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## Psychosocial Functioning Among College Students Who Misuse Stimulants versus Other Drugs

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### Abstract

The misuse of prescription stimulants (e.g., Ritalin, Adderall) is a large and growing problem on college campuses. Emerging research examines not only the demographic predictors of stimulant misuse but also the potentially role that stimulant misuse plays in a college student's overall functioning and mental health. To better understand the experiences specifically linked with stimulant misuse rather than substance use more broadly, we tested whether psychosocial functioning differed across four groups of college students: those who do not misuse stimulants or other hard drugs; those who misuse both stimulants and other hard drugs; those who misuse stimulants but not other hard drugs; and those who misuse other hard drugs but not stimulants ( $N = 1534$ ; 40.3% male; 33.9% ethnic minority). Those who misused stimulants reported higher levels of impulsivity, as well as substance use consequences, than those who did not use any hard drugs. However, these differences were exacerbated among those who misused stimulants and other hard drugs. Taken together, these findings suggest that stimulant misuse typically occurs in a broader pattern of substance use, and that stimulant misusers generally fall along a continuum of substance use severity in terms of psychosocial functioning.

### 1. Psychosocial Functioning Among College Students Who Misuse Stimulants versus Other Drugs

The misuse of prescription stimulants by college students is on the rise, with 11.1% of the college students in the most recent Monitoring the Future study reporting misusing the prescription drug Adderall in the past 12 months, compared with 8.1% of their non-college-attending counterparts (Schulenberg, Johnston, Bachman, O'Malley, & Miech, 2019). Accordingly, research has focused on the goal of understanding why college students engage

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Author VTC wrote the first draft of the manuscript and conducted all data analyses. Author AMH collected all of the data used in the manuscript, had the original idea for this manuscript, and provided extensive edits on the first and subsequent drafts of this manuscript.

#### Conflicts of Interest

Both authors declare that they have no conflicts of interest to disclose.

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in prescription stimulant misuse, here defined as in Monitoring the Future as the use of stimulants (such as Adderall or Ritalin) without a doctor's orders (Schulenberg et al., 2019). This research places stimulant misuse in the context of broader patterns of developmental psychopathology, establishing relationships between stimulant misuse and a variety of affective, educational, and social correlates (e.g., McCabe, Veliz, Wilens, & Schulenberg 2017; Walters, Bulmer, Troiano, Obiaka, & Bonhomme, 2018; Wilens & Kaminsky, 2019). Although these studies provide a broad picture of factors associated with the misuse of stimulants, they do not address the question of specificity; that is, whether there are a unique set of risk factors and consequences for stimulant misuse or whether these associations reflect liability for substance misuse more generally. The current study compares a group of college students who misuse stimulants to their non-using counterparts, including those who use other drugs, to address this question.

### 1.1. Developmental Pathways to Stimulant Misuse

Developmental theories of substance misuse and disorder suggest that peak rates and stronger associations with psychopathology occur during emerging adulthood (Chassin, Sher, Colder, & Hussong, 2016). Among purported developmental liabilities for substance misuse are disinhibited or externalizing behavior (associated with the early starter's, externalizing or antisocial pathway to SUDs) and emotion dysregulation (associated with an internalizing pathway; Hussong, Rothenberg, Smith, & Haroon, 2018). These models suggest potential psychopathology correlates of substance misuse, perhaps including prescription stimulant misuse. If prescription stimulant misuse is more likely to occur in the context of the well-established externalizing pathway to SUD, college students who misuse stimulants should report higher levels of impulsivity, more frequent behavioral problems, and perhaps lower levels of achievement (Costello, 2007; King, Iacono, & McGue, 2004; Zucker, 2006). Similarly, if prescription stimulant misuse is more likely among those whose substance use is part of an internalizing pathway to SUD, college students who misuse stimulants should report higher levels of anxiety and depressive symptoms, and possibly social difficulties (Hussong et al., 2011).

Evidence for an externalizing pathway to stimulant misuse is emerging in the literature. Compared with controls, stimulant misusers show consistently higher levels of impulsivity (Grant, Redden, Lust, & Chamberlain, 2018; Wilens et al., 2019; Bensen, Woodlief, Flory, Sicheloff, Coleman, & Lamont, 2018). Stimulant misuse is also associated with a number of the more specific drivers of impulsive behavior, such as high levels of sensation seeking (Van Eck, Markle, & Flory, 2012; Lookatch, Dunne, & Katz, 2012). As these symptoms may also characterize attention deficit hyperactivity disorder (ADHD), such findings are also consistent with the hypothesis that college students with undiagnosed or untreated ADHD self-medicate with prescription stimulants (Arria et al., 2011; Peterkin, Crone, Sheridan, & Wise, 2011; Rabiner, Rabiner, Anastopoulos, Costello, Hoyle, McCabe, & Swartzwelder, 2009a; 2009b; Van Eck et al., 2012; Wilens, Zulauf, Martleton, Morrison, Yule, & Anselmo, 2016).

Stimulant misuse is also related to some of the educational sequelae of the externalizing pathway. Despite the fact that stimulant misuse is frequently motivated by a desire to

improve one's academic performance, stimulant misuse has either not been associated with academic performance (e.g., Advokat, Guildry, & Martino, 2011) or associated with underperformance (Arria, Wilcox, Caldeira, Vincent, & Garnier-Dykstra, 2013). This relationship is a complex one in a college sample, with some evidence that an escalating pattern of academic difficulties predicts the misuse of stimulants for studying (Arria et al., 2013). Similar associations have been observed prospectively, with adolescents who misuse stimulants showing lower educational attainment in adulthood (McCabe et al., 2017).

