalizing problems that often emerge in adolescence, such as conduct disorder, attention problems, or substance use (Young et al., 2009). Procrastination may be strongly associated with these externalizing problems, for example, because procrastinators are impulsive and therefore may be more likely to give into their temptations (e.g., to use substances). Furthermore, there may be an iterative interaction between procrastination and these other behavioral problems. Initial substance use may lead to procrastination on assignments, subsequently hurting performance in school. After receiving bad grades, an individual is likely to have lower academic motivation to do well, causing more behavioral problems and procrastination. Of course, these behavioral outcomes likely rely on multiple personality and cognitive factors within an individual (e.g., goal management, EFs), so these measures may not directly inform the underlying mechanisms that cause and underlie procrastination and externalizing problems. Nevertheless, externalizing problems in early adolescence may be a good predictor of procrastination later in adolescence or young adulthood.

Similarly, procrastination may be associated with the tendency to experience internalizing problems (e.g., anxiety and depression) as well, but possibly for different reasons.

For example, procrastination is positively associated with the fear of failure, including the concern over making mistakes, evaluation anxiety, and self-consciousness (Steel, 2007). These anxiety-related aspects of perfectionism that are correlated with procrastination may represent an underlying association between procrastination and internalizing problems more generally. Therefore, future research may not only identify an association between procrastination and internalizing problems, but procrastination later in adulthood may also be predicted by early indicators of internalizing (or vice-versa, predicting anxiety or depression diagnoses by procrastination early in middle or high school).

Implications for Theoretical Development on Procrastination and Goal Management

Perhaps the most important future direction suggested by the work described here is a need for a comprehensive theory of procrastination and goal management. Some of the hypotheses tested in this study (e.g., regarding goal-related interventions) were motivated by a collection of various theoretical perspectives that have emphasized different aspects of goal management in procrastination (Burka & Yuen, 1983; Steel & König, 2006; Krause & Freund, 2014a; Pychyl, 2013). Each of these perspectives have suggested that different goal-related abilities are associated with procrastination, or may aid in reducing procrastination. However, each perspective focuses on different aspects of goal management, and few if any are truly process-oriented theories of procrastination and goal management. Therefore, to facilitate the generation of testable hypotheses regarding the understudied aspects of procrastination described here (e.g., goal-related interventions, early precursors, and the cognitive underpinnings of procrastination more generally), it will be important to integrate these various perspectives into a more complete theory.

One promising way to advance theoretical frameworks of procrastination and goal management will be to integrate theories of procrastination with research on the action-behavior gap in health psychology. Temporal self-regulation theory (Hall & Fong, 2007, 2015), for example, focuses on the gap between intentions and actual behaviors in health domains such as physical activity, but may be highly relevant to procrastination. These intention-behavior gaps in research on health behaviors are similar to situations involved in procrastination, where individuals have an intention to follow-through on their long term goal but are distracted by salient temptations. Temporal self-regulation theory also draws on economic principles such as expected value, similar to existing theories of procrastinations such as temporal motivation theory (Steel & König, 2006). Therefore, integrating theories of procrastination and theories of planned behavior may be useful to both independent lines of research, especially as the goal-management and self-regulatory processes involved in the accomplishment of intended actions become more understood.

An example of how temporal self-regulation theory can be combined with a goal-management account of procrastination is displayed in Figure 4-1. In this model, I integrated a recent model of temporal self-regulation theory (Hall & Fong, 2015) with insights from my recent work on procrastination and goal management (Gustavson et al., 2014, 2015) and some of the conclusions of the work described here (especially the intervention study described in Chapter 2). Procrastination (or lack thereof) lies in between intended actions (i.e., goals) and actual goal-striving behaviors. According to temporal self-regulation theory, both EFs and prepotency (i.e., habits or norms) moderate the association between intentions and behavior (in Figure 4-1, I show that EF is linked through its association with procrastination, based on my

recent research linking these constructs, but it is possible that EF could have an effect on intentions vs. behavior above and beyond procrastination as well).

