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Genetic Relations Among Procrastination, Impulsivity, and Goal-Management Ability: Implications for the Evolutionary Origin of Procrastination

Daniel E. Gustavson, **Akira Miyake**, **John K. Hewitt**, and **Naomi P. Friedman**
University of Colorado Boulder

Abstract

Previous research has revealed a moderate positive correlation between procrastination and impulsivity. However, little is known about why these two constructs are related. This study used behavioral genetic methodology to test three predictions derived from an evolutionary account that postulates that procrastination arose as a by-product of impulsivity (Steel, 2010): (a) Procrastination is heritable; (b) the two traits share considerable genetic variation; and (c) goal-management ability is an important component of this shared variation. These predictions were confirmed. First, both procrastination and impulsivity were moderately heritable (46% and 49%, respectively). Second, although the two traits were separable at the phenotypic level (r=.65), they were not separable at the genetic level (r_g=1.0). Finally, variation in goal-management ability accounted for much of this shared genetic variation. These results suggest that procrastination and impulsivity are linked primarily through genetic influences on the ability to use their high-priority goals effectively to regulate their action.

Keywords

procrastination; impulsivity; goal management; self-control; heritability; individual differences

Procrastination—the voluntary but irrational delay of an intended course of action—is a widespread behavioral problem (Ferrari, 2010; Steel, 2010) that can be harmful not only to the procrastinator's psychological, physical, and financial well-being, but also to other people that count on him/her (Jaffe, 2013; Pychyl & Flett, 2012). Previous research, mostly based on self-report questionnaire measures, has established that one's tendency to procrastinate is a stable trait applicable to various everyday contexts (Steel, 2007; Steel & Ferrari, 2013). Previous research has also specified various personality traits associated with procrastination (for a meta-analytic review, see Steel, 2007).

Correspondence concerning this article should be addressed to Daniel Gustavson, Department of Psychology and Neuroscience, 345 UCB, University of Colorado Boulder, CO 80309. Daniel.Gustavson@colorado.edu.
Daniel E. Gustavson, Department of Psychology and Neuroscience, University of Colorado Boulder; Akira Miyake, Department of Psychology and Neuroscience, University of Colorado Boulder; John K. Hewitt, Institute for Behavioral Genetics and Department of Psychology and Neuroscience, University of Colorado Boulder; Naomi P. Friedman, Institute for Behavioral Genetics and Department of Psychology and Neuroscience, University of Colorado Boulder.

Despite such progress in delineating the characteristics and correlates of individual differences in procrastination tendencies, relatively neglected questions concern the origins of procrastination. Some research has examined potential environmental factors influencing procrastination tendencies, such as parenting style (Ferrari & Olivette, 1994) and social support network (Ferrari, Harriott, & Zimmerman, 1997), but little systematic research has been conducted to address some fundamental questions: What makes some individuals more likely to procrastinate than others? What are the cognitive and biological (including genetic) underpinnings such individual differences? We addressed these fundamental questions by conducting a multivariate behavioral genetic analysis of the relationship between procrastination and impulsivity. In doing so, we evaluated one recent evolutionary account of the origins of procrastination, namely that procrastination is a “by-product” of an evolutionarily more basic trait, impulsivity (Steel, 2010). Moreover, we specified the cognitive basis of the procrastination–impulsivity link by demonstrating that individual differences in goal-management ability accounts for much of the shared variation between these traits.

On first glance, the idea that procrastination has originated from impulsivity may be counterintuitive. Procrastination is about tendencies to intentionally delay actions, whereas impulsivity is about tendencies to make rash actions, without thinking or planning (Lynam, Smith, Whiteside, & Cyders, 2006). If anything, they might seem like opposites (Ferrari, 1993). Substantial evidence, however, disconfirms the view that procrastination is inversely related to impulsivity. Ferrari (1993) found that these traits were positively correlated (r=.23–.46), suggesting that more impulsive individuals procrastinate more. Subsequent research replicated this result and established impulsivity as one of the strongest correlates of procrastination (r=.41 with a 95% confidence interval [CI] of .37–.46, k=22, N=4,005; Steel, 2007). What still remains unclear is why these two traits are related. In this study, we tested the predictions derived from two complementary theoretical perspectives—one cognitive and one evolutionary—that can jointly provide novel explanations of this robust relationship between the two traits.

