The Relation Between Stress and Impulsivity During the First Year of College

Katherine Seldin

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science

University of Washington

2020

Committee:

Kevin M. King

Liliana J. Lengua

Program Authorized to Offer Degree:

Department of Psychology

University of Washington

Abstract

The Relation Between Stress and Impulsivity During the First Year of College

Katherine Seldin

Chair of the Supervisory Committee:

Kevin M. King

Department of Psychology

Previous research has established that acute and chronic stress negatively impact mental health. People are thought to become more impulsive in response to stress, but there is a paucity of literature examining how stress might relate to the development of the different dimensions of impulsivity over time. The present study tests the acute and chronic associations between stress and three impulsigenic traits, negative urgency, planning, and persistence, across six months among young adults (n=366) in their first year of college. Pre-registered analyses using multilevel growth curve models revealed that higher between-person (i.e. chronic) stress was related to higher negative urgency and lower persistence, as well as a decreasing trajectory of persistence over time. Surprisingly, higher chronic stress was related to higher planning, but an effect was found only in racial and ethnic minority participants. Higher acute stress also predicted higher planning, regardless of race/ethnicity, which was contrary to hypotheses. In line with hypotheses, within-person (i.e. acute) stress was related to higher negative urgency, but was not related to persistence. Results suggest that chronic exposure to stress may be associated with some facets of impulsivity, but the effects of acute stress are more complex.

Stress has detrimental effects on mental health, impacting anxiety, depression, eating disorders, substance use disorders, and risk-taking behavior (Jenness, Peverill, King, Hankin, & McLaughlin, 2019; King & Chassin, 2008; McMahon, Grant, Compas, Thurm, & Ey, 2003; Porcelli & Delgado, 2017). The first year of college is a particularly stressful time in an individual's life, with a recent report finding, for instance, that only half of incoming students felt that they are "at least somewhat strong" in managing their time and over half indicated that there was a "very good chance" they would need a job to help finance their studies (Stolzenberg et al., 2020). In addition, young adults are vulnerable to the onset of psychopathology (Schulenberg, Sameroff, & Cicchetti, 2004), and the novel social environment that young adults attending college face includes increased opportunities to engage in risky behaviors, such as substance use and unsafe sex. Given that stress has been linked to adverse mental health outcomes and risk-taking behavior, it is of particular importance to understand the ways in which stress may impact first-year college students during this critical, high stress period.

Stress has been thought to influence psychopathology through its impact on both emotion-based and cognitive processes. Stress, especially when it is prolonged, chronic, or repeated, can result in adverse psychological outcomes, such as depression and problematic substance use (Jenness et al., 2019; Sinha, 2008). Stress has been shown to increase negative affect which, when combined with maladaptive coping strategies and poor emotion regulation, can ultimately contribute to the development of both internalizing and externalizing symptoms (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Sinha, 2008). Some proposed theories of the effects of stress on cognitive functioning, on the other hand, include: altering motivation to engage in cognitive control, depleting cognitive control resources needed for behavioral inhibition and self-control, interfering with attention, impairing higher-level cognition, and

lowering frustration tolerance (or giving up more quickly) (Calvo & Gutiérrez-García, 2016; Cohen, 1980; Hockey, 1997; Inzlicht, Schmeichel, & Macrae, 2014; Muraven & Baumeister, 2000; Sinha, 2008). Impairments in cognitive domains such as these have been considered transdiagnostic and have been tied to specific disorders such as depression, ADHD, and substance use disorders (Goschke, 2014; Grahek, Everaert, Krebs, & Koster, 2018; Snyder, Miyake, & Hankin, 2015; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005).

It has also been demonstrated that stress is related to impulsivity and impulsive behavior (Ansell, Gu, Tuit, & Sinha, 2012; Hamilton, Ansell, Reynolds, Potenza, & Sinha, 2013; Moustafa, Tindle, Frydecka, & Misiak, 2017; Sperry, Lynam, & Kwapil, 2018). There have been disagreements regarding the definition of "impulsivity", and it is often used as an umbrella term for a number of different constructs and varies widely across studies (Enticott & Ogloff, 2006; King, Patock-Peckham, Dager, Thimm, & Gates, 2014). One way of defining impulsivity that has received strong support is a four- to five-factor model of impulsigenic traits (Berg, Latzman, Bliwise, & Lilienfeld, 2015; Miller, Flory, Lynam, & Leukefeld, 2003; Whiteside & Lynam, 2001). Impulsigenic traits refer to specific personality traits that reflect a propensity for behaving impulsively (Whiteside & Lynam, 2001). In this model, each impulsigenic trait supports a distinct facet of impulsivity. Negative and positive urgency (which are sometimes combined into a single urgency factor) tap acting impulsively in the face of negative or positive emotions, respectively. Two moderately associated dimensions reflect low conscientiousness: lack of premeditation reflects acting without thinking ahead or a lack of planning, while lack of perseverance taps failures of persistence. Finally, sensation seeking reflects an individual's inclination for thrilling and adventurous behavior and activities. Traits have been traditionally considered to be stable and relatively unchanging in adulthood (Costa Jr & McCrae, 1994),

however, there is support for the idea that traits, including impulsigenic traits, undergo changes during young adulthood (Littlefield, Sher, & Steinley, 2010; Quinn & Harden, 2013), and are susceptible to the influence of external factors even within relatively short periods of time (e.g., Littlefield et al., 2015). Although stress is thought to relate to behaving impulsively, there is a paucity of literature exploring how stress might relate to the development of the different impulsigenic traits that underlie the inclination to engage in such behavior.

Based on the current state of the literature regarding the effects of stress on cognition, impulsigenic traits whose development is likely to be related to stress are negative urgency, planning, and persistence. The previously mentioned impact of stress on frustration tolerance suggests an association between stress and persistence, as persistence is defined as the ability to persist through boring or frustrating tasks. Two other previously mentioned cognitive effects of stress, impaired attention and higher-order cognition, are linked to the impulsigenic trait of planning, which is the ability to think through consequences and plan ahead (Whiteside & Lynam, 2001). Finally, negative urgency has been tied to cognitive control (see Johnson, Elliott, & Carver, 2019 for review). Indeed, there has been one recent daily diary study that linked the momentary feeling of stress to a single aggregate measure of momentary impulsivity based on Whiteside & Lynam's model of impulsivity, and also linked momentary stress to trait negative urgency and persistence (Sperry, Lynam & Kwapil, 2018). There was also another recent study tying negative urgency to cumulative stress (McMullin, Shields, Slavich, & Buchanan, 2020). However, what has not been explored is how stress may relate to changes in and the development of discrete facets of trait impulsivity over time. Just as stress has been tied to negative mental health outcomes, people who are high on impulsigenic traits are also at risk for developing psychopathology such as bipolar disorder, substance use disorders, ADHD, and

eating disorders, as well as a variety of problem behaviors such as risk taking and aggression (Acton, 2003; Berg et al., 2015; Carver & Johnson, 2018; Fischer, Smith, & Cyders, 2008; King, Karyadi, Luk, & Patock-Peckham, 2011; Muhtadie, Johnson, Carver, Gotlib, & Ketter, 2014). Therefore, the examination of the relation between stress and negative urgency, planning, and persistence over time will serve to further elucidate the role of stress in the development of factors closely tied to psychopathology and risky behavior.

The aim of the present study is to elucidate the temporal relation between stress and impulsivity (negative urgency, planning, and persistence) in young adults across three timepoints during their first year of college. A propensity for experiencing stressful life events has been shown to be almost trait-like and differs significantly between individuals (King, Molina, & Chassin, 2008). We hypothesize that those who demonstrate this propensity and therefore experience higher chronic stress, as measured by their average stress across the academic year, will also experience higher levels of and increasing trajectories of impulsivity (meaning higher negative urgency and lower planning and persistence) over time. These are between-person comparisons: individuals who have higher chronic stress compared to others will be more impulsive regardless of timepoint and, given the previously discussed deleterious effects of chronic stress, will become more impulsive over time. We additionally hypothesize that higher acute stress will predict higher levels of impulsivity above and beyond the predicted trajectory of impulsivity based on chronic stress. This is a within-person comparison: when an individual is experiencing high acute stress relative to their own average, they will experience higher levels of impulsivity within that same timepoint over and above the predicted trajectory.