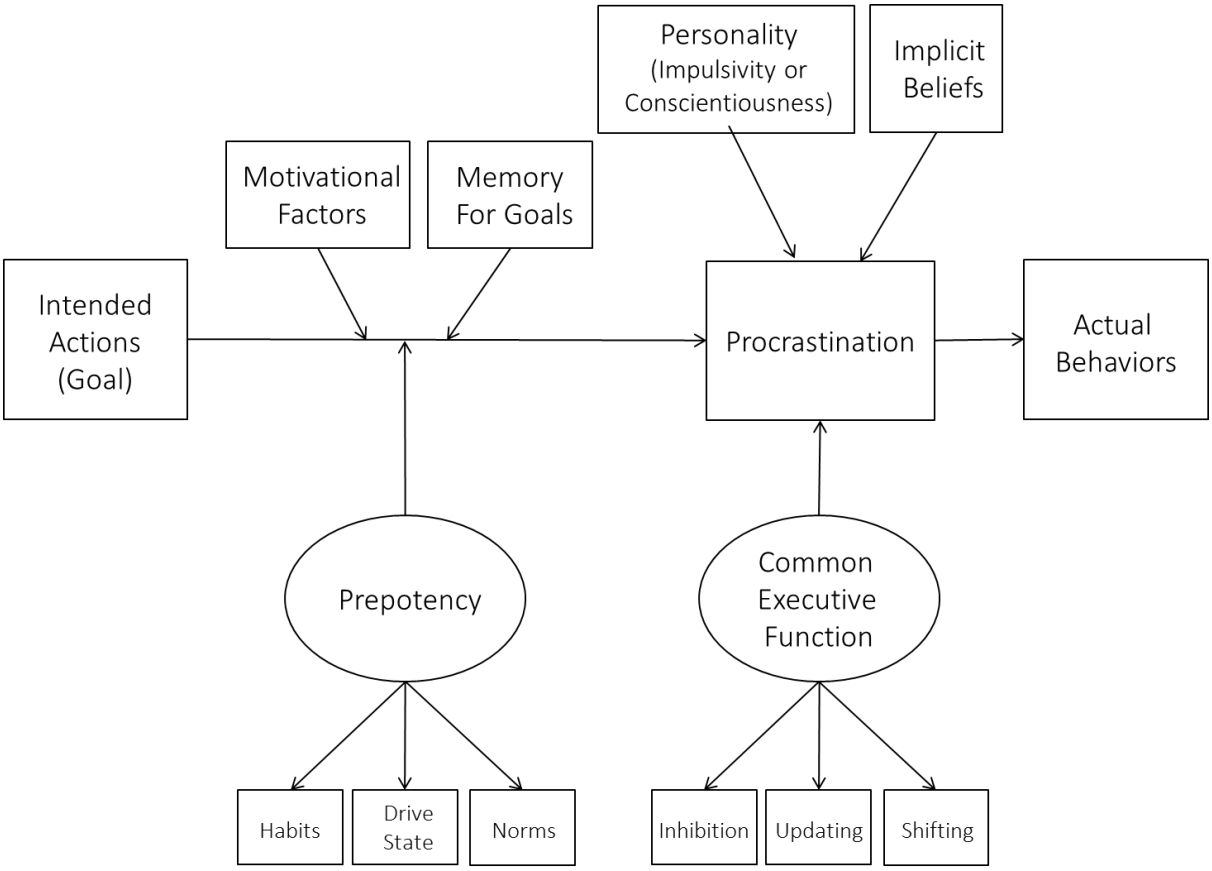

Figure 4-1: A possible integration between temporal self-regulation theory and my previous and current research on procrastination and goal accomplishment, adapted from Hall & Fong (2015).

On the top half of Figure 4-1, I also display some other constructs that may be associated with procrastination, or the intention-behavior gap directly. For example, it is clear that personality factors like impulsivity and conscientiousness are associated with levels of procrastination (Gustavson et al., 2014; Steel, 2007), but other factors such as implicit beliefs also may have a direct effect on procrastination (e.g., in Chapter 2, the belief that procrastination was malleable resulted in a back-firing effect, and was associated with greater procrastination at Session 2). Finally, I included two other constructs that may directly moderate the intention-action gap, based on the findings of the intervention study. Motivation (for goals) was associated

with the ability to resist temptations and the effectiveness of the implementation intentions and memory for goals was associated with goal accomplishment (both controlling for procrastination), suggesting that these factors may relate directly to the ability to follow through on intended actions.

The model displayed in Figure 4-1 is certainly not an exhaustive list of the factors that influence the intention-action gap, or structural paths between the displayed constructs. For example, procrastination may affect the formation of goal intentions directly (i.e., decisional procrastination). Nevertheless, this model is a useful illustration of how my own research on procrastination could be integrated with an extended model of planned behavior (Hall & Fong, 2015). This model, or similar models, could lead to more testable hypotheses in both research domains, and could be further extended to incorporate other theories of procrastination as well. Therefore, the integration of these various perspectives may be highly useful in terms of working toward a unified theory of procrastination and goal management.

Concluding Remarks

In summary, the studies presented here helped further quantify the associations between procrastination and goal-related cognitive abilities. Some of the conclusions were limited by the fact that individuals did not reduce their academic procrastination as a function of the goal-setting exercises or that procrastination in adulthood could not be predicted by the candidate cognitive abilities in childhood thought to support goal-management and self-regulation. However, these findings were an informative first examination of these understudied research questions, and provided further evidence that observed associations between procrastination and goal management were likely not due to other personality traits or situational factors (Chapter 2) or general cognitive abilities such as IQ (Chapter 3). Future research will continue to explore the

effects of procrastination interventions and identify potential early indicators of procrastination. Meanwhile, the integration of existing theories of procrastination with one another, and with other related veins of research (e.g., the intention-action gap), will lead to new hypotheses that more clearly identify the goal-management abilities impaired in procrastination, and predict variation in this problematic and pervasive behavior.

References Cited

Bayley, N. (1969). *Manual for the Bayley Scales of Infant Development*. New York, NY: Psychological Corporation.

Beswick, G., Rothblum, E. D., & Mann, L. (1988). Psychological antecedents of student procrastination. *Australian Psychologist, 23*, 207-217.

Blunt, A. K. & Pychyl, T. A. (2000). Task aversiveness and procrastination: A multi-dimensional approach to task aversiveness across stages of personal projects. *Personality and Individual Differences, 28,* 153-167.

Blunt, A. K. & Pychyl, T. A. (2005). Project systems of procrastinators: A personal project-analytic and action control perspective. *Personality and Individual Differences, 38,* 1771-1780.

Bovend'Eerdt, T. J., Botell, R. E., & Wade, D. T. (2009). Writing SMART rehabilitation goals and achieving goal attainment scaling: A practical guide. *Clinical Rehabilitation, 23,* 352-361. doi: 10.1177/0269215508101741

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The cognitive failure questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology, 21,* 1-16. doi:10.1111/j.2044-8260.1982.tb01421.x

Burka, J. B., & Yuen, L. M. (2008). *Procrastination: Why you do it, what to do about it now.* Da Capo Press.

Byrne, B. M. (1989). *A primer of LISREL: Basic applications and programming for confirmatory factor analytic models*. New York, NY: Springer-Verlag. doi:10.1007/978-1-4613-8885-2

Caspi, A., & Silva, P. A. (1995). Temperamental qualities at age three predict personality traits in young adulthood: Longitudinal evidence from a birth cohort. *Child Development*, 486-498.

Chandola, T., Deary, I. J., Blane, D., & Batty, G. D. (2006). Childhood IQ in relation to obesity and weight gain in adult life: The national child development (1958) study. *International Journal of Obesity, 30,* 1422-1432. doi: 10.1038/sj.ijo.0803279

Costa, P. T., Jr. & McCrae, R. R. (1992). *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) professional manual*. Odessa, FL: Psychological Assessment Resources, Inc.