First, procrastination and impulsivity seem to share a common underlying cognitive ability, namely goal-management ability, defined here as the ability to actively maintain and, if necessary, retrieve (or reactivate) one’s short-term and long-term goals to effectively guide behaviors. From this goal-management perspective, procrastination is about irrationally delaying actions that help accomplish one’s important goals, whereas impulsivity is about giving in to temptations, often at the expense of making progress on important long-term goals. Thus, it seems plausible that much of the commonality between these traits reflects goal-management ability. Indeed, a recent theory, called Temporal Motivation Theory (Steel & König, 2006), proposes “goal-setting” (Locke & Latham, 2002) as an important component of procrastination tendencies, but much of the existing research on individual differences in procrastination has focused on specifying personality variables related to procrastination and largely neglected the cognitive mechanisms underlying procrastination. As a result, prior evidence demonstrating the link between goal-management ability and procrastination has been limited (Gropel & Steel, 2008).

Second, a recent proposal by Steel (2010)—that procrastination is an evolutionary byproduct of impulsivity—also highlights goal management as an important component of the procrastination–impulsivity relationship. According to this account, impulsivity was a useful trait for early humans (hunter-gatherers) who needed to satisfy their basic survival needs quickly. In those preagricultural days, there may have been little reason to spend time creating long-term plans for the distant future; in fact, taking too much time thinking about the future could sometimes have been harmful if it meant distraction from satisfying immediate needs. The modern world, however, is structured differently. Modern-day humans must juggle and make progress on many long-term goals to ensure future successes. Although the environment has shifted to valuing long-term goals over immediate survival needs, the impulsive tendencies that have been firmly ingrained during the course of human evolution are still present and thereby make modern-day humans highly susceptible to succumbing to temptations without much consideration for long-term goals, resulting in procrastination.

Because procrastination is proposed to have its origins in an evolutionarily adaptive trait, impulsivity, Steel (2010) hypothesizes a genetic basis for procrastination: "Without a genetic component, the ability to procrastinate couldn't easily be passed on. We evolved to be procrastinators" (p. 52). Thus, according to this account, modern individuals with a greater genetic predisposition for impulsivity may also be more likely to procrastinate as a result of these same genetic influences.

Although intriguing, this evolutionary account is speculative in that no direct evidence exists to support such conjectures. In fact, to the best of our knowledge, no compelling report on the heritability of procrastination tendencies has been published.[1] Moreover, because the existing research focused exclusively on phenotypic correlations, it is impossible to verify whether the positive procrastination–impulsivity relationship indeed reflects a common genetic basis.

To test these cognitively and evolutionarily based goal-management accounts of the procrastination–impulsivity relationship, we analyzed data from a large-scale twin study and decomposed individual differences in procrastination and impulsivity into common and unique sources of genetic and environmental influences. Specifically, we tested three predictions that can be derived from the above goal-management accounts. First, if procrastination is indeed "wired" in our genes through evolution, it should be a heritable trait, like impulsivity (Bezdjian, Baker, & Tuvblad, 2011; Niv, Tuvblad, Raine, Wang, & Baker, 2011). Second, if procrastination is an evolutionary by-product of impulsivity, the genetic influences on procrastination should overlap highly with those on impulsivity; there should be little or no genetic influences on procrastination aside from those shared with impulsivity. Finally, if these two traits are linked because of an underlying goal-management ability, individual variation in everyday goal-management failures should account for much of this shared genetic variation between procrastination and impulsivity.

[1]Steel (2007) cited a conference presentation reporting the heritability of procrastination tendencies (h^2=.22), but this result is not included in the published report (Arvey, Rotundo, Johnson, Zhang, & McGue, 2006). Another study reported a heritability estimate (h^2=.18) based on a single questionnaire item (Cesarini, Johannesson, Magnusson, & Wallace, 2012).

We tested these predictions at the level of latent variables by using multiple measures of procrastination, impulsivity, and goal failures, thereby minimizing measurement error.

Method

Subjects

The analysis was based on 663 individuals (364 females, 299 males) from 347 same-sex twin pairs (181 monozygotic [MZ] and 166 dizygotic [DZ]) in the ongoing Colorado Longitudinal Twin Study. All individuals who had completed the study at the time of analysis were included here, although, in some cases, observations for individual questionnaires were missing (subjects did not receive a score for a questionnaire if they did not respond to at least 80% of the items in that questionnaire). The twins were representative of the general population in their cognitive abilities (for detailed characterizations of this sample, see Rhea, Gross, Haberstick, & Corley, 2013). The mean age when they completed the measures was 22.66 years (*SD*=1.12).

Measures

The questionnaires, administered on computers, were all broad-scope and tapped domain-general aspects of procrastination, impulsivity, or goal failures, although some of them included domain-specific items. Some representative items from these measures are shown in Table 1.