Though the externalizing pathway is robustly associated with stimulant misuse, a smaller but growing body of research examines the hypothesized links between prescription stimulant misuse and internalizing symptoms. Among American college students, misusers of prescription stimulants report higher rates of depressed mood, suicidal ideation, and anxiety (Dussault & Weyandt, 2013; Teter, Falone, Cranford, Boyd, & McCabe., 2010; Weyandt et al., 2009; Zullig & Divin, 2012; Walters et al., 2018). Similar findings have been observed internationally, with associations between stimulant misuse and distress and suicidal ideation in Belgian (Ponnet et al., 2013) and Chinese (Guo et al., 2016) samples.

In sum, prior research suggests that stimulant misuse may be associated with factors implicated in substance misuse in both the externalizing and internalizing pathways to substance use and disorder. However, much of this work has focused on correlates of stimulant misuse alone and not on whether there are unique associations of stimulant misuse with these factors above and beyond their association with substance misuse more generally.

## 1.2. Considering Stimulant Misuse in the Context of General SUD Liability

Developmental theories of substance use as a non-specific liability, such as problem-behavior theory (Jessor & Jessor, 1977; Jessor, 2014), argue that different forms of substance use and problem behaviors all arise from a common set of person and environmental risk factors. Consistent with this view, many factors associated with both the internalizing and externalizing pathways have been associated with misuse of a variety of substances (Hussong et al., 2018), making the specific correlates of stimulant misuse difficult to ascertain. Moreover, the demographic and academic correlates of stimulant misuse mirror substance use more generally, with the highest rates of misuse among students who are European American, male, and involved in Greek life (Arria et al., 2008; 2011; Dussault & Weyandt, 2013; Teter et al., 2003; 2005; McCabe et al., 2005; McCabe, 2008; Weyandt et al., 2009). Further complicating matters is the finding that prescription stimulant misuse is strongly associated with the use of other drugs such as alcohol, tobacco, marijuana, and cocaine (McCabe & Boyd, 2005; McCabe, Teter, & Boyd, 2006; Teter et al., 2005; 2010; Chen, Crum, Strain, Martins, & Mojtabai, 2015). This makes the disaggregation of stimulant-specific effects challenging in practice and suggests that there may be little specificity, with similar risk mechanisms underlying both prescription stimulant misuse and risky substance use more generally.

However, there are a number of reasons to consider the possibility that unique, drug-specific predictors and consequences characterize the misuse of prescription stimulants over and above these developmental mechanisms. By contrast to other drugs, the motivation for stimulant misuse is often to improve one's academic performance. The most commonly

endorsed reasons for misusing prescription stimulants pertain to academic enhancement, including the desire to study more, improve concentration, and perform better on tests (De Santis et al., 2008; Peterkin, Crone, Sheridan, & Wise, 2011; Rabiner et al, 2009a). Additionally, students who misuse stimulants report high levels of performance goal-orientation with respect to academics, indicating that stimulant misuse may be more likely among those who wish to be academically competitive (Antshel, Parascandola, Taylor, & Faraone, 2019). If college students are specifically motivated to misuse stimulants by a desire to increase academic performance (e.g., Arria et al., 2017; 2018), it may be that a student's academic life (including overall academic performance) plays a larger role than associated psychopathology in prescription stimulant misuse. It is not clear, however, whether findings regarding academic performance differ for those who misuse stimulants alone versus those who misuse other drugs of abuse as well.

The association between stimulant misuse and the goal of improving academic performance comes with two caveats. First, there is no evidence in prior studies of improved GPA among college students who misuse prescription stimulants (McCabe et al., 2005; Advokat et al., 2011; Benson et al., 2015). Indeed, prescription stimulant misuse is sometimes associated with academic underperformance (Arria et al., 2013). Second, it is worth noting that not all motives for prescription stimulant misuse concern academic performance. A minority of college students endorse non-academic motives for misusing prescription stimulants, including curiosity, a desire to get high, and appetite suppression (De Santis et al., 2008; Garnier-Dykstra et al., 2012; Lookatch et al., 2012). In one recent college sample, 30.7% endorsed recreational motives for stimulant misuse and 21.2% endorsed appetite and weight-related motives (Thiel, Kilwein, De Young, & Looby, 2019).

Taken together, these findings offer evidence that the misuse of stimulants may be associated with a different pattern of motives than other drugs. The extent to which these unique motives translate into different experiences and psychopathology correlates for stimulant misuse versus substance misuse more generally – including the affective, social, and behavioral elements of common pathways to substance use – requires a comparative approach that contrasts those who misuse stimulants with those who misuse other substances only or as well.

### 1.3. The Current Study

In the current study, we present a descriptive pooled analysis drawn from two undergraduate samples to investigate two aims. The first was to replicate and extend prior findings concerning the demographic correlates of stimulant misuse as well as use of other substances. The second was to assess the unique relations between indicators of psychopathology and risky social contexts with prescription stimulant misuse relative to other forms of substance use. In particular, we investigated whether and how college students who misuse prescription stimulants differ from not only their abstaining counterparts but also those who misuse other illicit substances but not prescription stimulants.

## 2. Methods

Data come from two coordinated studies of substance use and psychosocial development in college students, the Real Experiences and Lives in the University Study (REAL-U) and the Millennial Friendship Study (MFS; Hussong, Cole, Curran, Bauer & Gottfredson, in press).