Crowne, D. P. & Marlowe, D. (1964). A new scale of social desirability independent of psychopathology. *Journal of Cognitive Psychology, 24,* 349-354

Day, V., Mensink, D., & O'Sullivan, M. (2000). Patterns of academic procrastination. *Journal of College Reading and Learning, 30,* 120-134. doi: 10.1080/10790195.2000.10850090

Deary, I. J., Pattie, A., & Starr, J. M. (2013). The stability of intelligence from age 11 to age 90 years: The lothian birth cohort of 1921. *Psychological science, 24,* 2361-2368. doi: 10.1177/0956797613486487

Derks, E. M., Dolan, C. V., & Boomsma, D. I. (2004). Effects of censoring on parameter estimates and power in genetic modeling. *Twin Research, 7,* 659-669. doi: 10.1375/twin.7.6.659

DeWitte, S., & Schouwenburg, H. C. (2002). Procrastination, temptations, and incentives: The struggle between the present and the future in procrastinators and the punctual. *European Journal of Personality, 16,* 469-489. doi: 10.1002/per.461

Duckworth, A. L., & Kern, M. L. (2011). A meta-analysis of the convergent validity of self-control measures. *Journal of Research in Personality, 45,* 259-268. doi: 10.1016/j.jrp.2011.02.004

Di Fabio, A., & Palazzeschi, L. (2012). Incremental variance of the core self-evaluation construct compared to fluid intelligence and personality traits in aspects of decision-making. *Personality and Individual Differences, 53,* 196-201. doi: 10.1016/j.paid.2012.03.012

Ferrari, J. R. (1991). Compulsive procrastination: Some self-reported characteristics. *Psychological Reports, 68,* 455-458.

Ferrari, J. R. (1993). Procrastination and impulsiveness: Two sides of a coin? In W. G. McCown, J. L. Johnson & M. B. Shure (Eds.), *The impulsive client: Theory, research, and treatment* (pp. 265-276). Washington, DC: American Psychological Association.

Ferrari, J. R. (2010). *Still procrastinating: The no regrets guide to getting it done*. Hoboken, NY: John Wiley & Sons

Friedman, N. P., Miyake, A., Robinson, J. L., & Hewitt, J. K. (2011). Developmental trajectories in toddlers' self-restraint predict individual differences in executive functions 14 years later: A behavioral genetic analysis. *Developmental Psychology, 47,* 1410-1430. doi: 10.1037/a0023750

Friedman, N. P., Miyake, A., Young, S. E., DeFries, J. C., Corley, R. P., & Hewitt, J. (2008). Individual differences in executive function are almost entirely genetic in origin. *Journal of Experimental Psychology: General, 137,* 201-225. doi:10.1037/0096-3445.137.2.201

Gallagher, R. P., Golin, A., & Kelleher, K. (1992). The personal, career, and learning skills needs of college students. *Journal of College Student Development, 33,* 301-309.

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin, 134,* 31-60. doi: 10.1037/0033-2909.134.1.31

Gollwitzer, P. M. & Brandstatter, V. (1997). Implementation intentions and effective goal pursuit. *Journal of Personality and Social Psychology, 73,* 186-199.

Gottfredson, L. S., & Deary, I. J. (2004). Intelligence predicts health and longevity, but why? *Current Directions in Psychological Science, 13,* 1-4. doi: 10.1111/j.0963-7214.2004.01301001.x

Gröpel, P., & Steel, P. (2008). A mega-trial investigation of goal setting, interest enhancement, and energy on procrastination. *Personality and Individual Differences, 45,* 406-411. doi:10.1016/j.paid.2008.05.015

Gustavson, D. E., Miyake, A., Hewitt, J. K., & Friedman, N. P. (2014). Genetic relations among procrastination, impulsivity, and goal-management ability: Implications for the evolutionary origin of procrastination. *Psychological Science, 25,* 1178-1188. doi: 10.1177/0956797614526260

Gustavson, D. E., Miyake, A., Hewitt, J. K., & Friedman, N. P. (2015). Understanding the cognitive and genetic underpinnings of procrastination: Evidence for shared genetic influences with goal-management and executive function abilities. *Journal of Experimental Psychology: General, 144,* 1063–1079. doi: 10.1037/xge0000110

Hall, P. A., & Fong, G. T. (2007). Temporal self-regulation theory: A model for individual health behavior. *Health Psychology Review, 1,* 6-52. doi: 10.1080/17437190701492437

Hall, P. A., & Fong, G. T. (2015). Temporal self-regulation theory: A neurobiologically informed model for physical activity behavior. *Frontiers in Human Neuroscience, 9,* 1-8. doi: 10.3389/fnhum.2015.00117

Halvorson, H. G. (2010). *Succeed: How we can reach our goals.* Penguin.

Hannon, R., Adams, P., Harrington, S., Fries-Dias, C., & Gipson, M. T. (1995). Effects of brain injury and age on prospective memory self-rating and performance. *Rehabilitation Psychology, 40,* 289-298. doi:10.1037/0090-5550.40.4.289

Hongwanishkul, D., Happaney, K. R., Lee, W. S., & Zelazo, P. D. (2005). Assessment of hot and cool executive function in young children: Age-related changes and individual differences. *Developmental Neuropsychology, 28,* 617-644. doi: 10.1207/s15326942dn2802_4

Howell, A. J., Watson, D. C., Powell, R. A., & Buro, K. (2006). Academic procrastination: The pattern and correlates of behavioural postponement. *Personality and Individual Differences, 40,* 1519-1530. doi: 10.1016/j.paid.2005.11.023

Hu, L., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods, 3,* 424-453. doi:10.1037/1082-989X.3.4.424

Jaffe, E. (2013). Why wait? The science behind procrastination. *APS Observer*, *26*, 4.