Procrastination—Levels of procrastination were assessed with (a) the General Procrastination Scale (GPS; Lay, 1986), (b) the average of three subscales (external control, goal neglect, and effort avoidance) of the Volitional Components Inventory (VCI; Kuhl & Fuhrmann, 1998), and (c) the prospective and decision-related action orientation vs. hesitation subscale of the Action Control Scale (ACS; Kuhl, 1994). Because not all twins were attending college, none of the questionnaires included items related to academic procrastination. Of these scales, the GPS is used most often to measure procrastination, but these items/subscales of the VCI and ACS have also been used to assess procrastination before and have demonstrated high correlations with GPS (Blunt & Pychyl, 1988; Gropel & Steel, 2008).

Impulsivity—Impulsivity is a multifaceted trait, and different dimensions of impulsivity have been proposed (Lynam, et al. 2006). We targeted two components of impulsivity that previous research on the procrastination–impulsivity relationship has focused on (Ferrari, 1993; Steel, 2007): the tendencies to give into cravings (urgency) and to act without thinking or planning (lack of premeditation). Although other dimensions (e.g., sensation seeking) are sometimes conceived of as part of impulsivity, Steel's (2007) meta-analysis revealed that sensation seeking does not correlate with procrastination as strongly (r=.17, k=11) as these other components of impulsivity (r=.41, k=22). Thus, we used (a) the average of three subscales (negative urgency, positive urgency, and lack of premeditation) of the UPPS Impulsive Behavior Scale (Lynam, et al., 2006) and (b) the average of the 20 (out of 36) items from the Self-Control Scale (SCS; Tangney et al., 2004) clearly related to urgency or lack of premeditation.[2]

Goal failures—Goal-management failures were assessed with two measures that concerned how well one can actively maintain and, if necessary, retrieve relevant task goals to guide one's actions: (a) the total score of the Cognitive Failures Questionnaire (CFQ), which measures "memory, attention, and psychomotor slips" as well as "everyday task failures" (Wallace, 2004), and (b) the log-transformed average of items from three subscales (short-term, long-term, & internally-cued) of the Prospective Memory Questionnaire (PMQ; Hannon et al., 1995). The PMQ has one other subscale (the extent to which one adopts memory strategies to prevent the forgetting of future goals), but this scale was excluded because it does not assess actual goal-management failures and because previous research has suggested that it does not correlate significantly with impulsivity (Chang & Carlson, 2014).

Data Analysis

The twin analysis is based on the following assumptions. MZ twins share 100% of their alleles identical-by-descent, whereas DZ twins share an average of 50% of their alleles identical-by-descent. Because both types of twins share a common environment (e.g., family), but differ in the degree to which they are related genetically, the extent to which MZ twins are more similar to each other than DZ twins provides information about the magnitude of genetic and environmental influences.

We analyzed the data with Mplus 6.11, which adjusts for nonindependence (for phenotypic analyses) and missing data. Model fit was evaluated with chi-square statistic (χ^2) and the root-mean-square error of approximation (RMSEA). A nonsignificant χ^2 and RMSEA <.06 indicate good fit (Hu & Bentler, 1998). Significance of parameters was determined with chi-square difference tests, adjusting for clustering when appropriate (in phenotypic models).

We focus on the AE (additive genetic and nonshared environmental) model here, because, as with many personality traits, there was no compelling evidence for shared-environmental influences in any of the analyses presented here (all estimates for shared-environmental influences were small [<9%] and nonsignificant, and almost all factor loadings were estimated at 0). Because many personality traits are known to have nonadditive genetic influences (Eaves, Heath, Neale, Hewitt, & Martin, 1998), we also tested for dominance at both univariate and multivariate levels of analysis. In a few cases, some evidence for dominance was found (e.g., the GPS and UPPS measures at the univariate level), but these effects were not consistent across models. Moreover, in all models with multiple nonadditive genetic factor loadings, it was possible to drop these loadings without a significant decrement in fit, thus justifying the current focus on the AE models.[3]

Although sex was previously found to be weakly yet significantly correlated (r=.08) with procrastination in large samples (Gropel & Steel, 2008; Steel & Ferrari, 2013), there were no

[2]Two items directly related to procrastination were not included in this 20-item scale. We validated the coherence of this impulsivity subscale by conducting exploratory factor analysis on all items. Most of the 20 identified items loaded highly on the first factor. The other items mostly concerned health, organization, and time management, and hence were excluded from these analyses.
[3]This lack of evidence for dominance is due partly to insufficient power to differentiate additive from nonadditive genetic effects in a traditional twin model (Martin, Eaves, Kearsey, & Davies, 1978). Thus, the genetic estimates provided here should be interpreted as broad-sense heritability (the overall effect of genes), rather than narrow-sense heritability (specific to additive genetic influences).

significant sex differences in our sample, either in means or parameter estimates in the univariate twin models. Thus, sex was not included in the models reported here.

Results

Descriptive statistics and twin correlations are summarized in Table 2. Zero-order phenotypic correlations are shown in Table 3.