Method

Participants

Participants (baseline n = 366)[1] were college freshmen (M_{age} = 18.26, *SD* = 0.60) at a university in the Pacific Northwest and were enrolled through the university's study subject pool. Participants were 52% male, 63% White, 30% Asian, and 3% Hispanic, with the remaining participants comprising other races and ethnicities. Baseline descriptive statistics are provided in Table 1.

Data were collected as part of a larger longitudinal study with three timepoints, with enrollment taking place over a period of 2 years. The baseline visit occurred during the Fall (October – November) of students' first quarter. Follow-ups were four and six months following the baseline visit. At each timepoint, participants completed self-report measures on impulsivity and stress, among other variables. Participants received course credit for completing the baseline questionnaire and were compensated an additional $25 and $35 for the second and third timepoints, respectively. There was a retention rate of 66% across all three timepoints, with 78% of participants contributing to data at least one follow-up. Males were more likely to drop out, X^2 (1, N = 366) = 4.9, p = 0.03, but we observed no other differences in retention on predictors, outcomes or covariates measured at baseline.

Of note, the impulsivity measure was only introduced to the follow-up surveys in the second year of data collection, so the first 90 participants had impulsivity data at baseline only, even if they had stress data in their follow-ups. We conducted t-tests and found no differences on variables of interest between those who were enrolled in the first year of data collection versus the second year, although participants enrolled during the first year of data collection were

[1]This sample size differs from the expected and pre-registered sample size (n=471). Participants who had no data on the variables of interest at any timepoint (n=18), who did not have any baseline data on the variables of interest (n=26), and who were not first-year students (n=61) were not included in the final baseline n. Data were re-analyzed with older participants and were robust to their inclusion.

slightly younger (M = 18.14, SD = 0.35) than those enrolled during the second year (M = 18.30, SD = 0.65), $t(284.04) = -2.82$, $p < 0.01$. Furthermore, as an additional sensitivity analysis, we added year of enrollment as a covariate in the final models. Results of these sensitivity analyses were robust to inclusion of enrollment year. Given this, and that multilevel models are robust to missing data at the innermost level due to the weighting of clusters (i.e. participants) based on amount of data available (i.e. observations) (Raudenbush & Bryk, 2002), we included all participants in analyses and did not include year of enrollment as a covariate.

Measures

Impulsigenic Traits

The three impulsigenic traits of interest (negative urgency, planning, and persistence) were measured using the well-validated UPPS-P Impulsive Behavioral Scale (Lynam, Smith, Whiteside, & Cyders, 2006), which was developed by integrating the original four-factor UPPS measure (Whiteside & Lynam, 2001) with the subsequently developed Positive Urgency Measure (PUM) (Cyders et al., 2007). The UPPS-P includes 12 items that tap negative urgency (i.e., “I make matters worse because I act without thinking when upset”), 11 items that tap planning (i.e., “I like to stop and think things over before doing them”), and 10 items that tap persistence (i.e., “I generally like to see things through to the end”). For all items, participants indicated likelihood of occurrence using a 5-point Likert scale ranging from 1-5, with 1 being “Not at all” and 5 being “Very much.” All items were coded such that high values reflected high levels of the construct. The means for each subscale were used. Internal consistency was high for all three subscales of negative urgency, planning, and persistence ($\alpha = 0.90$ [$\omega = 0.92$] , $\alpha = 0.91$ [$\omega = 0.93$], and $\alpha = 0.85$ [$\omega = 0.89$], respectively).

Stress

The 49-item Inventory of College Students' Recent Life Experience (ICSRLE; Kohn et al., 1990) was administered to assess participants' experience of stress. Participants reported the extent to which each of the 49 total items (i.e., "important decisions about your future career") had been a part of their lives over the past month. Response options were on a 4-point Likert scale ranging from 1 ("not at all a part of my life") to 4 ("very much a part of my life"). This measure includes 7 subscales: Developmental Challenge, Time Pressure, Academic Alienation, Romantic Problems, Assorted Annoyances, General Social Mistreatment, and Friendship Problems. However, as there were no hypotheses regarding differential associations between these subscales and the impulsigenic traits, a full-scale mean was used. Full-scale internal consistency for this measure was good ($\alpha = 0.94$ [$\omega = 0.95$]).

Covariates

As negative affect and perceived stress have some conceptual overlap as well as previously established associations (Bolger, DeLongis, Kessler, & Schilling, 1989; Schilling & Diehl, 2014), and negative affect has also been tied to impulsivity (Feil, Halvorson, Lengua, & King, 2020; Moustafa et al., 2017; Sperry et al., 2018; Sperry, Lynam, Walsh, Horton, & Kwapil, 2016), it was important to account for negative affect in order to appropriately disentangle the degree to which stress, as opposed to negative affect, may predict impulsivity. Negative affectivity is defined as the greater likelihood of experiencing negative affect even in the absence of an overt stressor (Watson & Clark, 1984) and, in the present study, we used trait anger and trait anxiety as proxy measures for this construct. We measured trait anger and trait anxiety with the State-Trait Anger Expression Inventory (Spielberger, 1988) and the State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The former measure included 10 items assessing the frequency of anger-related experiences (i.e., "get furious when

criticized in front of others") on a scale of 1 ("Almost never") to 4 ("Almost always"). The latter measure included 20 items assessing the frequency of anxiety-related experiences (i.e., "worry too much over something that really doesn't matter"), also on a scale of 1 ("Almost never") to 4 ("Almost always"). Internal reliability for both measures was good ($\alpha = 0.82$ [$\omega = 0.89$] and $\alpha = 0.92$ [$\omega = 0.93$], respectively).

We also included gender (male = 0, female = 1), race/ethnicity (White = 0, non-White = 1), age, and time as covariates. The three timepoints were coded 0, 2, and 3 to account for the 4-month gap between the first two timepoints and the 2-month gap between the second two timepoints.

Analyses

Analyses were pre-registered through the OSF website[2]. The senior author had access to these data prior to pre-registration, but the first author, who was the primary analyst, did not.

All analyses were conducted in RStudio (R Core Team, 2019) using the 'nlme' statistical package (Pinheiro, Bates, & R-core, 2019)[3]. We used multilevel growth curve models and, in order to appropriately disaggregate between- and within-person variance, we computed between-person centered (i.e., centering each participant's average for all three timepoints around the mean of the entire sample) and within-person centered (i.e., centering each participant's observations around their own individual average) stress scores. Age, trait anger, and trait anxiety were grand mean centered, such that 0 was equal to the average of all participants. Alpha was set at 0.05 and we used 95% confidence intervals when determining coefficient significance. As stated earlier, multilevel models are robust to missing data at the innermost level

[2] Link: https://osf.io/untm5/?view_only=3094e669ca334089b584cc4be1ecfaff

[3] In our pre-registration, we stated that we planned to use the 'lme4' statistical package (Bates, Mächler, Bolker, & Walker, 2015) to run our multilevel models. After submitting the pre-registration, we ultimately decided to instead use the 'nlme' package for flexibility, and these models generally replicated in the 'lme4' package.

(Raudenbush & Bryk, 2002). Therefore, participants were required to have responses to at least 4 items per UPPS subscale and a response rate of at least 25% across the full ICSRLE for those data to be included within a given timepoint. There were a total of 3 observations that did not meet these thresholds for one or more variables (n=1 for negative urgency and n=3 for persistence, with 1 overlapping observation).

