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Who Persists and Who Desists? A Prospective Study of Prescription Stimulant Misuse in College Graduates [post-print]

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A Prospective Study of Prescription Stimulant Misuse in College Graduates

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ABSTRACT

Prescription stimulant misuse (PSM) has been studied extensively in college populations, but few studies have examined how PSM changes after graduation. We used a longitudinal design to follow individuals at risk for PSM two years after college graduation to document PSM prevalence, motives, and predictors of PSM persistence. Participants from two small, private colleges completed online surveys focused on intrapersonal, interpersonal, and sociocultural predictors of PSM. Overall, PSM declined over time. Lack of premeditation, perceived peer norms, positive expectancies, media exposure, and other substance use were associated with continued PSM; however, only lack of premeditation, descriptive norms, and other substance use predicted PSM in a multivariate model. This preliminary study suggests dispositional and behavioral risk factors may help to explain why PSM persists after college. Interventions that enhance decision-making skills, correct misperceptions about peers' PSM, and reduce polysubstance use may be effective in curbing PSM in college graduates.

INTRODUCTION

Prescription stimulant misuse (PSM), which is the use of medications typically used to treat attention-deficit hyperactivity disorder (ADHD)(e.g., Adderall, Ritalin) without a prescription or in ways not prescribed (McCabe et al., 2014), has been increasingly recognized as a behavior of concern in emerging adults, or individuals between the ages of 18 and 25 (Faraone et al., 2020). A meta-analysis of 30 studies focused on college students showed an estimated lifetime PSM prevalence of 17% (Benson et al., 2015). Prescription stimulants increase focus and concentration and thus, the predominant motive for use and misuse is often to improve academic performance, even in people without diagnosed ADHD (Judson & Langdon, 2009), despite longitudinal research suggesting that PSM is not associated with improvements in college grade point average (Arria et al., 2017). PSM continues for a subset of individuals after the academic pressures of college have ended (Sales et al., 2019; Schwarz, 2015). Indeed, over half of college graduates who misused stimulants in college continued after college, despite plans or expectations to stop (Holt & McCarthy, 2020; Underhill & Langdon, 2013). Additionally, PSM is becoming more common across a wide range of workplaces (Leon et al., 2019; Sales et al., 2019), suggesting more research is needed to understand how PSM changes after college. Although prevalence estimates of PSM typically are lower in college graduates (2-12%; Emanuel, 2013; McNiel et al., 2011; Schepis et al., 2018; Tuttle, 2010; Underhill & Langdon, 2013; Verdi et al., 2016), examining prevalence longitudinally and identifying predictors of continued PSM is critical to help graduates avoid negative outcomes including insomnia, palpitations, sweating, depression, and anxiety (Sales et al., 2019) and chronic problems such as other substance use disorders later in adulthood (McCabe et al., 2019).

Motivations for PSM after college are similar to motivations in college and include a desire to improve attention, increase alertness, and facilitate completion of academic or work-related tasks (Emanuel, 2013; Holt & McCarthy, 2020; McNiel et al., 2011; Tuttle, 2010; Verdi et al., 2016). The full range of graduates' non-academic motives for PSM may not be well understood, however, since much of the extant research on graduates has focused on individuals in graduate or professional programs. Indeed, a recent qualitative study of employed adults (Sales et al., 2019) highlighted the prominence of

recreational, in addition to cognitive enhancement motives. For example, more than half of participants reported co-ingesting stimulants with alcohol to reduce alcohol's depressant effects, suggesting PSM after college is not motivated solely by a desire to enhance productivity.