We first replicated the phenotypic correlation between procrastination and impulsivity at a latent-variable level. As shown in Figure 1a, a two-factor model assuming that procrastination and impulsivity are correlated yet separable fit the data well, $\chi^2(4)=6.80$, $p=.147$, RMSEA=.032, and each measure had a significant factor loading on its respective trait. The phenotypic correlation between procrastination and impulsivity was .65 (95% CI=.58–.71). This correlation was higher than Steel's (2007) meta-analytic estimate of .41, likely due to the use of manifest variables in previous research, which may underestimate the magnitude of the procrastination–impulsivity relationship. The zero-order correlations between the individual procrastination and impulsivity measures, shown in Table 2, are closer to Steel's estimates. Important to note, it was not possible to collapse procrastination and impulsivity into one latent construct without a significant decrement in fit, $\chi^2(1)=229.69$, $p<.001$, suggesting that, phenotypically, these traits are correlated yet separable constructs.

The genetic model that decomposes the above phenotypic correlation between the two traits into additive genetic (A) and nonshared-environmental (E) components is shown in Figure 1b. This model shows that not only impulsivity but also procrastination are moderately heritable traits ($h^2=.49$ and .46, respectively). More important, the genetic correlation between procrastination and impulsivity was estimated at 1.0 (95% CI=.86–1.0), $\chi^2(106)=111.96$, $p=.327$, RMSEA=.000, suggesting that overlapping genetic influences accounted for all of the genetic influences on both traits (i.e., there are no unique genetic influences affecting only one trait). This high genetic correlation means that the phenotypic correlation of .65 is mostly (73%) due to shared genetic influences. These findings are consistent with Steel's (2010) proposal that, genetically, procrastination is an evolutionary by-product of impulsivity.

Figure 1b also shows that there was an additional significant nonshared environmental correlation of .33 (95% CI=.14–.50), but this correlation was far from 1.0, $\chi^2(1)=91.71$, $p<.001$. Thus, although impulsivity and procrastination share some environmental influences, it is mainly unique environmental influences that make the two traits phenotypically separable.

Finally, we examined to what extent the shared genetic variation between procrastination and impulsivity is also shared with variation in goal-management ability. To do so, we added a latent variable for goal failures to both the phenotypic and genetic models described above. Phenotypic analyses revealed that goal failures were highly correlated with both procrastination and impulsivity (*r*s =.74 and .64, respectively, $p<.001$). Moreover, the phenotypic correlation between procrastination and impulsivity (.65) was reduced to .39

after controlling for shared variation with goal failures, suggesting that there is shared variation among all three traits.

The genetic model (Cholesky decomposition) is shown in Figure 2, $\chi^2(201)=221.27$, $p=.151$, RMSEA=.025, where common additive genetic (A_{Com}) and nonshared environmental influences (E_{Com}) predict variation in all three traits. The model also includes the genetic and environmental factors that are shared only between procrastination and impulsivity ($A_{P\&I}$ & $E_{P\&I}$) and those specific to only procrastination (A_{Proc} & E_{Proc}). Of interest here is the magnitude of the genetic influences shared between procrastination and impulsivity ($A_{P\&I}$) after accounting for the genetic influences common to all three traits (A_{Com}).

As shown in Figure 2, the common genetic factor (A_{Com}) accounted for a substantial portion of the variation in both procrastination and impulsivity (34% for both traits) as well as goal failures (59%). More important, genetic influences specific to procrastination and impulsivity ($A_{P\&I}$) explained a much smaller portion of the variation in each trait (13% and 19%, respectively). There were no unique genetic influences on procrastination alone (0%). These results suggest that, as hypothesized, genetic influences on goal management substantially (if not entirely) overlap with those shared between procrastination and impulsivity.

Figure 2 also shows the effects of nonshared environments. Some of the total variation in procrastination can be explained by nonshared environmental influences (E_{Com}) common to all three traits (23%) as well as by nonshared environmental influences (E_{Proc}) specific to just procrastination (30%). However, there was no nonshared environmental influence on procrastination ($E_{P\&I}$) common to only procrastination and impulsivity (0%).

To better quantify the extent to which the shared variation between procrastination and impulsivity is accounted for by variation in goal failures, we summarized the key results reported above using an alternative format (Figure 3), where factor loadings from the phenotypic and Cholesky models were used to calculate the overall percentage of variation shared between procrastination and impulsivity (top panels) and the percentage of this shared variation that is also shared with goal failures (bottom panels). Phenotypically (Figure 3a), 42% of the variation in procrastination is shared with impulsivity, and 74% of this shared variation is also shared with goal failures. Genetically (Figure 3b), of the 100% of the genetic variation in procrastination shared with impulsivity, more than two-thirds (68%) of this shared genetic variation is also shared with goal failures. These results suggest that the shared genetic influences on procrastination and impulsivity are substantially shared with goal-management failures, although some genetic influences (32%) shared between procrastination and impulsivity cannot be explained solely by goal failures.