We tested all final models for normality of residuals by examining Q-Q plots and running D'Agostino-Pearson and Shapiro-Wilks normality tests. We also checked the assumption of homoscedasticity by plotting residuals against fitted values, with the expectation being that there would be no distinguishable pattern. We checked for independence of predictors by testing all covariate by predictor interactions, retaining only those significant at *p*-value of less than 0.001 to minimize mis-estimation of main effects, and refrained from substantive interpretation of any retained interactions.

For all models, the residuals were not normally distributed, and heteroscedasticity was detected. As such, we log-transformed the outcome variables and tested for a quadratic effect of within-person stress, but these adjustments did not have any significant impact on residual distributions or results, so we kept the variables untransformed. The non-normal distribution of residuals is likely due to the skew of all three outcome variables (negative urgency, planning, and persistence) toward low impulsivity. We additionally plotted observed versus predicted values of the outcome variables as a low correlation might indicate an issue with model predictions, but this did not appear to be the case.

We used Cook's distance (Cook's D, or D_i), which is appropriate for multilevel model structures (Van der Meer, Te Grotenhuis, & Pelzer, 2010), to test for influential outliers[4] via the R package 'predictmeans' (Luo, Ganesh, & Koolaard, 2020). Different cutoff points of D_i have been used to determine whether a given observation warrants further investigation (e.g., Pinho, Nobre, & Singer, 2015; Zakaria, 2014) , but we opted to use a conservative recommendation, which is to investigate any value greater than $4/n$ (where n is equal to the number of observations) (Altman & Krzywinski, 2016). We then re-ran the models without observations that had D_i values greater than this threshold to determine if inferences regarding our hypotheses changed. Results were robust to the deletion of observations with large D_i values, so no observations were excluded from analyses.

Confirmatory Analyses

We conducted the following sequential model-building process three separate times, once for each impulsigenic trait of interest. For simplicity, we will refer to the outcome variables as "impulsivity" when describing the model-building process. We first built unconditional growth curve models for each trait with a random intercept and an added random slope for time to establish change and variation in trajectories of impulsivity without the influence of other variables that might impact that trajectory. We compared the models with and without a random slope for time using -2 log likelihood (logLik), Akaike information criteria (AIC) and Bayesian information criteria (BIC) as relative fit indices. The better fitting model, as determined by a likelihood ration test, was used for subsequent model building.

[4] We pre-registered that we would use the 'influence.ME' package (Nieuwenhuis, Te Grotenhuis, & Pelzer, 2012) to test for influential outliers. However, as this package is only compatible with models built with the 'lme4' package, we used Cook's distance as an alternative method for outlier detection, which is compatible with models built with 'nlme.'

We next added the predictors of interest: between-person stress to assess the effect of chronic stress, within-person stress to assess the acute effect of stress, and an interaction term between timepoint and between-person stress to assess the effect of chronic stress on the trajectory of impulsivity. We then added the covariates of age, gender, race/ethnicity, trait anger, and trait anxiety as a final step in all models to ensure that significant associations remained. Any significant interactions detected in the test for independence of predictors were included as covariates in this step. The following model includes a random slope for time for illustrative purposes, but it was not included if the addition of that term did not improve model fit.

$$imp_{ij} = \beta_0 + u_{0j} + \beta_1 time_{ij} + u_{1j} time_{ij} + \beta_2 stress_j + \beta_3 (stress_j * time_{ij}) + \beta_4 stress_{ij} + covariates + \varepsilon_{ij}$$

Results

We report descriptive statistics in Table 1, and correlations between key variables and covariates in Figure 1 and Table 2. More than half of the variance in negative urgency, planning, and persistence was accounted for by between-person variation, as indicated by the intraclass correlation coefficients (ICCs; 0.60, 0.58, and 0.68, respectively).

The addition of covariates did not change the significance of coefficients for any of the three models but did change beta estimates for the negative urgency model. Therefore, for consistency, we included covariates in the final models for all three impulsivity outcome variables.

Confirmatory Analyses

Table 3 summarizes the results from confirmatory analyses.

Negative Urgency

The unconditional growth curve model with a random-slope for negative urgency did not show significantly improved model fit over the model with a fixed-slope, Δ AIC = 1.76, Δ BIC = 10.90 , Δ logLik = 1.12, χ^2 (2)= 2.24, p = 0.33, and indicated that, on average, negative urgency decreased slightly over time (b = -0.09, SE = 0.01, p < 0.001, 95% CI = [-0.12, -0.06]), and that this trajectory did not significantly vary between individuals.

In the final urgency model, which included covariates, between-person variation in stress was associated with higher levels of negative urgency such that a 1-unit increase in between-person stress was related to a 0.61-unit increase in negative urgency (SE = 0.08, p < 0.001, 95% CI = [0.45, 0.78]). Within-person variation in stress was also associated with negative urgency, such that when participants reported higher stress than what was typical for them, they also reported higher negative urgency: a 1-unit increase in within-person stress was related to a 0.35-unit increase in negative urgency (SE = 0.08, p < 0.001, 95% CI = [0.19, 0.50]). On the other hand, between-person stress was not related to individual differences in change over time in negative urgency (b = 0.06, SE = 0.04, p = 0.11, 95% CI = [-0.01, 0.14]).

Planning

In contrast to the negative urgency model, adding a random slope for time improved the model fit for planning, Δ AIC = -11.09, Δ BIC = -1.95, Δ logLik = 7.54, χ^2 (2) = 15.09, p < 0.001, indicating that there were individual differences in trajectories of planning (Var = 0.02, SD = 0.13), with no significant main effect of time in this model (b = -0.02, SE = 0.02, p = 0.29, 95% CI = [-0.05, 0.02]).

In the final model with covariates, there was a significant effect of within-person stress on planning, but it was contrary to our hypothesis: higher within-person stress, or acute stress, predicted *higher* planning within that same timepoint such that a 1-unit increase in within-person stress was related to a 0.19-unit *increase* in planning (SE = 0.09, $p < 0.05$, 95% CI = [0.01, 0.37]). There was no main effect of between-person stress on planning (b = -0.23, SE = 0.13, p = 0.07, 95% CI = [-0.48, 0.01]), nor was there an interaction effect of between-person stress and timepoint (b = -0.06, SE = 0.05, p = 0.22, 95% CI = [-0.16, 0.04]).

When we assessed for independence of predictors, however, we found a significant interaction between race/ethnicity and between-person stress (b = 0.68, SE = 0.20, $p < 0.001$, 95% CI = [0.30, 1.07]), indicating that the effect of between-person stress on planning changes depending on racial and ethnic identity. We included this interaction term in our final model with covariates. Since there was an interaction between race/ethnicity and between-person stress, we recoded race/ethnicity such that the model was centered at non-White participants in order to fully estimate the main effect of between-person stress on planning. We found that for every 1-unit increase in between-person stress, there was a 0.45-unit *increase* in planning (SE = 0.16, $p <$ 0.01, 95% CI = [0.17, 0.93]) for non-White participants.

Persistence

When persistence was the outcome variable, adding a random slope for time improved model fit, Δ AIC = -12.19, Δ BIC = -3.07, Δ logLik = 8.10, χ^2 (2) = 16.19, p < 0.001, indicating that trajectories of persistence over time varied by individual (Var = 0.01, SD = 0.12). There was no significant main effect of time (b = -0.02, SE = 0.01, p = 0.19, 95% CI = [-0.05, 0.01]).

In the final persistence model, which included a random slope for time, variables of interest, and covariates, between-person stress was related to persistence (b = -0.42, SE = 0.09, $p < 0.001$, 95% CI = [-0.60, -0.25]) and higher between-person stress predicted decreasing persistence over time such that a 1-unit increase in between-person stress predicted a 0.13-unit addition to an inverse relation between time and persistence (SE = 0.04, $p < 0.001$, 95% CI =[-0.21, -0.06]) (Figure 2). The main effect of within-person stress on persistence was not significant (b = -0.002, SE = 0.07, p = 0.93, 95% CI = [-0.14, 0.14]).