### 2.1. Participants

Participants in both samples were college students aged 18–23 at a southeastern university in the United States. For the REAL-U study, we created a recruitment pool from a list of 8,995 undergraduates randomly sampled from university registrar records (with oversampling for males and African Americans who were underrepresented in the student body) and 57 undergraduates who contacted us directly about the study. We invited the resulting 9,052 students via email to complete a screening survey. Inclusion criteria were being age 18–23 and reporting alcohol use in the past year; 1,403 (15.4%) of those in the recruitment pool completed the screening survey prior to study completion, of whom 1,141 (81.3%) were eligible. Of those eligible to participate, 854 students (75%) completed the first session and 840 completed a two-week follow-up survey (for a 98% retention rate).

The MFS study focused on friendship dyads such that each participant (targets) completed the study with their self-identified best friend. Targets were recruited from participants in the REAL-U study as well as from a list of undergraduates sampled as in the REAL-U study and using the same inclusion criteria. Of 8,315 targets invited to participate or who contacted us about participating, 1,270 completed the screening survey and were eligible to participate, 923 completed the first session before recruitment ended and 922 completed both sessions.

For the purpose of this study, we consider only one member of each friendship dyad in MFS. Additionally, among subjects who participated in both MFS and REAL-U, only one observation (i.e., their record from either MFS or REAL-U) was chosen through random sampling, in order to generate two independent samples. Participants reported their ethnicity according to a list of specific descriptors as described below (in the “Demographics” section), which were collapsed into the broad categories shown in Table 1. In order to maintain adequate sample size, we considered only those who identified as some combination of these categories. Additionally, participants were dropped if they were missing any of the independent or dependent variables described below. This yielded a final sample size of  $N = 727$  for REAL-U and  $N = 807$  for MFS, and thus a sample size of  $N = 1534$  for the pooled sample. Sample composition in the final pooled sample was largely representative of the student population (see Table 1).

### 2.2. Procedure

In both studies, participants completed two sessions of self-report data collection spaced two weeks apart. Each session was a computerized battery designed to take 75 minutes. For the REAL-U study, participants attended study visits alone. For the MFS study, participants attended with their self-identified best friend. To address methodological aims of the parent study, participants in each session (for REAL-U and all targets in MFS) completed one of two surveys (Form A or B) that contained some scales that were altered from their original

form across surveys (creating a battery of altered measures) and others that were held constant over surveys in their original form (creating a standard battery; for details see, Cole, Bauer, & Hussong, 2017). Participants received \$20 for completing the first study visit and \$25 for completing the second study visit in both studies. All procedures were approved by our university's Institutional Review Board.

To avoid issues with nested observations, here we consider exclusively observations from the first study visit in each study. As described below, the majority of questions assessed the frequency of a particular behavior over the past year, or a subject's typical attitude or beliefs. Because of the short time between the first and second visit (two weeks), it was hypothesized that there would be no meaningful changes in most of the constructs we measured. To confirm the impression that the first and second study visits offer mostly redundant information, we report test-retest reliability for all multiple-item measures below.

### 2.3. Measures

With the exceptions of substance use quantity-frequency, drug use consequences, and depressive symptoms measures, all measures were administered identically across participants. These three exceptions were part of the altered battery; in the pooled sample  $N = 823$  participants completed Form A and  $N = 711$  completed Form B. To harmonize across multiple-item measures in the altered battery (depressive symptoms and drug use consequences), we scored these measures using moderated nonlinear factor analysis (MNLFA; Bauer & Hussong, 2009; Hussong, Curran, & Bauer, 2013; Curran et al., 2014; Bauer, 2017), an iterative model-testing and scoring procedure (as described by Gottfredson et al., 2018) that takes into account potential differential item functioning across groups (in this case survey form). Other procedures were needed to account for differences in substance use, including stimulant use, as noted below.

**2.3.1. Demographics**—Participants reported their biological sex and whether they identified as transgender. Participants reported whether they identified as Hispanic/Latinx using a binary item. Race was reported by asking participants to check all of the following descriptors which applied to them: *White, Black/African American, Alaska Native, Native Hawaiian, Guamanian, Samoan, Other Pacific Islander, Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, Other Asian, or Some other race* (Center for Disease Control, 2005). These descriptors were then collapsed into broad categories. As described above (in "Participants"), to maintain adequate sample size to make between-group comparisons, here we considered only participants who identified as Hispanic/Latinx of any race, Black/African American, Asian American, or White/European American. These categories were not mutually exclusive, and 13 participants identified with multiple categories.

**2.3.2. Substance use**—Past-year binge drinking, tobacco use, marijuana use, opioid and sedative use, cocaine use, and stimulant use were assessed using items from the Monitoring the Future study (Schulenberg et al., 2018). Participants were asked on how many occasions they engaged in a given behavior, with responses on a 7-point response scale ranging from never (0) to over 40 occasions (6). After examining the response distributions in our pooled sample, we collapsed over sparse item categories. Tobacco,

marijuana, cocaine, stimulant, and opioid/sedative use were converted to binary items which took a value of 1 if the participant had used the substance in the past year and 0 otherwise. Binge drinking retained its original 7-point scale.

Substance use measures were altered across test forms such that the item stem, but not response options, differed slightly for some items between the two test forms. For instance, in Form A, prescription stimulant misuse was assessed as the maximum of the following two items: *On how many occasions (if any) have you taken amphetamines on your own-- that is, without a doctor telling you to take them-- in your lifetime?* and *On how many occasions (If any) have you taken Adderall® (without a doctor's orders) in your lifetime?* In Form B, prescription stimulant misuse was assessed as the maximum of the following two items: *In your lifetime, how often have you used stimulants or amphetamines?* and *In your lifetime, how often have you taken Ritalin® or Adderall® in ways not prescribed for you by a doctor? (Do not include taking less than was prescribed for you.)* Similar alterations were made to items assessing opioids, sedatives and tobacco.