Discussion

The current study tested and confirmed three predictions derived from the cognitive and evolutionary accounts of the procrastination–impulsivity relationship outlined earlier. First, procrastination showed substantial genetic contributions ($h^2=.46$). Second, the genetic correlation between procrastination and impulsivity was estimated to be 1.0, suggesting that, once genetic variation shared with impulsivity is accounted for, there is virtually no genetic variance left unique to procrastination. Finally, this shared genetic variation overlapped substantially (68%) with genetic variation in the tendency to fail to activate and maintain short-term and long-term goals, thus supporting the view that goal-management ability underlies the genetic commonality between procrastination and impulsivity.

Although these results support the proposal that procrastination is an evolutionary byproduct of impulsivity (Steel, 2010), it is important to note that we cannot infer causation from these correlational data: Instead of procrastination being a by-product of impulsivity, impulsivity could be a by-product of procrastination. In fact, it has been suggested that procrastination and impulsivity show positive correlations because procrastination may lead to impulsive responding when deadlines are fast approaching (Ferrari, 1993, 2010). Although this alternative possibility cannot be entirely dismissed, it has difficulty explaining the observation that the genetic correlation between procrastination and impulsivity was 1.0. In contrast, Steel's (2010) account provides a natural explanation for such a substantial genetic overlap between the two traits.

In addition, although we interpret our results as consistent with the view that goal-management ability underlies the procrastination–impulsivity relationship, one could argue that the substantial commonality among the three traits primarily reflected method variance due to the use of questionnaires, rather than goal-management ability per se. Although we cannot deny some contribution of the method variance, this alternative explanation is unlikely because another trait assessed with questionnaires—perfectionism—did not explain much of the genetic commonality between procrastination and impulsivity. Perfectionism, often considered an important personality correlate of procrastination (Flett, Hewitt, & Martin, 1995; Pychyl & Flett, 2012), was correlated significantly with both procrastination and impulsivity in this sample (r=.24 and .34, p<.001, respectively).[4] However, it accounted for little shared variation between procrastination and impulsivity (13% and 8% at the phenotypic and genetic levels, respectively), suggesting that the shared variation between procrastination and impulsivity is unlikely due to other correlated constructs (e.g., perfectionism) or potential biases due to self-reporting.

The results reported here are novel and important for several reasons. First, this study goes beyond prior studies of the procrastination–impulsivity relationship by examining the relationship at the level of latent (rather than manifest) variables. Second, to the best of our knowledge, this is the first twin study that reports the heritability of procrastination tendencies. Third, this study provides new insights into the origin of the positive phenotypic relationship between procrastination and impulsivity. Moreover, by analyzing the procrastination–impulsivity relationship at the genetic level, the study provides a rigorous test of Steel's (2010) account of the etiology of procrastination and thereby demonstrates that behavioral genetic studies like this can provide a compelling way to test theoretical accounts, in addition to quantifying the genetic and environmental contributions to traits.

[4]This additional analysis was conducted with two measures of perfectionism, the Concern for Mistakes and Parental Criticism subscales of the Modern Perfectionism Scale, which has been shown before to positively correlate with levels of procrastination (Frost, 1990).

Finally, this study provides the first evidence that shared variation between procrastination and impulsivity can be explained by one's goal-management ability. This new finding not only helps develop more mechanistic models of procrastination (Krause & Freund, 2013; Steel, 2010) but also points to new promising ways to reduce procrastination (e.g., increasing the likelihood of activating and maintaining appropriate goals in the presence of potential temptations).

An important future research direction is to better specify the nature of the goal-management ability shared between procrastination and impulsivity. One possibility is that the goal-management ability examined in this study reflects individual differences in self-regulation ability or executive functions, a set of complex cognitive abilities that control and regulate behavior (Miyake et al., 2000; Miyake & Friedman, 2012). Procrastination is frequently considered a failure of self-regulation (Pychyl & Flett, 2012; Rabin et al., 2011; Senecal et al., 1995), and so is impulsivity. At a more mechanistic level, executive functions are considered crucial for goal-driven behaviors and have shown substantial heritability (Friedman et al., 2008). In light of the evidence that goal-management ability may be a central underlying problem for both procrastination and impulsivity, executive functions may also be predictive of individual differences in both of these traits, especially at the genetic level.