Discussion

The first year of college can present challenges and stressful situations for young adults, is a sensitive time for developing psychopathology, and comes with increased opportunities to engage in risky behavior. The aim of the present study was to explore the associations between college-related stress and three distinct impulsigenic traits as they unfold across the course of the first year of college. Our pre-registered analyses were partially confirmed: we found some evidence that reporting higher chronic stress was associated with higher levels and worsening impulsivity over time for some, but not all, impulsigenic traits, and we found mixed support for the hypothesis that within-person increases in stress would be associated with higher impulsivity.

Between persons, reporting higher chronic stress was associated with higher negative urgency and lower persistence regardless of timepoint, and with decreases in persistence over time. These findings are in line with existing literature connecting chronic stress to impulsivity (Ansell et al., 2012; Hamilton et al., 2013). Of note, the association between chronic stress and negative urgency was slightly stronger than that of chronic stress and persistence, and in a recent study with a sample of college students, cumulative stress was associated with negative urgency

exclusively among the five facets of the UPPS-P impulsivity measure (McMullin et al., 2020). Taken together, these results suggest that the relation between chronic stress and negative urgency may be the strongest of the impulsigenic traits outlined by Whiteside and Lynam (2001) and Cyders et al. (2007), although there is evidence supporting a relation between chronic stress and persistence as well.

Despite the comparatively stronger relation between negative urgency and chronic stress, it was only persistence that decreased over time in those who reported higher chronic stress. Thus, there appears to be some unique feature of the relation between persistence and chronic stress that accounts for this pattern, as it cannot be solely attributed to a stronger association. One alternative explanation is that perhaps persistence is simply more malleable than negative urgency. This seems unlikely, however, as one meta-analysis found that negative urgency changed more consistently across studies than persistence in response to substance use disorder treatment, although the change was small (Hershberger, Um, & Cyders, 2017). This suggests that persistence is not simply the most globally malleable of the traits examined here and may, indeed, have a trajectory that is uniquely associated with chronic stress. Persistence has been tied to psychopathology and other adverse outcomes such as depression, suicidality, disordered eating, and substance use (Berg et al., 2015), so its deterioration over time may be a particularly relevant target of clinical intervention. Since our results suggest that there is damage over time, early stress intervention may prevent this decline in persistence and thus, potentially, associated negative mental health outcomes. Further studies are needed to determine directionality or causality of this relation.

Within-person, we hypothesized that at times when participants reported more stress than what was typical for them, they would also report higher than expected impulsivity. Only the

within-person association between stress and negative urgency was in line with our hypotheses. The previously found association between momentary stress and a momentary impulsivity index (Sperry et al., 2018) is in line with the association between acute stress and negative urgency found here. This association suggests that reports of increased stress may be accompanied by an acute increase in rash behavior in the face of negative affect, which is of particular clinical significance given the possibility for said rash behavior to have negative consequences (Cyders & Smith, 2008). It is important to note that, of the three impulsigenic traits examined here, negative urgency is both conceptually and empirically the most closely tied to negative affect (Feil et al., 2020; Sperry et al., 2018, 2016), which is reflected in our findings that both trait anger and anxiety were the most strongly associated with negative urgency in the present study sample. Perceived stress is also tied to negative affect (Bolger et al., 1989; Schilling & Diehl, 2014). Thus, one alternative explanation of our results may be that, while we included negative affectivity in our model, there was still unaccounted for variance from acute negative affect that is driving the association between acute stress and negative urgency.

Higher acute stress was associated with higher negative urgency but, contrary to our hypothesis, higher acute stress was also associated with *higher* planning, suggesting that when people were more stressed than was typical for them, they behaved more rashly in response to negative emotion but also were *better* at thinking ahead. We did not find the expected association between persistence and acute stress. There is some evidence to suggest that acute stress may improve cognitive performance under certain conditions, which is in contrast to the more consistently found negative impact of chronic stress (Calvo & Gutiérrez-García, 2016). Our finding that planning was higher when acute stress was higher, although it was a small effect,

may reflect a minor improvement in cognitive performance or adaptation to meet the demands of the environment.

However, the effects of stress on planning are perplexing in the context of previously established relations between stress and various measures of impulsivity, particularly since, of the UPPS impulsigenic traits, the construct of planning is the "most widely represented among the previous impulsivity measures" (Whiteside & Lynam, 2001). In addition to finding that higher acute stress related to a *better* ability to plan ahead, we detected an unexpected interaction between chronic stress and race such that higher chronic stress was only associated with planning in racial and ethnic minority participants, and this association was in the opposite direction as expected, suggesting that racial and ethnic minorities in this study sample who were more chronically stressed experienced a better ability to plan ahead than those who were not as chronically stressed. There are previously established differences in how White and racial and ethnic minority individuals experience stress, such as a recent APA report indicating that a higher proportion of youth of color face stressors such as discrimination, personal debt, and housing instability (American Psychological Association, 2018) than their White peers do. An additional APA report on health disparities (American Psychological Association & APA Working Group on Stress and Health Disparities, 2017) stated that exposure to these amplified stressors can result in worse health outcomes, including impaired cognitive control processes (although, surprisingly, our findings suggest that planning was actually higher in conjunction with higher chronic stress). Given that we did not hypothesize an effect of race/ethnicity on the relation between chronic stress and planning and our sample did not include an adequate number of participants across different racial and ethnic groups to explore this in more depth, we will refrain from further interpreting this incidental finding. Thus, replication and further exploration

of differential relations between stress and impulsivity across racial and ethnic groups would be recommended.

Our results are, overall, somewhat reflective of a pattern of associations previously detected between these specific impulsigenic traits and stress by Sperry et al. (2018), though on a different timescale. The associations between momentary stress and both trait negative urgency and trait persistence, as well no detection of an association between momentary stress and trait planning, that were reported in their study are similar to the associations we found between chronic stress and these impulsigenic traits, regardless of timepoint. Furthermore, in the aforementioned study, the relation between momentary stress and trait negative urgency was slightly stronger than that of momentary stress and trait persistence, which is also consistent with our findings regarding the stronger association between chronic stress and negative urgency than between chronic stress and persistence. The relation we found between acute stress and concurrent negative urgency was also consistent with this pattern, but our findings related to acute stress and planning and persistence were not. Thus, it would seem that planning and persistence may be somewhat inconsistently related to stress on different timescales, but negative urgency has been consistently connected to stress across timescales.

As relations between stress and impulsivity appear to vary across timescales, establishing clear timescales would be of central importance in drawing appropriate conclusions. The present study would have benefited from a more consistent timescale of assessments, as the timepoints were not evenly spaced across the academic year. It would have also benefitted from more precision in survey questions, as the timeframes for the stress and impulsivity measures were inconsistent with one another: the ICSRLE asked participants about stress “within the past month,” whereas the UPPS timescale was not specified. Furthermore, a month is a relatively

large window of time, so a more temporally granular and specific assessment of these constructs would be suggested for future studies. This would also help to clarify directionality of these associations, as it is possible that, consistent with the stress generation hypothesis of depression (Hammen, 1991), individuals generate stress for themselves as a result of their impulsive actions. Indeed, one study found that higher negative urgency at baseline predicted a greater number of stressful events in the four weeks following; this effect was not found for planning or persistence (Liu & Kleiman, 2012). This indicates that there may be a bidirectionality to the association between stress and impulsivity. For example, an individual might impulsively decide to drink at a party rather than study for an exam, which might result in that person doing poorly on the exam, which would then become a new academic stressor. Such a pattern might then result in a positive feedback loop in which stress triggers problematic behavior, which then brings about increased stress from the consequences of the problematic behavior.