Due to the few items on these measures, MNLFA was not possible and logical harmonization was the only way to reconcile responses across test forms (Hussong, Curran, & Bauer, 2013). To evaluate the assumption of logical harmonization, we compared endorsement rates of altered stimulant, opioid/ sedative, and tobacco use items administered to a subsample of REAL-U participants over a two-week interval. First, among those who answered the same test form (i.e., Form A or B exclusively), the agreement rate (test-retest reliability rate for the identical item administration) was 97.8% for the endorsement of cocaine use, 96.2% for opioid/sedative use, and 97.1% for stimulant misuse. Among those who answered the different test forms (i.e., either Form A in Visit 1 and Form B in Visit 2 or vice-versa), the agreement rate (parallel forms reliability) was 98.7% for cocaine use, 94.8% for opioid/sedative use, and 95.2% for stimulant misuse. Given minimal differences in test-retest and parallel forms reliability indices, we felt logical harmonization was supported. However, to provide a conservative test of hypotheses, we included an indicator of form (A or B) as a between-subjects covariate in subsequent analyses and tested interactions between substantive predictors and form as related to outcomes.

**2.3.3. Academic performance**—Participants reported their past-year college GPA on a four-point scale. Importantly, because past-year college GPA was not available for first-year students, analyses predicting GPA was only conducted on sophomores, juniors, and seniors ( $N=1151$ ).

**Greek life:** Participants responded to binary items assessing whether they participated in social fraternities or sororities (including as a pledge) (Presley, Meilman, & Lyerla, 1994).

**Impulsivity:** Impulsivity was assessed using the Urgency Premeditation Planning Sensation Seeking Impulsivity Scale (UPPS-R; Whiteside & Lynam, 2001) and the Positive Urgency Measure (Cynders, Smith, Spillane, Fischer, Annus, & Peterson, 2007). Items were 26 statements indexing negative urgency (12 items) and positive urgency (14 items). Negative urgency represents the tendency to behave rashly in response to negative affect, and is measured by items such as: *When I am upset I often act without thinking*. Positive urgency

represents the tendency to behave rashly in response to positive affect, and is measured by items such as: *When I am really ecstatic I tend to get out of control*. This scale showed high levels of internal consistency ( $\alpha = .88$  for negative urgency;  $\alpha = .93$  for positive urgency) and test-retest reliability ( $r = .80$  for negative urgency;  $r = .73$  for positive urgency) and a mean score of items formed each scale. Both scales were standardized to have a mean of 0 and a standard deviation of 1.

**2.3.4. Depressive symptoms**—Depressive symptoms were assessed using the Short Mood and Feelings Questionnaire (SMFQ; Angold, Costello, Messer, & Pickles, 1995). Items were 13 statements describing a given depressive symptom (e.g., *I felt lonely* or *I didn't enjoy anything at all*). Participants were asked how frequently each statement described them in the past year, using a 3-point response scale (“not true,” “sometimes,” “true”). This scale was altered between Test Form A and Test Form B, such that half of the item stems differed between forms (e.g., *I cried a lot* in Test Form A and *I had crying spells* in Test Form B). Iterative MNLFA testing revealed DIF on the intercept parameters for eight items (average increment in log-odds associated with Test Form B = 0.56), of which four also showed DIF for loading parameters (average increment in log-odds associated with Test Form B = -0.44). Final scores, which adjusted for DIF, were scaled to have a mean of 0 and a variance of 1. Scales showed high levels of internal consistency ( $\alpha = .91$  in Test Form A;  $\alpha = .92$  in Test Form B) and test-retest reliability ( $r = .80$  in Test Form A;  $r = .85$  in Test Form B).

**2.3.5. Substance use consequences**—Consequences for substance use were assessed using an adapted version of the Rutgers Alcohol Problems Index (RAPI; White & Labouvie, 1989). Items were 23 statements describing a given consequence of using drugs (e.g., *Went to work or school high* or *Wanted to stop using drugs but couldn't*). Participants were asked to indicate the number of times they had experienced that consequence in the previous year on a four-point response scale (ranging from “none” to “five or more times”). Due to relatively sparse response, items were recoded as binary measures which took a value of 1 if the participant had experienced the consequence in the past year and 0 otherwise. Participants who reported no substance use (other than drinking) in the past year were given an automatic score of zero. This scale was altered between Test Form A and Test Form B, such that half of the item stems differed test forms (e.g., *Caused shame or embarrassment to someone* in Test Form A and *Made others ashamed by your drug use behavior or something you did when using drugs* in Test Form B). Iterative MNLFA testing revealed DIF on the intercept parameters for five items (average increment in log-odds associated with Test Form B = 0.61), of which three also showed DIF for loading parameters (average increment in log-odds associated with Test Form B = -0.63). Final scores, which adjusted for DIF, were scaled to have a mean of 0 and a variance of 1. Scales showed high levels of internal consistency ( $\alpha = .88$  in Test Form A;  $\alpha = .86$  in Test Form B) and test-retest reliability ( $r = .75$  in Test Form A;  $r = .75$  in Test Form B).