Klassen, R. M., Krawchuk, L. L., & Rajani, S. (2008). Academic procrastination of undergraduates: Low self-efficacy to self-regulate predicts higher levels of procrastination. *Contemporary Educational Psychology, 33*, 915-931. doi: 10.1016/j.cedpsych.2007.07.001

Kochanska, G., Coy, K. C., & Murray, K. T. (2001). The development of self-regulation in the first four years of life. *Child Development, 72,* 1091-1111. doi: 10.1111/1467-8624.00336

Kochanska, G., & Knaack, A. (2003). Effortful control as a personality characteristic of young children: Antecedents, correlates, and consequences. *Journal of Personality*, *71*, 1087-1112. doi: 10.1111/1467-6494.7106008

Kochanska, G., Murray, K. T., & Harlan, E. T. (2000). Effortful control in early childhood: Continuity and change, antecedents, and implications for social development. *Developmental Psychology, 36*, 220-232. doi: 10.1037/0012-1649_36.2.220

Koenen, K. C., Moffitt, T. E., Roberts, A. L., Martin, L. T., Kubzansky, L., Harrington, H., ... & Caspi, A. (2009). Childhood IQ and adult mental disorders: A test of the cognitive reserve hypothesis. *American Journal of Psychiatry, 166,* 50-57. doi: 10.1176/appi.ajp.2008.08030343

Krause, K., & Freund, A. M. (2014a). How to beat procrastination: The role of goal focus. *European Psychologist*, *19,* 132-144. doi:10.1027/1016-9040/a000153

Krause, K. & Freund, A. M. (2014b). Delay or procrastination – A comparison of self-report and behavioral measures of procrastination and their impact on affective well-being. *Personality and Individual Differences, 63,* 75-80. doi: 10.1016/j.paid.2014.01.050

Kuhl, J. (1994). Action versus state orientation: Psychometric properties of the Action Control Scale (ACS-90). In J. Kuhl & J. Beckman (Eds.), *Volition and personality: Action versus state orientation* (pp. 47-59). Gottingen, Germany: Hogrefe.

Kuhl, J., & Fuhrmann, A. (1998). Decomposing self-regulation and self-control: The volitional components inventory. In J. Heckhausen & C. S. Dweck (Eds.) *Motivation and self-regulation across the life span* (pp. 15-49). New York, NY: Cambridge University Press. doi:10.1017/CBO9780511527869.003

Latham, G. P., & Locke, E. A. (1991). Self-regulation through goal setting. *Organizational Behavior and Human Decision Processes, 50,* 212-247.

Lay, C. H. (1986). At last, my research article on procrastination. *Journal of Research in Personality, 20,* 474-495. doi:10.1016/0092-6566(86)90127-3

Little, B. R. (1983). Personal projects: A rationale and method for investigation. *Environment and Behavior, 15,* 279-309.

Lepper, M. R., Corpus, J. H., & Iyengar, S. S (2005). Intrinsic and extrinsic motivational orientations in the classroom: Age differences and academic correlates. *Journal of Educational Psychology, 2,* 184-196. doi: 10.1037/0022-0663.97.2.184

Locke, E. A., & Latham, G. P. (2006). New directions in goal-setting theory. *Current Directions in Psychological Science, 15,* 265-268. doi: 10.1111/j.1467-8721.2006.00449.x

Lynam, D. R., Smith, G. T., Whiteside, S. P., & Cyders, M. A. (2006). *The UPPS-P: Assessing five personality pathways to impulsive behavior.* West Lafayette, IN: Purdue University.

Matheny, A.P. (1980). Bayley's Infant Behavior Record: Behavioral components and twin analyses. *Child Development,* 51, 1157-67.

McCown, W. G., Johnson, J. L., & Petzel, T. (1989). Procrastination, a principal components analysis. *Personality and Individual Differences, 10,* 197–202.

McCrae, R. R., & Costa, P. T. (1994). The stability of personality: Observations and evaluations. *Current Directions in Psychological Science, 3,* 173-175.

Mischel, W., Ayduk, O., Berman, M. G., Casey, B. J., Gotlib, I. H., Jonides, J., ... & Shoda, Y. (2011). 'Willpower' over the life span: Decomposing self-regulation. *Social Cognitive and Affective Neuroscience, 6,* 252-256. doi: 10.1093/scan/nsq081

Mischel, W., Shoda, Y., & Rodriguez, M. L. (1989). Delay of gratification in children. *Science,* 244, 933–938.

Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science, 21,* 8-14. doi:10.1177/0963721411429458

Moon, S. M., & Illingworth, A. J. (2005). Exploring the dynamic nature of procrastination: A latent growth curve analysis of academic procrastination. *Personality and Individual Differences, 38,* 297-309. doi: 10.1016/j.paid.2004.04.009

Munakata, Y., Snyder, H. R., & Chatham, C. H. (2012). Developing cognitive control three key transitions. *Current Directions in Psychological Science, 21,* 71-77. doi: 10.1177/0963721412436807

Muthén, L. K., & Muthén, B. O. (2010). *Mplus user's guide* (7th ed.). Los Angeles, CA: Muthén & Muthén.

O'Neill, J. (2000). SMART goals, SMART schools. *Educational Leadership, 57,* 46-50.

Owens, S. G., Bowman, C. G., & Dill, C. A. (2008). Overcoming procrastination: The effect of implementation intentions. *Journal of Applied Social Psychology, 38,* 366-384. doi: 10.1111/j.1559-1816.2007.00309.x

Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the barratt impulsiveness scale. *Journal of Clinical Psychology, 51,* 768-774. doi: 10.1002/1097-4679(199511)51:6<768::AID-JCLP22705106 07>3.0.CO;2-1

Prather, C. W. (2005). The dumb thing about SMART goals for innovation. *Research Technology Management, 48,* 14-15.