Another limitation of the present study and potential source of bias is the use of retrospective self-report. This method of collecting data may be imprecise and influenced by momentary contextual factors (Bradburn, Rips, & Shevell, 1987; Kihlstrom, Eich, E., Sandbrand, & Tobias, 1999), so the imperfect nature of human recall may have resulted in inaccurate reporting. This bias may be reduced in future work through use of repeated assessments carried out in real time, which is also called ecological momentary assessment (EMA) (Shiffman, Stone, & Hufford, 2008). Additionally, we did not obtain data about timing of exam schedules or other key events that are commonly experienced during the freshman year of college, such as involvement in the Greek life “rush” process or the influx of social events associated with homecoming week. Such events may impact the context in which past experiences are recalled, thus contributing to bias, and may also impact the relation between stress and impulsivity. For

instance, say baseline surveys were disproportionately collected during times of increased social activity whereas follow-up surveys were disproportionately collected during exam weeks. This may result in varying contexts and opportunities to engage in different impulsive behaviors, thus potentially altering how these constructs relate. For instance, studying for midterms may present more opportunities to "just ignore little jobs because there are too many of them" or (fail to) be "productive and always get the job done" (persistence items) whereas social events during "rush" week may provide more opportunities to "say things they later regret when they feel rejected" or "say things they regret in the heat of an argument" (negative urgency items). Collecting and integrating information about greater social context may benefit this line of inquiry.

The association between stress and impulsivity in young adults entering college is of clinical importance due to the high-stress nature of this transition, as well as the increased opportunities to engage in risky behavior. Impulsivity has been consistently linked to problem substance use (e.g., King et al., 2011; Smith & Cyders, 2016) and other psychopathology and problem behaviors (Berg et al., 2015; Chambers & Potenza, 2003; Fischer et al., 2008). Negative urgency in particular has been strongly tied to psychopathology and other adverse outcomes (Cyders, Coskunpinar, & VanderVeen, 2016; Cyders & Smith, 2008), and was associated with both chronic and acute stress in the present study. A better understanding of the interplay between stress and impulsivity as well as the temporal dynamics of these associations might elucidate targets of intervention during this sensitive time.

In sum, our hypotheses were supported to varying degrees across the three impulsigenic traits, adding to the rapidly growing body of literature supporting the importance of breaking down the broader construct of "impulsivity" into distinct facets, and surprising interactions were found between race/ethnicity and chronic stress in our planning model. It seems that higher

negative urgency and lower persistence are related to higher chronic stress, and that, conversely, *higher* planning is related to higher chronic stress in participants of color only. Only persistence had a trajectory that was related to chronic stress, in which individuals decreased in their ability to stick with tasks over time when reporting higher levels of chronic stress. The acute effects of stress varied across all three facets of impulsivity. Higher acute stress predicted higher negative urgency (higher impulsivity), higher planning (lower impulsivity), and was not related to persistence. This study's line of inquiry would benefit from further exploration of these associations on a more granular time scale as well as how they may relate to the development of psychopathology.

References

Acton, G. S. (2003). Measurement of Impulsivity in a Hierarchical Model of Personality Traits: Implications for Substance Use. *Substance Use & Misuse*, *38*(1), 67–83. https://doi.org/10.1081/JA-120016566

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*, *30*(2), 217–237. https://doi.org/10.1016/j.cpr.2009.11.004

Altman, N., & Krzywinski, M. (2016). Analyzing outliers: Influential or nuisance? *Nature Methods*, *13*(4), 281–282. https://doi.org/10.1038/nmeth.3812

American Psychological Association. (2018). *Stress in America: Generation Z*. Stress in America™ Survey.

American Psychological Association, & APA Working Group on Stress and Health Disparities. (2017). *Stress and health disparities: Contexts, mechanisms, and interventions among racial/ethnic minority and low-socioeconomic status populations*.

Ansell, E. B., Gu, P., Tuit, K., & Sinha, R. (2012). Effects of cumulative stress and impulsivity on smoking status. *Human Psychopharmacology*, *27*(2), 200–208. https://doi.org/10.1002/hup.1269

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using {lme4}. *Journal of Statistical Software*, *67*(1), 1–48. https://doi.org/10.18637/jss.v067.i01

Berg, J. M., Latzman, R. D., Bliwise, N. G., & Lilienfeld, S. O. (2015). Parsing the Heterogeneity of Impulsivity : A Meta-Analytic Review of the Behavioral Implications of the UPPS for Psychopathology. *Psychological Assessment*, *27*(4), 1129.

Bolger, N., DeLongis, A., Kessler, R. C., & Schilling, E. A. (1989). Effects of Daily Stress on Negative Mood. *Journal of Personality and Social Psychology*, *57*(5), 808–818. https://doi.org/10.1037/0022-3514.57.5.808

Bradburn, N. M., Rips, L. J., & Shevell, S. K. (1987). Answering autobiographical questions: The impact of memory and inference on surveys. *Science*, *236*(4798), 157–161. https://doi.org/10.1126/science.3563494

Calvo, M. G., & Gutiérrez-García, A. (2016). Cognition and Stress. *Stress: Concepts, Cognition, Emotion, and Behavior: Handbook of Stress*, 139–144. https://doi.org/10.1016/B978-0-12-800951-2.00016-9

Carver, C. S., & Johnson, S. L. (2018). Impulsive Reactivity to Emotion and Vulnerability to Psychopathology. *American Psychologist*, *73*(9), 1067–1078. https://doi.org/10.1016/j.gde.2016.03.011

Chambers, R. A., & Potenza, M. N. (2003). Neurodevelopment, Impulsivity, and Adolescent Gambling. *Journal of Gambling Studies*, *19*(1), 53–84. https://doi.org/10.1023/A

Cohen, S. (1980). Aftereffects of stress on human performance and social behavior: A review of research and theory. *Psychological Bulletin*, *88*(1), 82–108. https://doi.org/10.1037/0033-2909.88.1.82

Costa Jr, P. T., & McCrae, R. R. (1994). Set like plaster? Evidence for the stability of adult personality. In T. F. Heatherton & J. L. Weinberger (Eds.), *Can personality change?* (pp. 21–40). American Psychological Association. https://doi.org/https://doi.org/10.1037/10143-002

Cyders, M. A., Coskunpinar, A., & VanderVeen, J. D. (2016). Urgency: A common

transdiagnostic endophenotype for maladaptive risk taking. In *The dark side of personality: Science and practice in social, personality, and clinical psychology* (pp. 157–188). Washington: American Psychological Association.

Cyders, M. A., & Smith, G. T. (2008). Emotion-based Dispositions to Rash Action: Positive and Negative Urgency. *Psychological Bulletin*, *134*(6), 807–828. https://doi.org/10.1037/a0013341.Emotion-based

Cyders, M. A., Smith, G. T., Spillane, N. S., Fischer, S., Annus, A. M., & Peterson, C. (2007). Integration of impulsivity and positive mood to predict risky behavior: Development and validation of a measure of positive urgency. *Psychological Assessment*, *19*(1), 107–118. https://doi.org/10.1037/1040-3590.19.1.107

Enticott, P., & Ogloff, J. R. P. (2006). Elucidation of impulsivity. *Australian Psychologist*, *41*(1), 3–14. https://doi.org/10.1080/00050060500391894

Feil, M., Halvorson, M., Lengua, L., & King, K. M. (2020). A state model of negative urgency: Do momentary reports of emotional impulsivity reflect global self-report? *Journal of Research in Personality*, *86*, 103942. https://doi.org/10.1016/j.jrp.2020.103942

Fischer, S., Smith, G. T., & Cyders, M. A. (2008). Another Look at Impulsivity: A Meta-Analytic Review Comparing Specific Dispositions to Rash Action in their Relationship to Bulimic Symptoms. *Clinical Psychology Review*, *28*(8), 1413–1425. https://doi.org/10.1016/j.cpr.2008.09.001.Another

Goschke, T. (2014). Dysfunctions of decision-making and cognitive control as transdiagnostic mechanisms of mental disorders: advances, gaps, and needs in current research. *International Journal of Methods in Psychiatric Research*, *23*(S1), 41–57. https://doi.org/10.1002/mpr