## 2.4. Analytic procedure

Analyses addressing aim 1 were descriptive and included calculating conditional rates of stimulant misuse according to demographic characteristics and other forms of substance use



with the goal of replicating prior findings (Arria et al., 2008; 2011; Dussault & Weyandt, 2013; McCabe et al., 2008; Rabiner et al., 2009a; 2009b; Teter et al., 2005; Weyandt et al., 2009). Analyses addressing aim 2 tested whether students who misuse stimulants differ from those who misuse other hard drugs (in addition to or without stimulant misuse) on potential risk factors and consequences. We excluded common, gateway drugs from this comparison based on prevalence rates (see Table 2) and prior research suggesting that more common drugs (e.g., alcohol, tobacco, and marijuana) may have different correlates than hard drugs. Following stage theory (Kandel & Yamaguchi, 1999) we define gateway drugs as alcohol, tobacco, and marijuana; and hard drugs as cocaine, opioids, and sedatives. Notably, those who misused stimulants were more likely to also use more common gateway drugs in particular, making the unique relationship between stimulant misuse and the outcomes of interest harder to quantify. To address this question, we created four groups: (1) participants who misused stimulants in the past year but not other hard drugs (here, cocaine or opioids/sedatives;  $N=136$ ); (2) participants who misused hard drugs in the past year but not stimulants ( $N=93$ ); (3) participants who misused both stimulants and other hard drugs in the past year ( $N=169$ ); and (4) participants who misused neither stimulants nor hard drugs in the past year ( $N=1163$ ).

We used these groups in a series of generalized linear models, corresponding to linear regression for continuous outcomes and logistic regression for categorical and ordinal outcomes, which included the following predictors: stimulant use group, survey form, the interaction between stimulant use group and survey form, sample membership (i.e., MFS vs. REAL-U), sex, race, and year in school. Psychosocial outcomes included z-scores for positive and negative urgency, MNLFA scores for depressive symptoms and past-year drug consequences, and GPA. Substance use outcomes included the use of tobacco (binary), marijuana (binary), and binge drinking (ordinal). Finally, participation in Greek life was also tested as a potential outcome.

Because we did find some main effects of study membership on a number of outcomes (as described below), we conducted a set of sensitivity analyses which also included interaction terms between study membership and the substance use groupings. In these analyses, there were significant interactions between study membership and substance use groupings for both fraternity membership and positive urgency. These interactions were small in magnitude and reflected the same pattern of differences between stimulant misusers and other groups across studies as are described here; differences were significant in both studies, but generally greater in magnitude in the MFS sample. These findings indicate that the results reported below replicate across our two studies. (Complete results for positive urgency and fraternity membership, including an interaction term, are available from the first author upon request).

### 3. Results

#### 3.1. Aim 1: Rates of stimulant misuse by demographic group

Relative rates of stimulant misuse according to sex, race, and year in school are presented in Table 2. Being male was associated with a 2.17-fold increase in the odds of stimulant misuse (95% CI [1.68, 2.79]). No effects of year in school were found. European American

participants reported odds of using stimulants that were 1.86 times higher (95% CI [1.26, 2.76]) than African Americans; though stimulant misuse was most common in Hispanic/Latinx participants, this group did not significantly differ in their rates of use from others.

### 3.2. Aim 2: Patterns of risk factors and consequences

Table 3 shows the results of linear regression models predicting psychosocial functioning outcomes; Table 4 shows the corresponding results of logistic regression models predicting substance use and activity participation. In all models, stimulant misusers were the reference category. Notably, no significant interactions between stimulant misuse groupings and survey form were significant across analyses and a main effect of survey form was only present in predicting tobacco use (an item from the altered battery).

However, there were differences between the stimulant misuse groupings in overall level of drug use consequences as well as in positive and negative urgency. Stimulant misusers had higher rates of drug use consequences than non-users (of stimulants and hard drugs;  $b = -0.59, p < .001$ ) and lower rates than those using both stimulants and hard drugs ( $b = 0.66, p < .001$ ). There were no differences between those who misused stimulants only and those who used only other drugs. Stimulant misusers also showed higher levels of positive ( $b = -0.27, p < .01$ ) and negative ( $b = -0.22, p < .05$ ) urgency than those who used neither stimulants nor hard drugs, as well as lower levels of negative (but not positive) urgency than those who used both ( $b = 0.26, p < .01$ ). There were also no group differences in depressive symptoms or GPA.

Stimulant misusers were also more likely than nonusers ( $OR = 0.36, p < .001$ ), but less likely than those who used both stimulants and other drugs ( $OR = 1.67, p < .001$ ), to be members of fraternities or sororities. Patterns for tobacco use, marijuana use, and binge drinking produced similar results. Stimulant misusers were more likely than nonusers to use tobacco ( $OR = 0.34, p < .001$ ), use marijuana ( $OR = 0.17, p < .001$ ), and binge drink ( $OR = 0.25, p < .001$ ) as well as less likely than those who used both stimulants and other hard drugs to do so ( $OR = 4.33, p < .001, OR = 3.10, p < .001, and OR = 3.21, p < .001$ , respectively).

## 4. Discussion

The current study tested whether stimulant misuse was linked to a specific pattern of psychosocial functioning and psychopathology, relative to other types of substance use, among college students. First, in order to establish the validity of our measure of stimulant misuse, we successfully replicated prior findings relating stimulant misuse to basic demographic and behavioral correlates and other substance use. We then sought to isolate the unique effects of stimulant misuse by comparing those who misused stimulants to those who used other substances, either alone or in combination with stimulants. However, differences were essentially observed not on the basis of type of substance used but on overall level of substance use, with stimulant misusers falling between non-users and users of hard drugs in terms of internalizing and externalizing psychopathology as well as overall psychosocial functioning. This work follows recent studies which seek to classify adults who use prescription drugs into meaningful subtypes characterized by different demographic

and psychosocial features (e.g., McCabe, Wilens, Boyd, Chua, Voepel-Lewis, & Schepis, 2019).