Posner, M. I., & Rothbart, M. K. (2009). Toward a physical basis of attention and self-regulation. *Physics of Life Reviews, 6,* 103–120. doi: 10.1016/j.plrev.2009.02.001

Pychyl, T. A. (2013). *Solving the procrastination puzzle: A concise guide to strategies for change.* New York: Penguin Group.

Pychyl, T. A., & Flett, G. L. (2012). Procrastination and self-regulatory failure: An introduction to the special issue. *Journal of Rational-Emotive & Cognitive-Behavior Therapy, 30,* 203-212. doi:10.1007/s10942-012-0149-5

Rattan, A., & Dweck, C. S., (2010). Who confronts prejudice? The role of implicit theories in the motivation to confront prejudice. *Psychological Science, 21,* 952-959. doi: 10.1177/0956797610374740

Raven, J. C. (1960). *Standard Progressive Matrices: Sets A, B, C, D, & E.* London, H. K. Lewis & Co.

Rhea, S. A., Gross, A., Haberstick, B. C., & Corley, R. P. (2013). Colorado Twin Registry: An update. *Twin Research and Human Genetics, 16,* 351-357. doi:10.1017/thg.2012.93

Rothbart, M. K. (2007). Temperament, development, and personality. *Current Directions in Psychological Science, 16,* 207-212. doi: 10.1111/j.1467-8721.2007.00505.x

Rothbart, M. K., Ahadi, S. A., & Evans, D. E. (2000). Temperament and personality: Origins and outcomes. *Journal of Personality and Social Psychology, 78,* 122.

Rothbart, M. K., Ellis, L. K., Rueda, M. R., & Posner, M. I. (2003). Developing mechanisms of temperamental effortful control. *Journal of Personality, 71,* 1113-1144.

Rowe, D. C., & Plomin, R. (1977). Temperament in early childhood. *Journal of personality assessment, 41*, 150-156.

Satorra, A., & Bentler, P. M. (2001). A scaled difference chi-square test statistic for moment structure analysis. *Psychometrica, 66,* 507-514. doi:10.1007/BF02296192

Schwartzman, A. E., Gold, D., Andres, D., Arbuckle, T. Y., & Chaikelson, J. (1987). Stability of intelligence: A 40-year follow-up. *Canadian Journal of Psychology, 41*, 244.

Schouwenburg, H. C., & Lay, C. H. (1995). Procrastination and the big-five factors of personality. *Personality and Individual Differences, 18*, 481-490.

Senécal, C., Koestner, R., & Vallerand, R. J. (1995). Self-regulation and academic procrastination. *The Journal of Social Psychology, 135*, 607-619.

Sheeran, P. (2002). Intention-behavior relations: A conceptual and empirical review. *European Review of Social Psychology, 12,* 1-36. doi: 10.1080/14792772143000003

Smith Watts, A. K. (2014). Longitudinal examination of genetic and environmental influences on the associations between temperament and self-restraint in toddlerhood and executive function abilities in late adolescence (Unpublished doctoral dissertation). University of Colorado Boulder.

Solomon, L. J., & Rothblum, E. D. (1984). Academic procrastination: Frequency and cognitive-behavioral correlates. *Journal of Counseling Psychology, 31*, 503–509.

Steel, P. (2007). The nature of procrastination: A meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin, 133,* 65-94. doi:10.1037/0033-2909.133.1.65

Steel, P. (2010). *The procrastination equation: How to stop putting things off and start getting stuff done*. Toronto: Random House.

Steel, P., & Ferrari, J. (2013). Sex, education and procrastination: An epidemiological study of procrastination characteristics from a global sample. *European Journal of Personality, 27*, 51-58. doi:10.1002/per.1851

Steel, P. & König, C. J. (2006). Integrating theories of motivation. *Academy of Management Review, 31,* 889-913. doi: 10.5465/AMR.2006.22527462

Tangey, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72,* 271-324. doi: 10.1111/j.0022-3506.2004.00263.x

Terman, L. H., & Merrill, M. A. (1973). *Stanford-Binet Intelligence Scale: 1972 Norms Edition*. Boston, MA: Houghton Mifflin.

Tice, D. M., & Baumeister, R. F. (1997). Longitudinal study of procrastination, performance, stress, and health: The costs and benefits of dawdling. *Psychological Science, 8,* 454-458.

Tucker-Drob, E. M., & Briley, D. A. (2014). Continuity of genetic and environmental influences on cognition across the life span: A meta-analysis of longitudinal twin and adoption studies. *Psychological Bulletin, 140,* 949-979. doi: 10.1037/a0035893

van Eerde, W. (2000). Procrastination: Self-regulation in initiating aversive goals. *Applied Psychology, 49,* 372-389.

van Hooft, E. A., Born, M. P., Taris, T. W., van der Flier, H., & Blonk, R. W. (2005). Bridging the gap between intentions and behavior: Implementation intentions, action control, and procrastination. *Journal of Vocational Behavior, 66,* 238-256. doi: 10.1016/j.jvb.2004.10.003

Wechsler, D. (1997) *Wechsler Adult Intelligence Scale, 3rd ed. (WAIS-3)*. Harcourt Assessment, San Antonio, TX.

Young, S. E., Friedman, N. P., Miyake, A., Willcutt, E. G., Corley, R. P., Haberstick, B. C., & Hewitt, J. K. (2009). Behavioral disinhibition: Liability for externalizing spectrum disorders and its genetic and environmental relation to response inhibition across adolescence. *Journal of Abnormal Psychology, 118,* 117-130. doi:10.1037/a0014657

Appendix A: SMART and Implementation Intentions Interventions and Instructions

PLEASE STOP HERE AND GET MORE INSTRUCTIONS FROM YOUR EXPERIMENTER

Read through the S.M.A.R.T goal worksheet.
Then, look over your list of goals above and choose one for each domain that you think is the most important.
You should edit your goals to make sure they meet ALL OF THE SMART GOAL CRITERIA.