The Theory of Triadic Influence (TTI, Flay & Petraitis, 1994) purports that health behavior results from a complex interplay of intrapersonal, interpersonal, and sociocultural influences (Bavarian et al., 2014). The limited research on PSM in college graduates has found that numerous constructs from the TTI predicted PSM after college. In the intrapersonal domain, which focuses on more stable influences such as demographic and personality characteristics, male gender (Emanuel, 2013), sensation seeking (Holt & McCarthy, 2020), anxiety, stress (Verdi et al., 2016), and lower emotional stability (Baum et al., 2021) predicted PSM in college graduates. In the interpersonal domain, which describes how social contexts affect behavior (Bavarian et al., 2014), a perception that more of one's close friends misused prescription stimulants (i.e., descriptive norms) was associated with greater likelihood of PSM after college (Holt & McCarthy, 2020; Underhill & Langdon, 2013). Injunctive norms, or perceptions that one's social circle is more approving of PSM, also are important to examine given their relation to PSM in prior research (Bavarian et al., 2013a; Silvestri & Correia, 2016). Finally, in the sociocultural domain, work-related pressure (Franke et al., 2013; Holt & McCarthy, 2020), a lack of work-life balance (Baum et al., 2021), and positive expectancies for the effects of prescription stimulants (Holt & McCarthy, 2020) were associated with PSM after college. Other substance use, classified in the TTI as a "related behavior," also has been a consistent predictor of PSM in college students (Arria et al., 2008; Bavarian et al., 2015; Benson et al., 2015; Wilens et al., 2016) and graduates (Holt & McCarthy, 2020), likely because of shared risk factors (Flay & Petraitis, 1994). While this research provides preliminary guidance around risk factors for postgraduate PSM, its cross-sectional nature precludes an understanding of how *changes* in risk factors for PSM are associated with PSM persistence. Moreover, the focus on narrow subpopulations of graduates (e.g., medical students) may limit generalizability of findings to graduates involved in a broader range of occupations.

THE CURRENT STUDY

To address these gaps in the literature, we used a theoretically-grounded approach to follow a sample of emerging adults in a range of fields for two years after college graduation. We had four hypotheses, each corresponding to the TTI. In the intrapersonal domain, we hypothesized that continued PSM would be more likely in participants who male-identified; those with higher scores on one or more subscales of impulsivity; or those with higher depression, anxiety, or stress. In the interpersonal domain, we expected continued PSM among graduates who perceived PSM to be more common among their friends (i.e., descriptive norms) and who perceived their social circle to be more approving of PSM (i.e., injunctive norms). In the sociocultural domain, we expected continued PSM among individuals with higher positive expectancies and lower negative expectancies, greater perceived workload, and more exposure to media focused on prescription drugs. We also hypothesized that other substance use would predict PSM persistence. Due to a lack of previous research, we did not advance specific hypotheses about how PSM motives, source(s), and route(s) of administration would change.

METHOD

PARTICIPANTS

Participants included 103 students from two small private colleges in the Northeast United States (Site A: 47%, Site B: 53%). Most identified as female (65%) and White/non-Hispanic (83%). Mean age at baseline was approximately 22 years (*SD* = 1.51). Most participants reported that their mother (85%) and/or father (79%) had at least a college degree. Table 1 provides more detail regarding the sample's demographic characteristics.

[Insert Table 1 about here]

DESIGN AND PROCEDURE

Participants identifying as college seniors were recruited through classroom visits, flyers, e-mail, and social media posts. Recruitment materials provided a web link to a screening survey. Students who reported one or more of the following: (1) past-year PSM, (2) current stimulant prescription, (3) past-year marijuana, cocaine, or hallucinogen use or misuse of an anti-anxiety or painkiller medication *and* any intention to engage in PSM (i.e., endorsing a response other than "extremely unlikely" on a 5-point scale)

and/or any diminished self-efficacy to avoid PSM (i.e., endorsing a response other than "completely confident" on a 5-point scale)[1] were invited to complete the baseline survey immediately, and then follow-up online assessments one and two years later. Time-varying measures (see below) were administered at all time points, except for workload (years 1 and 2 only). Table 2 depicts the timeline of study assessments.

[Insert Table 2 about here]

Participants received a $10 gift card for completing the baseline survey and $25 gift cards for each follow-up. To encourage retention and to document changes in contact information, we distributed small college-themed gifts via mail during the two-year period. A list of mental health resources also was provided. Of note, the year 1 assessment was conducted in April-May 2020, shortly after COVID-19 pandemic stay-at-home orders were instituted in many locales in the United States. The Institutional Review Boards at both sites approved the study procedures.