The first task of the study was to replicate prior findings linking stimulant misuse to its well-known demographic and substance use correlates. As has been consistently observed elsewhere, misuse of prescription stimulants was most common among male college students (Arria et al., 2008; 2011; Dussault & Weyandt, 2013; McCabe et al., 2008; Teter et al., 2003; 2005) and fraternity or sorority members (De Santis, Noar, & Webb, 2009; Weyandt et al., 2009). Additionally, there were robust links between stimulant misuse and the use of other drugs (Arria et al., 2008), suggesting that, at least among those who have initiated alcohol use, stimulant misuse is unlikely an isolated form of substance use but is more often part of a broader pattern of drug use. Indeed, we found fewer students who reported use of hard drugs and no stimulant misuse ( $N=93$ ) than stimulant misuse alone ( $N=136$ ). Replicating these known relationships was an important prerequisite to investigating specific differences on the basis of stimulant misuse, as it provided evidence of the validity of inferences regarding stimulant misuse in this sample.

Our results suggested little specificity in the risk profile of those who misuse prescription stimulants versus other drugs (Arria et al., 2011; Zullig & Divin, 2012; Guo et al., 2016). When comparing those who used prescription stimulants only to those who misused other drugs only, no differences were observed. Our small sample of hard drug users reporting no stimulant misuse may partly explain the lack of differences between those who misuse prescription stimulants only and those who use other hard drugs only. However, it may also be the case that these two groups of substance users are very similar in their risk profile. This result is consistent with recent findings that trajectories of prescription drug misuse are quite similar across different drug classes, with comparable findings across stimulants, opioids, and sedatives (McCabe, Veliz, Dickinson, Schepis, & Schulenberg, 2019). It is also consistent with the finding that, like those who misuse stimulants, adolescents who misuse other prescription drugs such as sedatives and opioids are at increased risk with respect to drug consequences, alcohol and tobacco use, depression, and academic performance (Zullig & Divin, 2012; Guo, 2016).

This study does not provide evidence that a distinct pattern of externalizing and internalizing symptomatology characterizes stimulant misusers. As has consistently been found elsewhere, stimulant misuse was associated with a risk pattern characterized by higher levels of behavioral undercontrol and impulsivity (Grant, Redden, Lust, & Chamberlain, 2018; Wilens et al., 2019; Benson, Woodlief, Flory, Sicheloff, Coleman, & Lamont, 2018), indicating stimulant misuse which occurs in the context of externalizing psychopathology (King, Iacono, & McGue, 2004). However, although these findings may be consistent with the suggestion that prescription stimulant misuse is associated with the self-medication of ADHD-like symptoms, this risk pattern was not specific to prescription stimulant misuse but associated with the use of other hard drugs as well. Additionally, no relationship between stimulant misuse and depressive symptoms was found, providing no evidence of a pathway to stimulant misuse characterized by internalizing psychopathology (Hussong et al., 2018).

At the same time, these results suggest that there is heterogeneity among those who misuse stimulants based on whether or not they engaged in any other hard drug use. The group of students who misused stimulants and other hard drugs showed increased psychosocial risk relative to those who misused prescription stimulants only, including higher drug use consequences, negative urgency and use of tobacco, marijuana and binge drinking as well as heavier engagement in Greek life. This elevated risk profile might be due to severity associated with polydrug use, such that these individuals have used substances longer and more heavily and thus are further along in a drug use trajectory (Tucker, Ellickson, Orlando, Martino, & Klein, 2005; Chen et al., 2015; Derefinko, Charnigo, Peters, Adams, Milich, & Lynam, 2016). Results for a number of outcomes suggest that the substance use groups were arranged on a continuum of severity with those who did not use stimulants or any hard drugs at one end, those who misused both prescription stimulants and other hard drugs at the other end, and misusers of either prescription stimulants or other hard drugs (but not both) in the middle. It is perhaps unsurprising that substance use consequences, binge drinking, tobacco use, and marijuana use followed this pattern, as these constructs typically track with overall substance use severity (e.g., Degenhardt, Hall, & Lynskey, 2001; Moss, Chen, & Yi, 2007). Interestingly, this would suggest that misuse of prescription stimulants conveys risks in the context of polydrug use that compound those of hard drug use alone.

This study possesses a number of important limitations. Perhaps most notably, because all variables were measured at the same time, causality cannot be inferred from any of the relationships observed. In particular, these results should not be taken as evidence of any temporally-ordered developmental mechanism, as many of these variables (e.g., depressive symptoms or low GPA) could justifiably be considered as either predictors or outcomes of stimulant misuse. This also prohibited the testing of mediation and other time-ordered processes which could provide greater insight into how stimulant misuse unfolds. Additionally, it should be noted that these results are only generalizable to the population represented by our sample, which comprised students at a large, public, predominantly European American university.

Notwithstanding these limitations, the current analysis provides a clearer picture of psychosocial development among college students who misuse prescription stimulants, providing tentative evidence that stimulant misusers fall along a continuum of symptoms characterized by increased drug consequences and poor impulse control. The similarity between risk profiles for stimulant misuse and other substance use provides tentative evidence that brief interventions which have shown promise in deterring other risky behaviors, such as binge drinking, may be adapted for stimulant misuse. Future studies may evaluate whether this is indeed the case. Additionally, future work must focus on elucidating the mechanism by which stimulant misuse develops. Such work may involve examining the relationships between different domains of impulse control and more proximal predictors of stimulant misuse, such as motives for misuse (Thiel et al., 2019). Further work will require longitudinal analyses assessing a wide variety of domains over a student's college career.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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### Highlights

- Prescription stimulant misuse is linked with the use of marijuana, tobacco, alcohol, and hard drugs among college students.
- Higher levels of stimulant misuse were associated with increased impulsivity and substance use consequences.
- Stimulant misusers appear similar to users of other hard drugs (e.g., cocaine, opioids) in terms of overall risk.
- Findings support a common set of psychosocial risks associated with both stimulant misuse and other drug use.