First, chose the most important goal from DOMAIN 1 above and copy it here

(COPY DOWN 1A, 1B, or 1C)

Does this goal comply with the five S.M.A.R.T criteria? Check yes for each box

If not, EDIT IT UNTIL YOU CHECK EVERY BOX!

Is your goal:

- Specific
- Measurable
- Achievable
- Realistic
- Time-Defined

Please write one immediate, concrete, action you can take towards achieving this goal

Why is it important that you accomplish this goal? (please write 1-2 sentences)

Chose the most important goal from DOMAIN 2 above and copy it here

(COPY DOWN 2A, 2B, or 2C)

Does this goal comply with the five S.M.A.R.T criteria? Check yes for each box

If not, EDIT IT UNTIL YOU CHECK EVERY BOX!

Is your goal:

- Specific
- Measurable
- Achievable

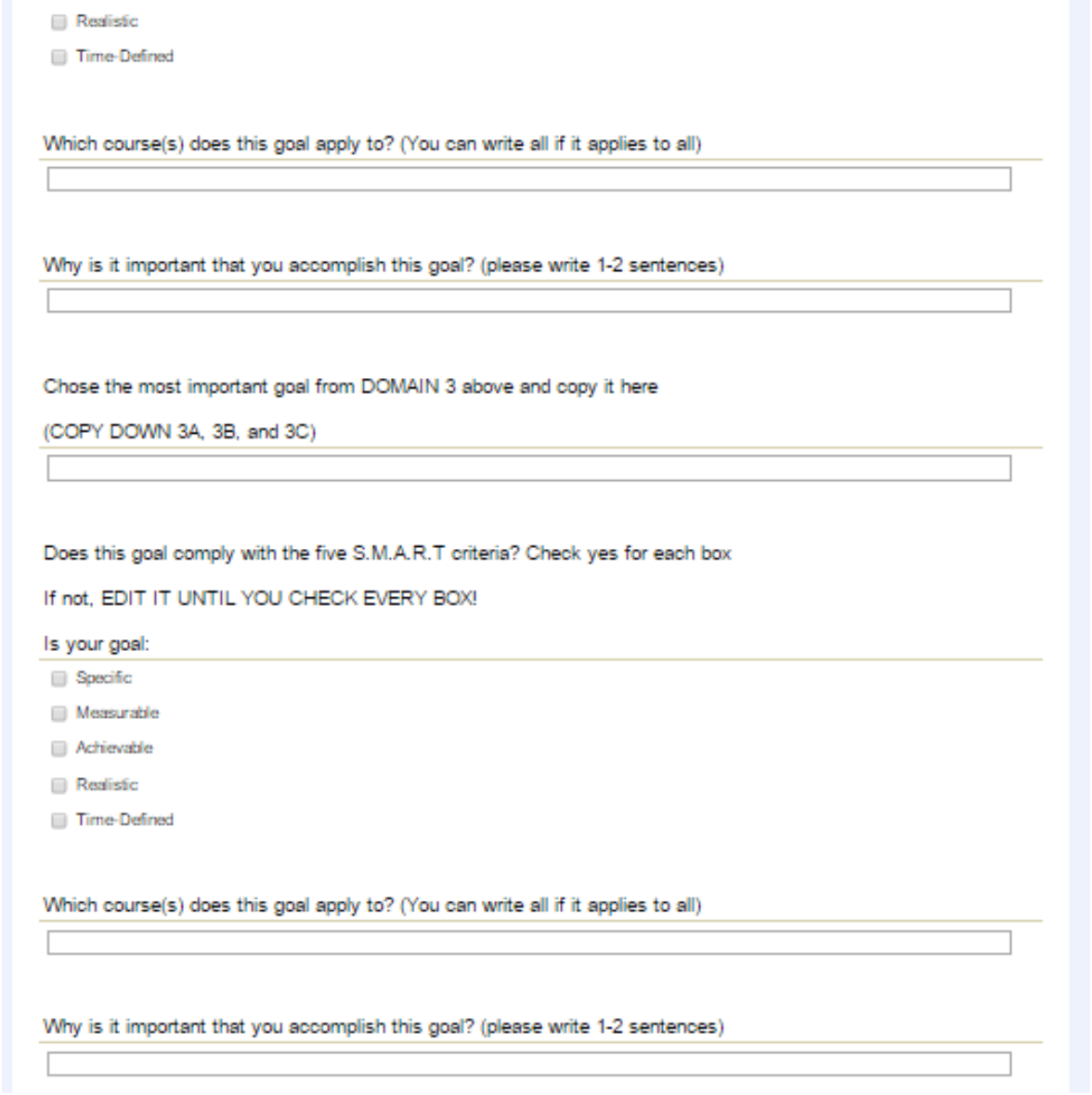

Figure A1: An example of the SMART intervention, performed only in the SMART condition after the initial goal-setting exercise.

Now, we want you to come up with some implementation intentions to help prevent you from being distracted by these temptations.

Remember, implementation intentions are IF/THEN rules that you follow when you notice that you are being distracted by one of your temptations. Here are some examples of implementation intentions for a health temptation from before:

Goal: I will exercise at least 3 times per week
Temptation: I will want to go home instead of to the gym for my afternoon workout
Implementation Intention: IF I'm tempted to go home instead of do my afternoon workout at the gym, THEN I will walk home instead of taking the bus

Goal: I will cook food at home at least 6 out of 7 days a week
Temptation: My roommate asks me to order delivery
Implementation Intention: IF my roommate asks me to order delivery, THEN I will first make a salad at home, and at most only order an appetizer

Please write one implementation intention for each of your top 3 temptations. ASK THE EXPERIMENTER IF YOU HAVE ANY QUESTIONS ABOUT HOW TO WRITE IMPLEMENTATION INTENTIONS!