MEASURES

BASELINE MEASURES. At baseline, participants completed a 20-item multidimensional impulsivity measure, which was a short version of the Urgency Premeditation Planning Sensation Seeking Impulsivity Scale (SUPPS-P; Cyders et al., 2014; Whiteside & Lynam, 2001). The SUPPS-P consists of five subscales, each with four items, and a four-point response scale (1=*strongly disagree*, 4=*strongly agree*). Subscales include negative urgency (α=.80; e.g., "When I am upset, I often act without thinking"), positive urgency (α=.71; e.g., "I tend to lose control when I am in a great mood"), lack of perseverance [α=.63; "Unfinished tasks really bother me" (reverse-scored)], lack of premeditation [α=.74; "My thinking is usually careful and purposeful" (reverse-scored)], and sensation seeking (α=.58; "I quite enjoy taking risks"). The SUPPS-P has a similar factor structure to the full scale and intercorrelations among the subscales were comparable to the full scale (Cyders et al., 2014). Our subscale reliabilities for the subscales in the current study were somewhat lower than those reported by Cyders et al. (2014).

[1]Intentions and self-efficacy were the most consistent proximal predictors of PSM in previous research using the TTI (Bavarian et al., 2013a).

To assess media exposure to prescription drug advertisements, we used the two questions from the Behaviors, Expectancies, Attitudes, and College Health Questionnaire (BEACH-Q; Bavarian et al., 2013b). Questions assessed exposure to prescription drug advertisements in (1) print media and in (2) television or streaming media on a five-point response scale (1=*strongly disagree*, 5=*strongly agree*). The two items were highly correlated (r = .68, p <. 001).

TIME-VARYING MEASURES. At all three time points, to assess negative affect in the past week, we administered the 21-item short form of the Depression, Anxiety, and Stress Scales (DASS-21; Lovibond & Lovibond, 1995). Specifically, depressive symptoms were assessed with seven items (e.g., I felt I had nothing to look forward to), as were anxiety symptoms (e.g., I felt scared without any good reason), and stress symptoms (e.g., I tended to over-react to situations). A four-point response scale was used (0=*did not apply to me at all*, 3=*applied to me very much or most of the time*) and responses were summed and multiplied by 2 to ensure comparability with the original 42-item DASS. Reliabilities across all time points ranged from acceptable to excellent (α=.74-.95).

We assessed social norms for PSM, specifically descriptive and injunctive norms, with questions adapted from the BEACH-Q (Bavarian et al., 2013b) at each time point. For descriptive norms, participants reported the percentage (0-100) of their close friends they believed engaged in PSM. For injunctive norms, we inquired about perceived approval from friends, family, and campus faculty/staff for the participant engaging in PSM on a five-point scale (1=*very negatively*, 5=*very positively*). At the year 1 and year 2 follow-ups, we added three additional items (i.e., coworkers, supervisor or manager, fellow graduate students) and referenced graduate school professors instead of campus faculty/staff. Participants only responded to items that were relevant to their situation. Reliabilities for injunctive norms were .62 at baseline; .73 year 1; .77 year 2.

At all three time points, participants completed the 45-item Prescription Stimulant Expectancy Questionnaire II (PSEQ-II; Looby & Earleywine, 2010). The PSEQ-II assesses positive and negative consequences participants would anticipate from PSM using a four-point response scale (1=*not at all*, 4=*always*). We calculated a mean positive expectancy score (αs=.94-.95) from the 29 positive expectancy

items, which focused on cognitive (e.g., improved focus) and social enhancement (e.g., more enjoyment of parties) and a mean negative expectancy score (αs=.86-.88) from the 16 items that focused on anxiety and arousal (e.g., insomnia) and guilt and dependence (e.g., addiction concern). Prior research on the PSEQ-II showed that the positive and negative expectancy subscales differed by PSM status (e.g., nonuser, recreational user, medical user, recreational and medical user) (Looby & Earleywine, 2010).

We administered five items from the workload subscale of the Workplace Climate Questionnaire (WCQ; Kirby et al., 2003). Since the internal consistency reliabilities at year 1 (α=.58) and year 2 (α=.52) were low, we retained only two items ("There seems to be too much work to get through in my position" and "My workload is too heavy") that were most highly correlated (*r*s=.51-63). Participants who endorsed student status only at year 1 and/or year 2 completed parallel items referring to the workload in their graduate program. Participants responded on a 5-point Likert-type scale: 1=*strongly disagree* and 5=*strongly agree*.