**Table 1.**

Demographic Characteristics of the Sample

	UNC Fall 2014 Undergraduates		Pooled Sample	
	N	%	N	%
	N = 18,350		N = 1534	
Gender				
Male	7,763	42.3	617	40.2
Female	10,587	57.7	917	59.8
Age				
18	3,739	20.4	253	16.6
19	4,100	22.3	366	24.0
20	4,217	23.0	337	22.1
21	3,928	21.4	394	25.8
22	776	4.2	160	10.5
23	257	1.4	18	1.2
Race/Ethnicity				
Hispanic – Any Race	1,351	7.4	98	6.4
American Indian or Alaska Native			6	0.4
Asian	1,717	9.4	180	11.8
Black/African-American	1,543	8.4	226	14.8
White/Caucasian	11,903	64.9	1012	66.1
Two or More Races	776	4.2	82	5.4
Other/Unknown	460	2.5	24	1.6
Classification				
First-Year	4,397	24.0	378	24.6
Sophomore	3,909	21.3	360	23.5
Junior	4,578	24.9	343	22.4
Senior	5,024	27.4	453	29.5
	Mean	SD	Mean	SD
Cumulative GPA	3.17		3.29	0.472

Note: UNC = University of North Carolina, Chapel Hill. The race/ethnicity classifications used in the current study are different from those used by UNC's Office of Institutional Research and Assessment as described in the Measures section.

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**Table 2.**

Rates of stimulant misuse by demographics.

	<b>Prevalence of Stimulant Misuse</b>		<b>Chi-Squared Test of Independence</b>		
	<b>Battery A</b>	<b>Battery B</b>	$\chi^2$	df	<i>p</i>
Sex			35.74	1	<.001
Male	29.62%	24.91%			
Female	15.23%	14.35%			
Race/Ethnicity			15.95	3	0.002
European American	21.28%	20.88%			
Asian American	27.84%	12.84%			
African American	9.38%	14.82%			
Hispanic/Latinx	32.07%	24.44%			
Year in school			4.52	3	0.2106
First-year	18.78%	13.26%			
Sophomore	20.87%	20.13%			
Junior	22.75%	19.48%			
Senior	21.21%	21.62%			

**Table 3.**

Linear models predicting psychosocial outcomes from stimulant misuse and covariates.

Predictors	Outcomes														
	Drug Consequences			Positive Urgency			Negative Urgency			Depressive Symptoms			GPA		
	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p
Intercept	0.38	0.23 – 0.52	<0.001	0.26	0.05 – 0.47	0.017	0.38	0.17 – 0.60	0.001	0.03	-0.18 – 0.24	0.781	3.22	3.09 – 3.36	<0.001
Demographics															
Race															
Asian American	0.02	-0.08 – 0.12	0.739	0.32	0.18 – 0.46	<0.001	0.04	-0.11 – 0.18	0.632	0.14	-0.00 – 0.28	0.056	0	-0.07 – 0.08	0.939
African American	0.2	0.11 – 0.30	<0.001	0.12	-0.01 – 0.26	0.076	0.05	-0.09 – 0.19	0.484	0.12	-0.01 – 0.25	0.078	-0.47	-0.54 – -0.40	<0.001
Hispanic/Latino	-0.05	-0.19 – 0.09	0.455	0.02	-0.18 – 0.22	0.868	-0.06	-0.27 – 0.14	0.554	0.08	-0.12 – 0.27	0.434	-0.12	-0.22 – -0.01	0.027
Male	0.16	0.09 – 0.23	<0.001	0.26	0.16 – 0.36	<0.001	-0.05	-0.15 – 0.06	0.381	-0.27	-0.37 – -0.17	<0.001	-0.02	-0.08 – 0.03	0.395
Year in school	-0.04	-0.07 – -0.01	0.004	-0.06	-0.10 – -0.01	0.008	-0.06	-0.10 – -0.01	0.012	0.01	-0.03 – 0.05	0.527	0.03	0.00 – 0.06	0.032
Study effects															
MFS vs. REAL-U	0.06	-0.01 – 0.13	0.101	-0.22	-0.32 – -0.12	<0.001	-0.18	-0.28 – -0.08	0.001	-0.05	-0.15 – 0.04	0.287	0.03	-0.02 – 0.08	0.276
Test Form B	-0.04	-0.15 – 0.07	0.494	0.07	-0.09 – 0.23	0.415	0.07	-0.10 – 0.23	0.44	0.05	-0.11 – 0.21	0.529	0.01	-0.08 – 0.09	0.846
Comparisons to stimulant-only group															
Main effects															
Other hard drugs only	0.01	-0.16 – 0.19	0.877	-0.11	-0.37 – 0.15	0.399	-0.12	-0.38 – 0.14	0.375	0.08	-0.17 – 0.33	0.551	0.08	-0.05 – 0.21	0.224
Both stimulants and other hard drugs	0.66	0.51 – 0.82	<0.001	0.21	-0.01 – 0.43	0.056	0.26	0.03 – 0.49	0.024	0.15	-0.07 – 0.36	0.178	-0.03	-0.14 – 0.09	0.634
Neither stimulants nor other hard drugs	-0.59	-0.71 – -0.47	<0.001	-0.27	-0.44 – -0.09	0.003	-0.22	-0.40 – -0.05	0.014	0.04	-0.13 – 0.20	0.679	0.07	-0.02 – 0.16	0.139
Interactions with test form															