Although the current study advances our understanding of the origins of procrastination and the nature of its relationship to impulsivity, we also acknowledge some limitations. First, this study focused on domain-general aspects of procrastination and impulsivity. Although existing evidence suggests that both procrastination and impulsive tendencies manifest themselves across different domains (Steel, 2007; Tangney et al., 2004), there is also evidence that people may procrastinate or be impulsive only on certain tasks (e.g., Tsukayama, Duckworth, & Kim, 2012). Such domain-specific effects may show substantially different patterns of genetic and environmental influences. Second, although we interpret the high genetic correlation as indicative of overlapping genetic influences, there are other interpretations (e.g., gametic-phase disequilibrium due to assortative mating) that, in some cases, do not necessitate that the exact same alleles influence both traits (Carey, 1988; Keller et al., 2013). Although it is not clear how these alternative interpretations can explain the specific patterns of results reported here, it is nevertheless important to keep such general limitations of genetic analyses in mind.

In summary, this study used behavioral genetics methodology to test specific predictions derived from goal-management accounts of the relationship between procrastination and impulsivity. We showed that genetic variations for procrastination and impulsivity overlap substantially and that these shared genetic influences explain the majority of the phenotypic correlation between these traits and highly overlap with genetic influences on goal-management ability. In other words, procrastinators are also impulsive in large part because they fail to manage goals effectively to guide their behaviors. Such results are consistent with the proposal that procrastination may be an evolutionary by-product of impulsivity (Steel, 2010). They also provide important new constraints on further theoretical development on the nature and origins of procrastination tendencies and suggest new approaches to developing effective intervention methods to reduce procrastination.

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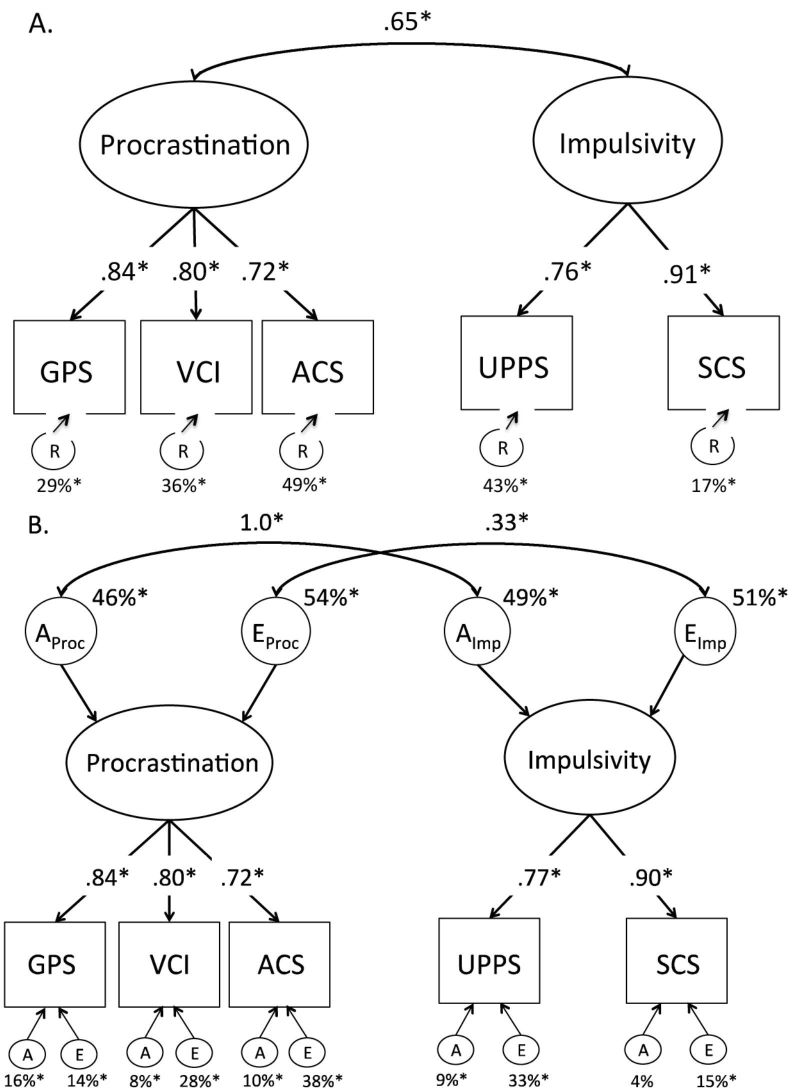

Figure 1.

Phenotypic model of procrastination and impulsivity (A), and final bivariate genetic model (B). Values with percentage signs on genetic (e.g., A_{proc}), environmental (e.g., E_{proc}), or residual (R) factors indicate the percentage of variance accounted for by these influences. * indicates a significant factor loading or correlation ($p < .05$). GPS = General Procrastination Scale, VCI = Volitional Components Inventory, ACS = Action Control Scale, SCS = Self Control Scale, UPPS = UPPS Impulsive Behavior Scale, PMQ = Prospective Memory Questionnaire, CFQ = Cognitive Failures Questionnaire.