Finally, at each time point, participants reported on past-year use of alcohol, tobacco/nicotine, marijuana, cocaine, hallucinogens, and misuse of anti-anxiety, opioid, or stimulant medications using a 1=*never* to 7=*40 or more times* scale. Substances with ratings of 2 or more, indicating any use of the substance, were summed for a total number of substances used.

DATA ANALYSIS PLAN

To model change in PSM and other substance use over time, we used generalized estimating equations (GEE) with binomial distribution and logit link. Demographics, the multidimensional impulsivity measure, and media exposure, which were measured only at baseline, were entered in the model as main effects and as interaction terms with the time points (baseline, year 1, year 2). The test of the *main effect* determined if there were differences in PSM at baseline (i.e., senior year); tests for *interactions* determined if rate of change over time in PSM differed by baseline predictors. For example, if males showed a significantly greater reduction in PSM over time compared to females this would be identified by the interaction term between time and gender.

Time-varying predictors, measured at each time point, included anxiety, depression, stress, descriptive norms, injunctive norms, positive expectancies, negative expectancies, workload (years 1 and 2), and other substance use. These predictors were partitioned into two components: a *within-person* component, which was the deviation at a specific time point from the average score for that participant across time points, and a *between-person* component, which was the average for that participant across time points. The test of the *within-person* component determines if a person's time-specific deviation in a construct is associated with PSM at that time point, while the test of the *between-person* component evaluates if there are differences between participants given their overall mean score on a construct (Curran & Bauer, 2011). The GEE model with both a non-varying (baseline only) predictor W and time-varying predictor X is shown below:

$$\log(\frac{\pi it}{1-\pi it}) = \beta o + \beta 1 W_i + \beta 2 Time_t + \beta 3 W_i * Time_t + \beta 4 \overline{Xi} + \beta 5(\overline{Xi} - X_{it})$$

Because the outcome PSM is binary, the dependent variable is the log odds of PSM. βo is the intercept; β1 is the effect of the non-varying predictor at baseline; β2 is the effect of time while β3 assesses how PSM varies over time depending on the predictor W; and β4 is the effect of the between-person average for predictor X, while β5 is the within-person effect for predictor X.

We first tested the baseline and time-varying measures individually, and then followed up with a multivariate model predicting any PSM across all time points. To achieve the most parsimonious model with the greatest explanatory power, we used a backward stepwise elimination approach that began with all significant bivariate predictors to obtain a final multivariate model. All available data were included using GEE with no imputation of missing time point values. Analyses were conducted in SPSS 27 and statistical significance was set at α=0.05.

RESULTS

PARTICIPANT FLOW AND DESCRIPTIVE STATISTICS

Of 278 students who completed the screening survey, 143 (51%) met eligibility criteria and accessed the baseline survey. Two students (1%) did not consent; 38 (27%) did not access or provided

incomplete data on the baseline survey, resulting in a final baseline sample of *N*=103. Retention at year 1 (*n*=91, 88%) and 2 (*n*=88, 85%) was good. Eight participants missed both year 1 and 2 follow-ups; seven missed the year 2 follow-up but completed the year 1 follow-up; and four missed the year 1 follow-up but completed the year 2 follow-up. Participants with one or more missing assessments (*n*=19, 19%) did not differ from other participants on any of the study variables.

PSM and other substance use reported by participants across the three time points are shown in Table 1. There was a significant decrease in PSM (time point $p < .001$): 51% misused during their senior year (62% during all undergraduate years), 31% at year 1, and 16% at year 2. All pairwise differences between time points were statistically significant (*p*s < .01). Eight of the 28 respondents (29%) at year 1 who endorsed PSM, or 9% of *all* respondents at year 1, had newly initiated the behavior (i.e., they denied using during their senior year of college, but started in year 1). Only one of the eight new initiates in year 1 reported PSM in the year 2 assessment. Two of the 14 respondents (14%), or 2% of *all* respondents at year 2, newly initiated PSM at year 2.

There was a significant decrease over time in tobacco/nicotine use (*p*=.003), marijuana use (*p*=.010), cocaine use (*p*<.001), and anti-anxiety medication misuse (*p*=.011). The decrease for the three latter drugs occurred between senior year and year 1 (all *p*s <.05) but not between years 1 and 2 (*p*s > .05), while tobacco/nicotine use decreased significantly between years 1 and 2 (*p*=.027). Chi-square tests showed that PSM at year 1 or 2 was not more likely among participants who identified as students at year 1 (χ^2=.931, *df*=1, *p*=.335) or year 2 (χ^2=.770, *df*=1, *p*=.380).