Implementation intention for TEMPTATION 1:

IF.... (remember, in most cases the 'IF' part of implementation intentions will just be a repetition of your temptation arising)

THEN....

Implementation intention for TEMPTATION 2:

IF....

THEN....

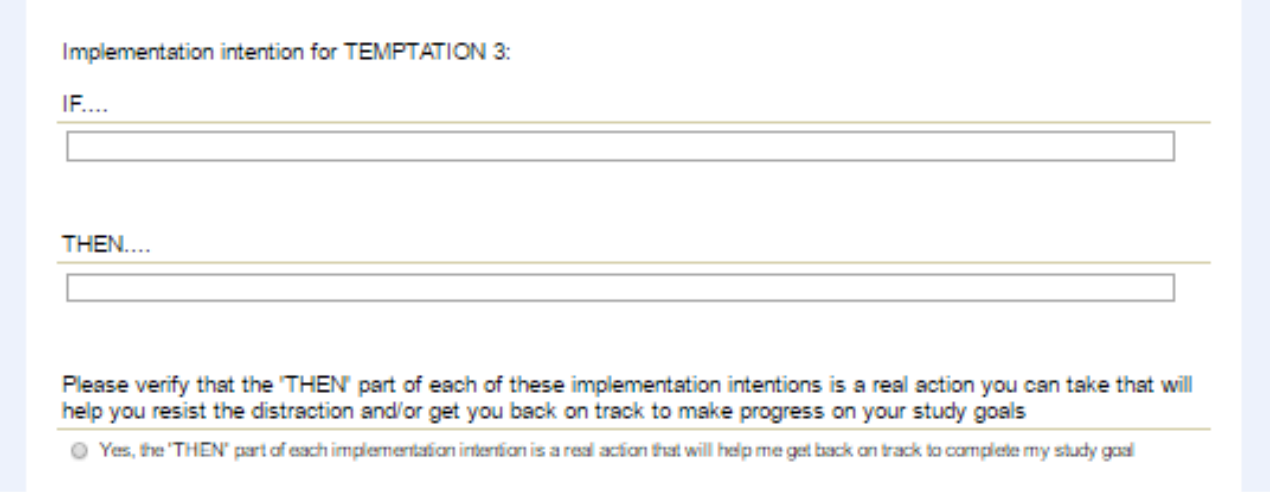

Figure A2: An example of the implementation intentions intervention, performed only in the implementation intentions condition after the identification of the top three temptations.

We want the goals you write today to be SMART! That is, ***specific, measureable, achievable, realistic, and time-defined***. The following instructions should be used to help you edit your academic goals to make them more SMART. Let's use a health goals as an example (but remember, your goals should be related to academics!)

Let's say you have this health goal: "*I want to get in shape*". We want to transform this goal into a SMART goal such as: *"I want to lose 20 pounds by the end of May"*
There are 5 steps to creating this type of "SMART" goal

SPECIFIC: Make sure it is clear what the goal will accomplish and what the end result of the goal is. It is also important to specify how the goal will be accomplished, so try to be as specific as you can

Example: "I want to lose weight" is much better than "I want to get in shape"

MEASURABLE: Progress on good goals can be measured objectively. When you create goals and tasks, try to make sure you can quantify how much progress has been made or how you will know when you have completed it

Example: "I want to lose 20 pounds" is much better than "I want to lose weight"

ACHIEVABLE: It is important that your goals are achievable. As you create goals, make sure that you know you have the ability to achieve the goals. If not, maybe you need to also specify what you need to do to make goals achievable

Example: "I want to lose 20 pounds" is achievable, but "I want to lose 50 pounds" is probably not (at least, in a few months)

REALISTIC: Are you actually able to complete this goal? If you don't actually have the resources (like enough time, knowledge, or help available), you should try to rethink your goal and make it more realistic.

Example: "I want to lose 20 pounds over a few months" is much better than "I want to lose 20 pounds in 2 weeks"

TIME-DEFINED: Your goals should be linked to a schedule (and remember, be as specific as possible!). Make sure your goals have a clear time-course to be completed.

Example: "I want to lose 20 pounds by the end of May" is much better than "I want to lose 20 pounds over a few months"

Now you have a SMART goal. *"I want to lost 20 pounds by the end of May"* is SPECIFIC (losing weight), MEASURABLE (20 pounds), ACHIEVABLE (May is plenty of time), REALISTIC (20 pounds is reasonable), and TIME-DEFINED (by the end of May). These are the kinds of goals you should write down in this exercise.

Figure A3: The instructions sheet given to subjects before they complete the SMART intervention (in that condition only).

Appendix B: Academic Domains Chosen in the Intervention Study

Table B1: Academic Domains Ranked First, Second, and Third

Domains	Rank 1	Rank 2	Rank 3	Sum (%)
Writing Term Papers	75	40	37	152 (23.3)
Study for Exams	27	50	44	121 (18.6)
Reading/Homework	44	33	38	115 (17.7)
Administrative Tasks	20	23	21	64 (9.8)
Attendance Tasks	23	33	28	84 (12.9)
Activities in General	17	28	39	84 (12.9)

Note: N = 217 for Rank 1, 2, and 3. N = 651 for the sum. % = the percent of subjects who ranked this domain in any of their top three (i.e., sum / 217).

Appendix C: Factor Loadings in the Phenotypic Correlational Model and Full Phenotypic Correlation Matrix for Measures Used in the Longitudinal Analysis

Table C1: Factor Loadings in the Phenotypic Correlational Model

Measure	Factor Loading
Self-Restraint (14 - 36 mo)	
14 mo	.44
20 mo	.35
24 mo	.62
36 mo	.60
Attentional Control (14 - 36 mo)	
14 mo	.42
20 mo	.49
24 mo	.59
IQ (14 - 36 mo)	
Stanford Binet	.70
Bayley Scales 14 mo	.46
Bayley Scales 20 mo	.83
Bayley Scales 24 mo	.88
IQ - WAIS (17 yr)	-
IQ - Raven (23 yr)	-
Procrastiantion	
GPS	.84
VCI	.69
ACS	.60
Impulsivity	
SCS	.81
UPPS	.72
Goal Failures	
CFQ	.79
PMQ	.75

Note: There are no factor loadings for IQ at age 17 or 23 because these constructs were not measured at the latent variable level. All factor loadings are significant ($p < .05$), and the model had acceptable fit, $\chi^2(141) = 199.97$, $p = .001$, RMSEA = .021, CFI = .973.