Grahek, I., Everaert, J., Krebs, R. M., & Koster, E. H. W. (2018). Cognitive Control in Depression: Toward Clinical Models Informed by Cognitive Neuroscience. *Clinical Psychological Science*, *6*(4), 464–480. https://doi.org/10.1177/2167702618758969

Hamilton, K. R., Ansell, E. B., Reynolds, B., Potenza, M. N., & Sinha, R. (2013). Self-reported impulsivity, but not behavioral choice or response impulsivity, partially mediates the effect of stress on drinking behavior. *Stress*, *16*(1), 3–15. https://doi.org/10.3109/10253890.2012.671397

Hammen, C. (1991). Generation of stress in the course of unipolar depression. *Journal of Abnormal Psychology*, *100*(4), 555–561. https://doi.org/https://doi.org/10.1037/0021-843X.100.4.555

Hershberger, A. R., Um, M., & Cyders, M. A. (2017). The relationship between the UPPS-P impulsive personality traits and substance use psychotherapy outcomes: A meta-analysis. *Drug and Alcohol Dependence*, *178*(June), 408–416. https://doi.org/10.1016/j.drugalcdep.2017.05.032

Hockey, G. R. J. (1997). Compensatory control in the regulation of human performance under stress and high workload: A cognitive-energetical framework. *Biological Psychology*, *45*(1–3), 73–93. https://doi.org/10.1016/S0301-0511(96)05223-4

Inzlicht, M., Schmeichel, B. J., & Macrae, C. N. (2014). Why self-control seems (but may not be) limited. *Trends in Cognitive Sciences*, *18*(3), 127–133. https://doi.org/10.1016/j.tics.2013.12.009

Jenness, J. L., Peverill, M., King, K. M., Hankin, B. L., & McLaughlin, K. A. (2019). Dynamic associations between stressful life events and adolescent internalizing psychopathology in a multiwave longitudinal study. *Journal of Abnormal Psychology*, *128*(6), 596–609.

https://doi.org/10.1037/abn0000450
Johnson, S. L., Elliott, M. V., & Carver, C. S. (2019). Impulsive Responses to Positive and Negative Emotions: Parallel Neurocognitive Correlates and their Implications. *Biological Psychiatry*. https://doi.org/10.1016/j.biopsych.2019.08.018
Kihlstrom, J. F., Eich, E., Sandbrand, D., & Tobias, B. A. (1999). Emotion and memory: Implications for self-report. In *The science of self-report* (pp. 93–112).
King, K. M., & Chassin, L. (2008). Adolescent stressors, psychopathology, and young adult substance dependence: a prospective study. *Journal of Studies on Alcohol and Drugs*, *69*(5), 629–638.
King, K. M., Karyadi, K. A., Luk, J. W., & Patock-Peckham, J. A. (2011). Dispositions to rash action moderate the associations between concurrent drinking, depressive symptoms, and alcohol problems during emerging adulthood. *Psychology of Addictive Behaviors*, *25*(3), 446–454. https://doi.org/10.1037/a0023777
King, K. M., Molina, B. S. G., & Chassin, L. (2008). A state-trait model of negative life event occurrence in adolescence: Predictors of stability in the occurrence of stressors. *Journal of Clinical Child and Adolescent Psychology*, *37*(4), 848–859. https://doi.org/10.1080/15374410802359643
King, K. M., Patock-Peckham, J. A., Dager, A. D., Thimm, K., & Gates, J. R. (2014). On the Mismeasurement of Impulsivity: Trait, Behavioral, and Neural Models in Alcohol Research among Adolescents and Young Adults. *Current Addiction Reports*, *1*(1), 19–32. https://doi.org/10.1007/s40429-013-0005-4
Kohn, P. M., Lafreniere, K., & Gurevich, M. (1990). The Inventory of College Students' Recent Life Experiences: A decontaminated hassles scale for a special population. *Journal of Behavioral Medicine*, *13*(6), 619–630. https://doi.org/10.1007/BF00844738
Littlefield, A. K., Sher, K. J., & Steinley, D. (2010). Developmental trajectories of impulsivity and their association with alcohol use and related outcomes during emerging and young adulthood I. *Alcoholism: Clinical and Experimental Research*, *34*(8), 1409–1416. https://doi.org/10.1111/j.1530-0277.2010.01224.x
Littlefield, A. K., Stevens, A. K., Cunningham, S., Jones, R. E., King, K. M., Schumacher, J. A., & Coffey, S. F. (2015). Stability and change in multi-method measures of impulsivity across residential addictions treatment. *Addictive Behaviors*, *42*, 126–129. https://doi.org/10.1016/j.addbeh.2014.11.002
Liu, R. T., & Kleiman, E. M. (2012). Impulsivity and the generation of negative life events: The role of negative urgency. *Personality and Individual Differences*, *53*(5), 609–612. https://doi.org/10.1016/j.paid.2012.05.003
Luo, D., Ganesh, S., & Koolaard, J. (2020). predictmeans: Calculate Predicted Means for Linear Models. Retrieved from https://cran.r-project.org/package=predictmeans
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.
McMahon, S. D., Grant, K. E., Compas, B. E., Thurm, A. E., & Ey, S. (2003). Stress and psychopathology in children and adolescents: Is there evidence of specificity? *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *44*(1), 107–133. https://doi.org/10.1111/1469-7610.00105
McMullin, S. D., Shields, G. S., Slavich, G. M., & Buchanan, T. W. (2020). Cumulative lifetime stress exposure predicts greater impulsivity and addictive behaviors. *Journal of Health Psychology*, 1–16. https://doi.org/10.1177/1359105320937055

Miller, J., Flory, K., Lynam, D., & Leukefeld, C. (2003). A test of the four-factor model of impulsivity-related traits. *Personality and Individual Differences*, *34*(8), 1403–1418. https://doi.org/10.1016/S0191-8869(02)00122-8

Moustafa, A. A., Tindle, R., Frydecka, D., & Misiak, B. (2017). Impulsivity and its relationship with anxiety, depression and stress. *Comprehensive Psychiatry*, *74*, 173–179. https://doi.org/10.1016/j.comppsych.2017.01.013

Muhtadie, L., Johnson, S. L., Carver, C. S., Gotlib, I. H., & Ketter, T. A. (2014). A profile approach to impulsivity in bipolar disorder: The key role of strong emotions. *Acta Psychiatrica Scandinavica*, *129*(2), 100–108. https://doi.org/10.1111/acps.12136

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin*, *126*(2), 247–259. https://doi.org/10.1037/0033-2909.126.2.247

Nieuwenhuis, R., Te Grotenhuis, M., & Pelzer, B. (2012). influence.ME: Tools for Detecting Influential Data in Mixed Effects Models. *R Journal*, *4*(2), 38–47.