Top motivations for PSM were relatively consistent across the three time points and included a desire to improve focus, to stay awake, and to improve concentration (Table 2). Partying longer was *not* among the top three motivations during college; however, in years 1 and 2 it was among the most frequently rated motivations. Counteracting the effects of other drugs also became a more frequently endorsed motivation. On the other hand, using to perform better academically was less common in years 1 and 2.

[Insert Table 3 about here]

BASELINE PREDICTORS. Regarding predictors of PSM assessed at baseline only, PSM did not differ by gender, race, age, or GPA. For impulsivity subscales, there was a significant interaction between lack of premeditation and time [Coeff=.475, *SE*=.205, OR=1.61, CIs (1.08, 2.40) *p*=.021], such that students with greater lack of premeditation at baseline were less likely to reduce PSM following college. Finally, there was a significant conditional main effect for media exposure, with greater exposure to prescription drug advertisements associated with lower risk of PSM during senior year [Coeff=-.309, *SE*=.137, OR=0.73, CIs (0.56, 0.96) *p*=.024] (see Supplemental Table 1).

TIME-VARYING PREDICTORS OF PSM. The GEE model for time-varying predictors of PSM showed no significant effects for anxiety, depression, stress, injunctive norms, or workload (see Supplemental Table 2). Descriptive norms had both significant positive within-person [Coeff=.022, *SE*=.008, OR=1.02, CIs (1.01, 1.04) *p*=.008] and between-person [Coeff=.023, *SE*=.010, OR=1.02, CIs (1.00, 1.04) *p*=.016] effects. That is, participants who reported that PSM was more common among their close friends at that time point were more likely to endorse PSM on that occasion. And participants who, overall, reported a greater percentage of friends engaged in PSM were more likely to report PSM during the two years.

Within-person effects for positive and negative expectancies were not statistically significant, but the between-person effect for positive expectancies was [Coeff=.879, *SE*=.355, OR=2.41, CIs (1.20, 4.83) *p*=.013]. Across students, higher positive expectancy scores were associated with greater likelihood of PSM. Finally, the number of other substances used had both a within-person [Coeff=.513, *SE*=.218, OR=1.67, CIs (1.09, 2.56) *p*=.019] and between-person effect [Coeff=1.17, *SE*=.180, OR=3.21, CIs (2.26, 4.58) *p*<.001]. Specifically, for every additional substance a student used above their average at a certain time point, the odds of PSM increased 67% at that time point. And, across students, for every additional substance used, odds of PSM increased by a factor of 3.21.

MULTIVARIATE MODEL PREDICTING PSM. Table 4 shows the multivariate model that retained the significant predictors from the bivariate analyses. The variables not retained were the between-person effects of descriptive norms, positive expectancies, and media exposure. (Between person

descriptive norms was not retained in multivariate model but the main effect of lack of premeditation was because lower order terms [main effects] must remain in model with higher order terms [interaction]). There was a decrease in PSM over time, as evidenced by the significant effect for time point (*B*=-2.02, *p*<.001). The significant interaction between lack of premeditation and time (*B*=.639, *p*=.010) suggested that a higher lack of premeditation at baseline was associated with a lower likelihood (smaller decrease) of PSM over time. The within-person effect for descriptive norms (*B*=.023, *p*=.016) indicated that at time points when descriptive norms were higher than average for a participant, PSM was more likely for that individual. In other words, at any given time point when an individual perceived greater than average norms, they were more likely to report PSM than usual. Lastly, the significant within-subjects (*B*=.503, *p*=.017) and between-subjects (*B*=1.17, *p*<.001) effects for number of other substances used indicated that PSM was more likely (1) when participants used other substances more than average (within), and (2) for participants who reported more frequent other substance use compared to those reporting less frequent other substance use (between).