*Outcomes*

Predictors	Drug Consequences			Positive Urgency			Negative Urgency			Depressive Symptoms			GPA		
	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p
Other hard drugs only	0.03	-0.15 – 0.21	0.738	-0.23	-0.48 – 0.03	0.078	-0.25	-0.51 – 0.01	0.059	-0.06	-0.30 – 0.19	0.659	-0.03	-0.16 – 0.10	0.631
Both stimulants and other hard drugs	0.02	-0.13 – 0.17	0.787	-0.2	-0.42 – 0.02	0.072	-0.06	-0.28 – 0.16	0.602	-0.01	-0.23 – 0.20	0.918	-0.03	-0.14 – 0.08	0.612
Neither stimulants nor other hard drugs	0.06	-0.06 – 0.18	0.35	-0.1	-0.28 – 0.07	0.234	-0.08	-0.25 – 0.10	0.399	0.04	-0.12 – 0.21	0.609	0	-0.09 – 0.09	0.982
Observations			1534			1534			1534			1534			1151
R <sup>2</sup> / adjusted R <sup>2</sup>			0.302 / 0.296			0.082 / 0.074			0.036 / 0.028			0.033 / 0.025			0.154 / 0.144

Generalized linear models predicting fraternity membership and substance use outcomes from stimulant misuse groupings and control variables.

Table 4.

Predictors	Outcomes											
	Fraternity/Sorority Membership			Tobacco Use			Marijuana Use			Binge Drinking		
	Odds Ratios	CI	P	Odds Ratios	CI	P	Odds Ratios	CI	P	Odds Ratios	CI	P
Intercept	0.65	0.40 – 1.06	0.082	1.11	0.68 – 1.82	0.668	1.45	0.88 – 2.39	0.149			
Response category intercepts (ordinal binge drinking only)												
(Intercept: 0 1)										0.11	0.07 – 0.17	<0.001
(Intercept: 1 2)										0.31	0.21 – 0.46	<0.001
(Intercept: 2 3)										0.61	0.41 – 0.91	0.015
(Intercept: 3 4)										1.06	0.71 – 1.56	0.788
(Intercept: 4 5)										2.96	1.99 – 4.41	<0.001
(Intercept: 5 6)										12.96	8.41 – 19.95	<0.001
Demographics												
Race												
Asian American	0.72	0.50 – 1.04	0.08	0.5	0.35 – 0.72	<0.001	0.64	0.43 – 0.95	0.027	0.49	0.38 – 0.65	<0.001
African American	0.48	0.32 – 0.71	<0.001	0.75	0.54 – 1.04	0.086	1.38	0.98 – 1.94	0.065	0.55	0.43 – 0.70	<0.001
Hispanic/Latino	1.01	0.63 – 1.62	0.958	0.65	0.39 – 1.07	0.093	0.97	0.58 – 1.63	0.913	0.74	0.51 – 1.08	0.122
Male	0.95	0.74 – 1.23	0.703	3.17	2.49 – 4.02	<0.001	2	1.55 – 2.59	<0.001	1.97	1.63 – 2.37	<0.001
Year in school	0.96	0.87 – 1.07	0.494	0.93	0.84 – 1.03	0.172	0.91	0.82 – 1.02	0.105	1.11	1.03 – 1.20	0.01
Study effects												
MFS vs. REAL-U	1.72	1.33 – 2.21	<0.001	0.79	0.62 – 1.00	0.052	0.77	0.60 – 1.00	0.054	1.21	1.00 – 1.45	0.046
Test Form B	0.93	0.65 – 1.32	0.665	0.67	0.46 – 0.96	0.029	0.96	0.68 – 1.37	0.84	0.97	0.73 – 1.31	0.861
Stimulant misuse groupings												
Main effects												
Other hard drugs only	0.68	0.38 – 1.20	0.183	1.31	0.74 – 2.31	0.347	1.3	0.74 – 2.26	0.362	1.19	0.74 – 1.92	0.464
Both stimulants and other hard drugs	1.67	1.04 – 2.68	0.035	4.33	2.45 – 7.67	<0.001	3.1	1.82 – 5.29	<0.001	3.21	2.13 – 4.83	<0.001
Neither stimulants nor other hard drugs	0.36	0.25 – 0.53	<0.001	0.34	0.23 – 0.51	<0.001	0.17	0.12 – 0.25	<0.001	0.25	0.18 – 0.34	<0.001
Interactions with test form												

<i>Predictors</i>	<i>Outcomes</i>											
	Fraternity/Sorority Membership			Tobacco Use			Marijuana Use			Binge Drinking		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Other hard drugs only	0.91	0.51 – 1.59	0.729	1.45	0.82 – 2.54	0.199	1.12	0.65 – 1.95	0.682	0.88	0.55 – 1.42	0.601
Both stimulants and other hard drugs	1.11	0.69 – 1.78	0.664	1.67	0.95 – 2.96	0.077	0.91	0.53 – 1.55	0.73	0.9	0.61 – 1.35	0.613
Neither stimulants nor other hard drugs	1.07	0.73 – 1.58	0.713	1.44	0.98 – 2.12	0.066	1.01	0.69 – 1.48	0.96	0.96	0.70 – 1.31	0.78
Observations			1534			1534			1534			1534
Tjur's R <sup>2</sup>			0.095			0.224			0.259			0.281