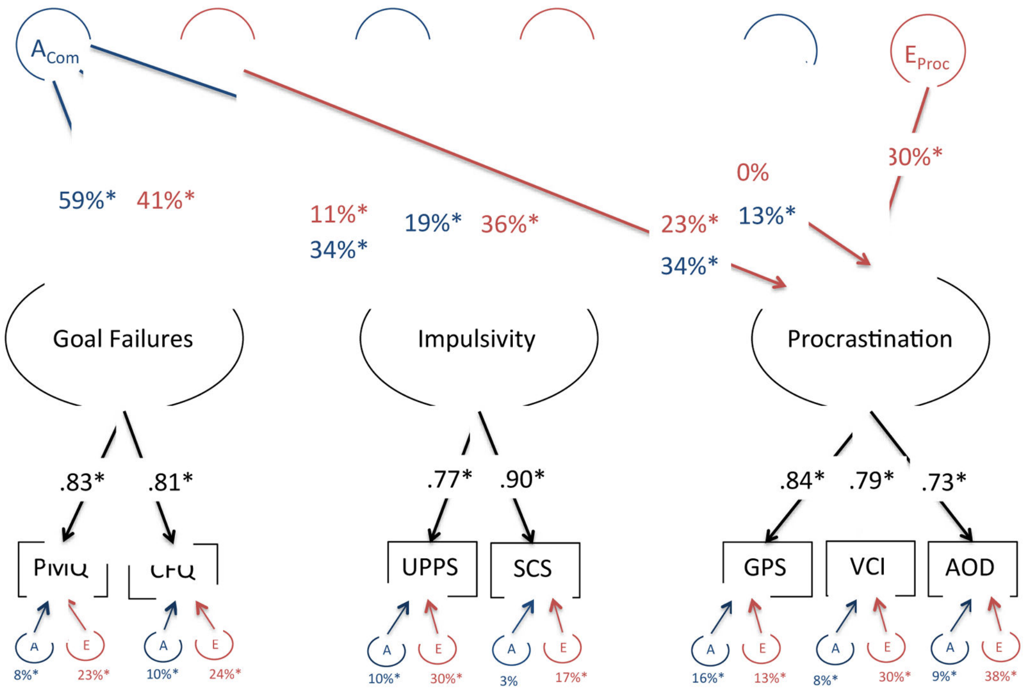

Figure 2.

Cholesky decomposition of the genetic influences on goal failures, impulsivity, and procrastination. Values with percentage signs indicate the percentage of variance accounted for by these genetic (A, in blue) or nonshared environmental (E, in red) influences for each latent-variable trait. * indicates a significant factor loading ($p < .05$). GPS = General Procrastination Scale, VCI = Volitional Components Inventory, ACS = Action Control Scale, SCS = Self Control Scale, UPPS = UPPS Impulsive Behavior Scale, PMQ = Prospective Memory Questionnaire, CFQ = Cognitive Failures Questionnaire.

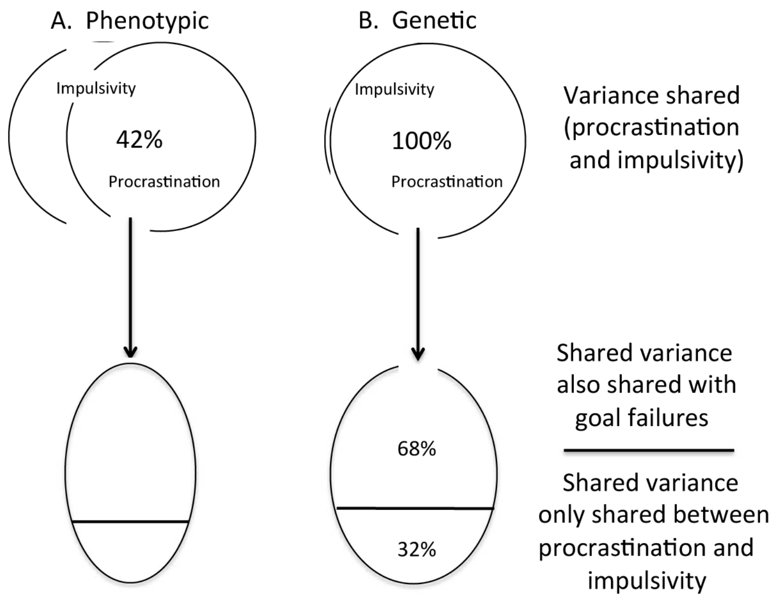

Figure 3.
Decomposition of the shared variation between impulsivity and procrastination into amount also shared with goal failures. The lower ovals describe how much of the shared variation from the upper diagram is also shared with goal failures, at the phenotypic level (left, Figure 3a) and genetic level (right, Figure 3b).