[Insert Table 4 about here]

DISCUSSION

Although a large body of literature has examined PSM and its sequelae in college students, few studies have documented how PSM changes after graduation and who is at risk for continuing PSM. In the current study, we used a longitudinal design to describe changes in PSM and its motives and a theoretically grounded approach to examine risk factors from the TTI most relevant to college graduates and how they predicted PSM in the two years following college graduation. Overall, the declining prevalence of PSM was consistent with the literature on "maturing out" of problematic substance use (Winick, as cited in Christo, 1998, p. 60). PSM decreased by nearly half in each of the two years following graduation. Nonetheless, our prevalence estimate of 16% was higher than an estimate from a national sample of college graduates 11% (Schepis et al., 2018) and a sample of alumni from a small private college in the northeast US (Underhill & Langdon, 2013), likely because we recruited a sample at elevated risk for PSM. A small proportion of the sample newly initiated PSM in year 1 and, of these

individuals, only one reported PSM in year 2; thus, PSM in year 1 largely was isolated and did not portend continued use. Even fewer participants reported newly initiating PSM in year 2, suggesting that risk of PSM initiation after college is relatively uncommon and might be greatest shortly after graduation. Consistent with past research (e.g., Verdi et al., 2016) a similar percentage of participants used stimulants to improve concentration, focus, and wakefulness at each assessment; however, recreational motives (e.g., to party longer) were endorsed more frequently in years 1 and 2 than at baseline, similar to previous research showing that recreational motives for PSM often were endorsed by individuals in the workforce (Sales et al., 2019).

We found limited support for our first hypothesis, namely that male-identified participants; those with higher scores on one or more subscales of impulsivity; or those with higher depression, anxiety, or stress would be more likely to report continued PSM after college. Lack of premeditation, or thinking carefully about one's behavior prior to action (Whiteside & Lynam, 2001), was the only intrapersonal variable that predicted change in PSM. Moreover, it was a unique predictor of PSM even after accounting for descriptive norms and other substance use, suggesting it may be a key feature of individuals at risk for continued PSM after college. Thiel et al. (2019) showed that college students with a history of PSM were elevated on all UPPS-P subscales compared to nonusers; our findings help to elucidate which dimension of impulsivity may be most salient to predicting PSM after college and in a sample at risk for PSM. Since this was the first study of graduates to employ a multidimensional measure of impulsivity, however, this finding needs to be replicated.

The lack of associations between PSM and male gender, depression, anxiety, and stress, and the other facets of impulsivity was both inconsistent with prior literature (Benson et al., 2015; Holt & McCarthy, 2020; Verdi et al., 2016) and our hypotheses. Because we focused on an at-risk sample, however, it is possible that these constructs no longer differentiate individuals at greater risk for PSM and/or that their salience is diminished following graduation. Interestingly, distress in this sample did not increase significantly, which was in contrast to findings from a larger and more heterogeneous sample of US emerging adults showing that distress increased during the COVID-19 pandemic (Vahratian et al.,

2021). Perhaps our participants' higher level of education and employment were protective against these increases in depressive and anxious symptoms.

For the interpersonal predictors of PSM, we found mixed support for our second hypothesis that descriptive and injunctive norms would be elevated among those who continued to engage in PSM after college. Our finding that descriptive norms, or perceptions of close friends' PSM, were elevated among graduates engaged in PSM was consistent with prior research (Holt & McCarthy, 2020) and suggests that perceptions of peers' behavior may still influence PSM after college. Contrary to our hypothesis, perceived approval of PSM (i.e., injunctive norms) did not predict PSM, consistent with research on college graduates (Holt & McCarthy, 2020), but inconsistent with research on college students (Silvestri & Correia, 2016). Perceived approval may be more consequential during the college years and/or may be difficult to assess during a transitional time, as graduates may not have a clear sense of co-workers', managers'/supervisors', and/or fellow graduate students' perceptions of PSM. Relatedly, since most participants reported at least a brief, if not extended period of remote work or graduate study between years 1 and 2, participants might not have been knowledgeable about their associates' attitudes or others' attitudes might have had limited influence.