Pinheiro, J., Bates, D., & R-core. (2019). nlme: Linear and Nonlinear Mixed Effects Models. Retrieved from https://cran.r-project.org/package=nlme

Pinho, L. G. B., Nobre, J. S., & Singer, J. M. (2015). Cook's distance for generalized linear mixed models. *Computational Statistics and Data Analysis*, *82*, 126–136. https://doi.org/10.1016/j.csda.2014.08.008

Porcelli, A. J., & Delgado, M. R. (2017). Stress and decision making: effects on valuation, learning, and risk-taking. *Current Opinion in Behavioral Sciences*, *14*, 33–39. https://doi.org/10.1016/j.cobeha.2016.11.015

Quinn, P. D., & Harden, K. P. (2013). Differential Changes in Impulsivity and Sensation Seeking and the Escalation of Substance Use from Adolescence to Early Adulthood. *Dev Psychopathol*, *25*(1), 223–239. https://doi.org/10.1038/jid.2014.371

R Core Team. (2019). R: A Language and Environment for Statistical Computing. Vienna, Austria. Retrieved from https://www.r-project.org/

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. *sage*. https://doi.org/10.1016/B0-12-369398-5/00166-3

Schilling, O. K., & Diehl, M. (2014). Reactivity to Stressor Pile-Up in Adulthood: Effects on Daily Negative and Positive Affect. *Psychol Aging*, *29*(1), 72–83. https://doi.org/10.1037/a0035500.Reactivity

Schulenberg, J. E., Sameroff, A. J., & Cicchetti, D. (2004). The transition to adulthood as a critical juncture in the course of psychopathology and mental health. *Development and Psychopathology*, *16*, 799–806. https://doi.org/10.1017/S0954579404040015

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological Momentary Assessment. *Annual Review of Clinical Psychology*, *4*(1), 1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415

Sinha, R. (2008). Chronic Stress, Drug Use, and Vulnerability to Addiction. *Changes*, *34*(6), 1443–1453. https://doi.org/10.1196/annals.1441.030.Chronic

Smith, G. T., & Cyders, M. A. (2016). Integrating affect and impulsivity: The role of positive and negative urgency in substance use risk. *Drug and Alcohol Dependence*, *163*, S3–S12. https://doi.org/10.1016/j.drugalcdep.2015.08.038

Snyder, H. R., Miyake, A., & Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: Bridging the gap between clinical and cognitive approaches. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00328

Sperry, S. H., Lynam, D. R., & Kwapil, T. R. (2018). The convergence and divergence of impulsivity facets in daily life. *Journal of Personality*, *86*(5), 841–852. https://doi.org/10.1111/jopy.12359

Sperry, S. H., Lynam, D. R., Walsh, M. A., Horton, L. E., & Kwapil, T. R. (2016). Examining the multidimensional structure of impulsivity in daily life. *Personality and Individual Differences*, *94*, 153–158. https://doi.org/10.1016/j.paid.2016.01.018

Spielberger, C. D. (1988). Manual for the state-trait anger expression scale (STAXI). *Odessa, FL: Psychological Assessment Resources*.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). Manual for the state-trait anxiety scale. *Consulting Psychologists*.

Stolzenberg, E. B., Aragon, M. C., Romo, E., Couch, V., McLennan, D., Eagan, M. K., & Kang, N. (2020). *The American Freshman: National Norms Fall 2019*. Los Angeles.

Van der Meer, T., Te Grotenhuis, M., & Pelzer, B. (2010). Influential cases in multilevel modeling: A methodological comment. *American Sociological Review*, *75*(1), 173–178. https://doi.org/10.1177/0003122409359166

Watson, D., & Clark, L. A. (1984). Negative affectivity: The disposition to experience aversive emotional states. *Psychological Bulletin*, *96*(3), 465–490. https://doi.org/10.1037/0033-2909.96.3.465

Whiteside, S. P., & Lynam, D. R. (2001). The five factor model and impulsivity: Using a structural model of personality to understand impulsivity. *Personality and Individual Differences*, *30*(4), 669–689. https://doi.org/10.1016/S0191-8869(00)00064-7

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/ hyperactivity disorder: A meta-analytic review. *Biological Psychiatry*, *57*, 1336–1346. https://doi.org/10.1016/j.biopsych.2005.02.006

Zakaria, A. (2014). On the Detection of Influential Outliers in Linear Regression Analysis. *American Journal of Theoretical and Applied Statistics*, *3*(4), 100. https://doi.org/10.11648/j.ajtas.20140304.14

Table 1. Baseline descriptive statistics.

Variable	Baseline N = 366
Race	
White	136 (37%)
Non-white	230 (63%)
Gender	
Male	191 (52%)
Female	175 (48%)
Age, yrs	18.26 (0.60)
Planning	3.45 (0.72)
Persistence	3.74 (0.62)
Negative Urgency	2.20 (0.70)
Stress	1.97 (0.41)
Trait Anger	1.79 (0.47)
Trait Anxiety	2.35 (0.23)

Note. Counts and percentages are shown for categorical variables (race, gender), and means and standard deviations are shown for continuous variables (age, planning, persistence, negative urgency, stress, trait anger, trait anxiety).

Table 2. Pearson correlations between covariates at all timepoints.

	stress.baseline	stress.4mo	stress.6mo	nurg.baseline	nurg.4mo	nurg.6mo	plan.baseline	plan.4mo	plan.6mo	per.baseline	per.4mo	per.6mo	age	tang	tanx
stress.baseline															
stress.4mo	0.53***														
stress.6mo	0.57***	0.73***													
nurg.baseline	0.44***	0.34***	0.36***												
nurg.4mo	0.40***	0.45***	0.44***	0.67***											
nurg.6mo	0.31***	0.39***	0.49***	0.58***	0.63***										
plan.baseline	-0.00	-0.01	-0.02	-0.21***	-0.10	-0.14									
plan.4mo	-0.07	0.07	0.07	-0.20**	-0.15	-0.18*	0.60***								
plan.6mo	-0.08	-0.03	0.03	-0.27***	-0.23**	-0.22**	0.48***	0.68***							
per.baseline	-0.23***	-0.24***	-0.28***	-0.34***	-0.36***	-0.27***	0.25***	0.33***	0.14						
per.4mo	-0.24**	-0.28***	-0.44***	-0.30***	-0.40***	-0.33***	0.16*	0.31***	0.15	0.69***					
per.6mo	-0.40***	-0.38***	-0.41***	-0.39***	-0.37***	-0.41***	0.11	0.32***	0.31***	0.61***	0.77***				
age	-0.06	-0.02	-0.07	-0.07	-0.06	-0.04	0.06	0.00	0.02	0.08	0.16*	0.15			
tang	0.34***	0.17**	0.16*	0.48***	0.36***	0.36***	-0.07	-0.03	-0.18*	-0.07	-0.06	-0.22**	-0.04		
tanx	0.14**	0.14*	0.13*	0.22***	0.09	0.15	0.11*	0.05	0.04	0.04	-0.07	0.06	-0.09	0.12*	

Note. Correlations between variables of interest (stress, negative urgency, planning, and persistence) collected at each of the three timepoints (baseline, 4-month follow-up, and 6-month follow-up) and continuous demographic variables (age, trait anger, and trait anxiety) collected at baseline. Nurg = negative urgency; plan = planning; per = persistence; tang = trait anger; tanx = trait anxiety.
*p < 0.05, **p < 0.01, ***p < 0.001

Table 3. Fixed and random effects in final models of confirmatory analyses.

Negative Urgency as the outcome variable							
	b	*SE*	*p*	LCL	UCL	*Variance*	*SD*
Fixed Effects							
Intercept	**2.15**	**0.05**	**< 0.001**	**2.06**	**2.24**		
Timepoint	**-0.05**	**0.02**	**< 0.001**	**-0.08**	**-0.02**		
Between-Person Stress	**0.61**	**0.08**	**< 0.001**	**0.45**	**0.78**		
Within-Person Stress	**0.35**	**0.08**	**< 0.001**	**0.19**	**0.50**		
Trait Anxiety	*0.30*	*0.12*	*0.01*	*0.07*	*0.54*		
Trait Anger	**0.49**	**0.06**	**< 0.001**	**0.37**	**0.61**		
Gender	0.02	0.05	0.71	-0.09	0.13		
Age	-0.03	0.05	0.49	-0.12	0.06		
Race	-0.01	0.06	0.89	-0.12	0.10		
Timepoint X Between-Person Stress	0.06	0.04	0.11	-0.01	0.14		
Random Effects							
Intercept						0.15	0.39
Residual						0.18	0.42

Planning as the outcome variable							
	b	*SE*	*p*	LCL	UCL	*Variance*	*SD*
Fixed Effects							
Intercept	**3.38**	**0.06**	**< 0.001**	**3.26**	**3.50**		
Timepoint	-0.01	0.02	0.77	-0.04	0.03		
Between-Person Stress	-0.23	0.13	0.07	-0.48	0.01		