Table 1

Example Items from the Five Measures of Procrastination and Impulsivity

Scale/Subscale	Example Item
Procrastination	
General Procrastination Scale (GPS)	When planning a party, I make the necessary arrangements well in advance (R)
	If a bill for a small amount comes, I pay it right away
	I am continually saying "I'll do it tomorrow"
Volitional Components Inventory (VCI): External Control	I don't get started until time is about to run out
	I take care of unpleasant things only at the last minute
Volitional Components Inventory (VCI): Goal Neglect	I repeatedly postpone something
	I tell myself: You can always do it tomorrow
Volitional Components Inventory (VCI): Effort Avoidance	I avoid difficult goals
	I readily put difficult things aside
Action Control Scale (ACS): Decision vs. Hesitation	When I know I must finish something soon:
	A. I have to push myself to get started,
	B. I find it easy to get it done and over with
	When I have a boring assignment:
	A. I usually don't have any problem getting through it,
	B. I sometimes just can't get moving on it
Impulsivity	
UPPS Impulsive Behavior Scale (UPPS): Positive Urgency	When I am really excited, I tend not to think of the consequences of my actions
	When I am really ecstatic, I tend to get out of control
UPPS Impulsive Behavior Scale (UPPS): Negative Urgency	I have trouble resisting my cravings (for food, cigarettes, etc.)
	When I feel rejected, I will often say things that I later regret
UPPS Impulsive Behavior Scale (UPPS): (lack of) Premeditation	My thinking is usually careful and purposeful (R)
	I like to stop and think things over before I do them (R)
Self Control Scale (SCS)	I do many things on the spur of the moment
	I am good at resisting temptation (R)
Goal Failures	
Prospective Memory Questionnaire (PMQ): Long Term	I forgot to return something I borrowed
	I forgot to pass on a message to someone

Scale/Subscale	Example Item
Prospective Memory Questionnaire (PMQ): Short Term	I forgot to lock the door when leaving my apartment or house
	I forgot to pay the bill when finishing a meal at a restaurant
Prospective Memory Questionnaire (PMQ): Internally Cued	I got part way through a chore and forgot to finish
	I forgot what I came into a room to get
Cognitive Failures Questionnaire (CFQ)	Do you find you forget what you came to shops to buy?
	Do you fail to notice signposts on the road?

Note: (R) = Reverse scored item.

Table 2

Descriptive Statistics and Twin1–Twin2 Correlations

Measure	*N*	Mean	SD	Range	Skewness	Kurtosis	*r*MZ	*r*DZ
General Procrastination Scale (GPS)	663	2.60	0.57	1.10 – 4.60	0.06	−0.05	0.56	0.07
Volitional Components Inventory (VCI)	662	2.84	0.95	1.00 – 5.79	0.37	−0.25	0.39	0.10
Action Control Scale (ACS)	659	7.88	2.93	0.00 – 12.0	−0.48	−0.61	0.32	0.05
Self Control Scale (SCS)	661	3.42	0.61	1.40 – 4.85	−0.35	0.10	0.47	−0.03
UPPS – Impulsive Behavioral Scale (UPPS)	637[a]	1.97	0.42	1.05 – 3.59	0.36	0.23	0.48	0.12
Prospective Memory Questionnaire (PMQ)	649	0.63	0.30	0.00 – 1.70	0.49	0.06	0.48	0.14
Cognitive Failures Questionnaire (CFQ)	663	1.41	0.47	0.13 – 3.26	0.31	0.62	0.47	0.26

Note: rMZ and rDZ = Twin1–Twin2 correlations for monozygotic and dizygotic twins, respectively.

[a]The UPPS was administered as part of a separate study. Seventeen subjects had not completed that separate study at the time of analysis, and an additional 6 subjects had completed a different initial version of that study. Thus, these 23 subjects were missing data for the UPPS.

Table 3

Phenotypic Correlations

Measure	GPS	VCI	ACS	SCS	UPPS	PMQ	CFQ
General Procrastination Scale (GPS)	**.89**						
Volitional Components Inventory (VCI)	.66	**.92**					
Action Control Scale (ACS)	.61	.59	**.77**				
Self Control Scale (SCS)	.51	.48	.39	**.88**			
UPPS Impulsive Behavioral Scale (UPPS)	.44	.40	.30	.69	**.88**		
Prospective Memory Questionnaire (PMQ)	.54	.46	.44	.49	.44	**.91**	
Cognitive Failures Questionnaire (CFQ)	.52	.47	.48	.46	.41	.67	**.90**

Note: $N = 633$. All correlations are significant ($p < .05$). Reliabilities (Cronbach's alpha) are shown on the diagonal in boldface type