Table C2: Correlation Matrix of All Measures Used in the Longitudinal Analysis

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
VCI	1																		
GPS	.53	1																	
ACS	.46	.51	1																
CFQ	.34	.44	.35	1															
PMQ	.31	.43	.30	.59	1														
SCS	.32	.36	.18	.34	.33	1													
UPPS	.23	.29	.10	.31	.30	.58	1												
SR 14m	-.05	.06	.00	-.01	-.02	.03	.04	1											
SR 20m	-.11	-.01	-.07	-.04	-.06	-.10	-.05	.21	1										
SR 24m	-.15	-.07	-.07	-.04	-.11	-.05	-.09	.21	.26	1									
SR 36m	.05	.07	.03	.06	-.05	-.04	.03	.30	.19	.36	1								
AC 14m	.01	.03	.03	.08	.04	-.04	.00	.08	.05	.13	.13	1							
AC 20m	.09	.01	.06	.12	.01	.04	-.04	.05	.13	.14	.13	.18	1						
AC 24m	-.02	.01	-.04	.01	-.06	-.03	-.05	.15	.10	.13	.16	.29	.28	1					
Raven	.00	-.03	.02	-.06	-.07	-.09	-.14	.14	-.01	.10	.15	.05	.15	.13	1				
WAIS	.01	-.03	-.02	-.04	-.05	-.07	-.15	.10	.08	.13	.14	.13	.17	.19	.58	1			
Binet	-.03	-.09	-.01	.01	-.02	-.05	-.11	.18	.07	.25	.24	.09	.18	.15	.31	.45	1		
Bayley 14m	.05	.01	.06	.05	-.02	-.05	-.05	.12	.07	.20	.09	.44	.12	.17	.06	.13	.29	1	
Bayley 20m	.00	-.08	.01	.02	-.09	-.07	-.12	.16	.17	.26	.28	.22	.36	.25	.26	.36	.55	.47	1
Bayley 24m	.01	-.04	.01	.02	-.01	-.06	-.10	.21	.10	.26	.27	.20	.26	.35	.28	.39	.62	.43	.68

Note: Bivariate correlations between all measures used in Chapter 3. VCI = Volitional Components Inventory, GPS = General Procrastination Scale, ACS = Action Control Scale, CFQ = Cognitive Failures Questionnaire, PMQ = Prospective Memory Questionnaire, SCS = Self-Control Scale, UPPS = UPPS Impulsivity Scale, SR = Self-Restraint (Prohibition task), AC = Attentional Control, Raven = Raven's Advanced Progressive Matrices, WAIS = Wechsler Adult Intelligence Scale, Binet = Stanford Binet, Bayley = Bayley Scales of Infant Development

Appendix D. Bivariate Genetic Models of all Constructs in the Longitudinal Analysis

Table D1. Bivariate Genetic/Environmental Correlations Between all Constructs in the Longitudinal Analysis

		Self-Restraint	AC	IQ-3	IQ-17	IQ-23	Proc	Imp	GF
		$r_a / r_c / r_e$	$r_a / r_c / r_e$	$r_a / r_c / r_e$	$r_a / r_c / r_e$	$r_a / r_c / r_e$	$r_a / r_c / r_e$	$r_a / r_c / r_e$	$r_a / r_c / r_e$
Self-Restraint	(14 – 36 mo)	.30 / **.58** / .12							
Att Control	(14 – 36 mo)	**.85** / - / -.02	**.94** / - / .06						
IQ – childhood	(14 – 36 mo)	.73 / .40 / .00*	**.91** / - / **1.0**	**.40** / **.59** / .01					
IQ – WAIS	(17 yr)	.24 / .63 / .28	**.34** / - / .26	**.58** / **.57** / .99	**.67** / **.15** / **.17**				
IQ – Raven's	(23 yr)	-.16 / .31 / .70	**.44** / - / -.39	.32 / **.70** / .33	**.87** / .55 / .08	**.48** / **.13** / **.40**			
Procrastination	(23 yr)	-.24 / - / -.01	-.02 / - / .35	.04 / - / -.04	-.09 / - / .02	-.18 / - / .08	**.28** / - / **.72**		
Impulsivity	(23 yr)	-.09 / - / -.17	.16 / - / -.50	-.25 / - / -.07	**-.30** / - / .00	**-.34** / - / -.02	**.94** / - / **.28**	**.35** / - / **.66**	
Goal Failures	(23 yr)	.44 / - / -.82	-.12 / - / .32	-.13 / - / 35	-.09 / - / -.03	-.09 / - / -.12	**.74** / - / **.64**	**.62** / - / **.51**	**.41** / - / **.59**

Note: Bivariate genetic (r_g), shared environmental (r_c), and nonshared environmental (r_e) correlations between all constructs in this study (except along the diagonal). Along the diagonal, I present the univariate genetic (A^2), shared environmental (C^2), and nonshared environmental (E^2) variance components for each construct. In models that include Attentional Control, Procrastination, Impulsivity, or Goal Management, the shared environmental correlations (r_c) were not estimated (noted by a dash) because there was no evidence for shared environmental influences on these traits (the estimates C^2 in the univariate models were also removed). * indicates that the nonshared environmental covariance was removed from the bivariate model of Self-Restraint and IQ (14 – 36 months) to aid in model convergence.