Within-Person Stress	*0.19*	*0.09*	*0.04*	*0.01*	*0.37*
Trait Anxiety	*0.36*	*0.16*	*0.02*	*0.05*	*0.66*
Trait Anger	-0.14	0.08	0.08	-0.29	0.02
Gender	-0.02	0.07	0.76	-0.16	0.12
Age	0.09	0.06	0.15	-0.03	0.20
Race	0.11	0.07	0.16	-0.04	0.25
Timepoint X Between-Person Stress	-0.06	0.05	0.22	-0.16	0.04
Between-Person Stress X Race	**0.68**	**0.20**	**< 0.001**	**0.30**	**1.07**
Random Effects					
Intercept				0.29	0.54
Timepoint				0.02	0.13
Residual				0.20	0.44

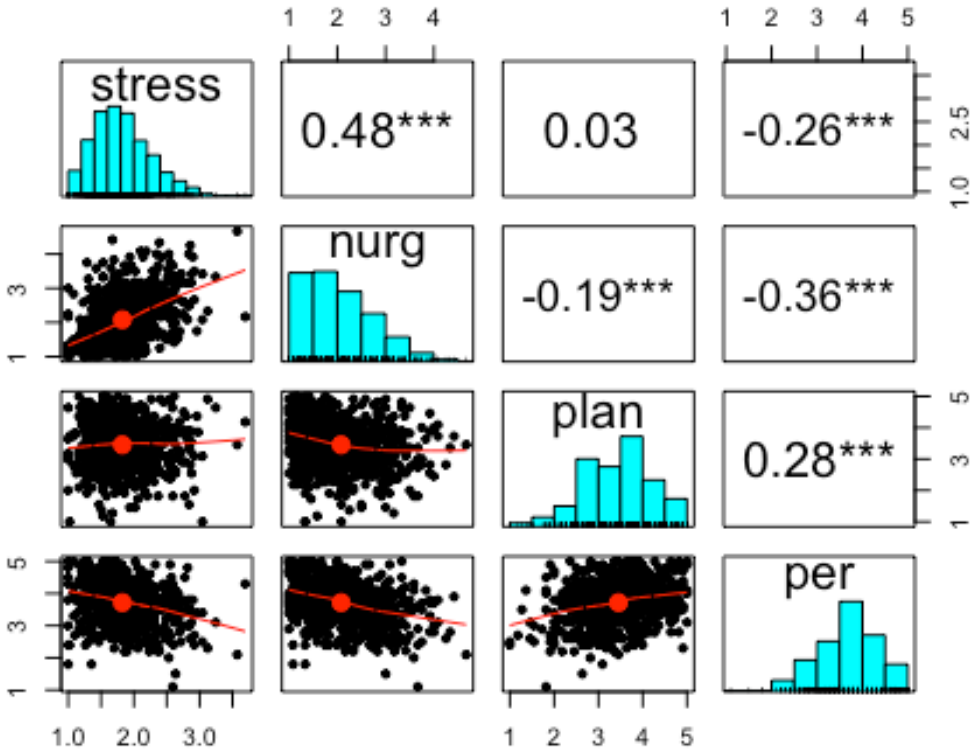
Persistence as the outcome variable

	b	*SE*	*p*	LCL	UCL	*Variance*	*SD*
Fixed Effects							
Intercept	**3.74**	**0.05**	**< 0.001**	**3.63**	**3.84**		
Timepoint	-0.03	0.01	0.06	-0.06	0.001		
Between-Person Stress	**-0.42**	**0.09**	**< 0.001**	**-0.60**	**-0.25**		
Within-Person Stress	-0.002	0.07	0.93	-0.14	0.14		
Trait Anxiety	0.26	0.13	0.05	< 0.001	0.52		
Trait Anger	-0.001	0.07	0.99	-0.13	0.13		
Gender	0.004	0.06	0.95	-0.12	0.12		
Age	*0.11*	*0.05*	*0.04*	*0.01*	*0.21*		
Race	0.001	0.06	0.98	-0.12	0.13		
Timepoint X Between-Person Stress	**-0.13**	**0.04**	**< 0.001**	**-0.21**	**-0.06**		

Random Effects			
	Intercept	0.26	0.51
	Timepoint	0.01	0.12
	Residual	0.11	0.33

Note. LCL = lower confidence limit; UCL = upper confidence limit. Final models include covariates.
Italicized predictors indicate $p < 0.05$; bolded predictors indicate $p < 0.01$.

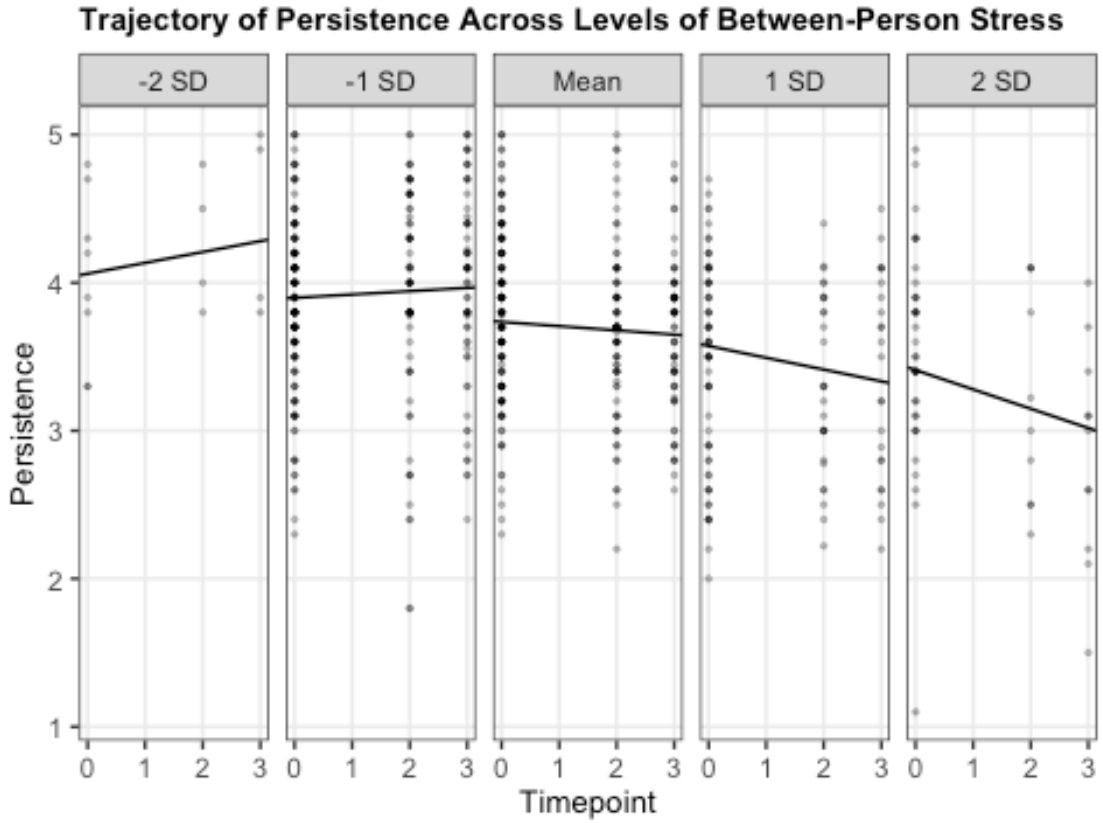
Figure 1. Correlations between stress and outcome variables of interest.



Note. Pearson's *r* is indicated in the boxes on the upper right of the figure. Nurg = negative urgency; plan = planning; per = persistence.

***p < 0.001

Figure 2. Interaction effects of between-person stress and timepoint on persistence**.**



Note. Along the x-axis, 0 = Baseline, 2 = 4-month follow-up, and 3 = 6-month follow-up. Each panel depicts the slope of persistence at different levels of between-person stress.