We also found mixed support for our third hypothesis, which focused on sociocultural predictors of PSM. Consistent with our hypothesis and previous research (Holt & McCarthy, 2020), positive expectancies were a significant predictor of PSM in the bivariate analysis, suggesting that beliefs about stimulants' cognitive and social enhancement properties helped to differentiate users from nonusers. This finding also may be reflected in the increase in recreational motives for persisters. The lack of a within-person effect for positive expectancies suggests that even if graduates are no longer using stimulants, it is unlikely that their expectancies, particularly for cognitive enhancement, change significantly. The lack of effects for perceived workload, media exposure, and negative expectancies was in contrast to previous research with college students (Bavarian et al., 2013a) and graduates (e.g., Franke et al., 2013) and our hypothesis. In fact, media exposure to prescription drugs was associated with *less* PSM at baseline. Because we did not inquire about the specific content of the media and the mean was at the neutral

midpoint of the scale, it is possible that participants internalized the risks or side effects of medications, thereby explaining the inverse association.

Finally, consistent with our fourth hypothesis, other substance use was the most robust predictor of post-graduate PSM. This finding was consistent with our hypothesis and previous research on PSM with college graduates (Holt & McCarthy, 2020) and undergraduates (Benson et al., 2015) and further illustrates that substance use and misuse share many common risk factors, as indicated by the TTI (Bavarian et al., 2013b). PSM after college likely is a proxy for polysubstance use and may signal a subgroup of graduates who are ultimately at greater risk for social, personal, legal, or employment-related problems. Indeed, McCabe et al. (2019) showed that substance use disorders at age 35 were more likely among individuals who reported PSM with the greatest frequency between ages of 23-24 or 27-28 (compared to age 18 or 19-20). These data support the notion that routine screening for prescription drug misuse and other substance use may be useful in the 20s to interrupt maladaptive patterns of substance use later in life.

LIMITATIONS AND FUTURE RESEARCH

There were several limitations to acknowledge. Generalizability of our findings is limited given that we purposely focused on at-risk college graduates from two competitive, non-commuter Northeastern US colleges, characteristics that were associated with higher rates of PSM (McCabe et al., 2005a), and because our sample had a higher percentage of students identifying as female and White compared to our student populations. Our small sample size did not have the power to detect small effects and precluded us from examining whether PSM was more common among graduates employed in specific industries. Future research with larger, heterogeneous samples would allow for exploration of this question, in addition to more sophisticated modeling of risk factors from the TTI that better account for their purported temporal relations (e.g., distal, proximal) with PSM (Bavarian et al., 2014). Moreover, since the percentage of participants who initiated PSM after college was relatively small, a larger sample might allow for the identification of factors associated with post-college initiation specifically. Future research also might examine additional intrapersonal constructs, such as conduct disorder and ADHD symptoms,

which have been shown to differentiate college students with and without a history of PSM (Wilens et al., 2016). Given that the year 1 and 2 assessments occurred during the COVID-19 pandemic, it is unknown if the pattern of findings is generalizable. On the one hand, PSM might be more prevalent during a non-pandemic period if in-person interactions lead to increased social pressure to engage in PSM or there are more opportunities to procure stimulant medication. On the other hand, extended hours in front of the digital devices, characteristic of remote work, may lead individuals to seek out stimulant medication for enhanced focus and motivation. Investigating whether PSM is more common among those working in person versus remotely should be investigated in future research, particularly since many individuals may continue working remotely in some capacity or entirely.

The limited support for our hypotheses also could be due, in part, to the longitudinal methodology. Our hypotheses were predicated on previous research that was largely cross-sectional. Findings from this study suggest that PSM after college may be associated with a narrower set of predictors than those identified in cross-sectional research. Focusing on an at-risk participant pool also could help to explain the minimal support for our hypotheses. Longitudinal research with a more varied sample of college graduates might help to further elucidate intrapersonal, interpersonal, and sociocultural factors that predict never misusing stimulants, persistence after college, desistance after college, and initiation following college.

Research on PSM has not always been theoretically grounded (Gallucci et al., 2015). The TTI and the Theory of Planned Behavior are the two most prominent theories in the PSM literature and have growing support. Of note, both theories include multiple factors and tend to be predictive of health behaviors at a conceptual level, meaning specific variables within the different conceptual categories may vary between studies, but the general categories remain predictive. Future research should continue to draw on these theoretical frameworks and perhaps others to identify the most robust predictors of PSM persistence after college.

CONCLUSIONS & IMPLICATIONS

To our knowledge, this is the first study documenting changes in college graduates' PSM and its motives in the years immediately after college. Our findings pointed to three constructs from the TTI, impulsivity (i.e., lack of premeditation), perceived peer norms (i.e., descriptive norms), and other substance use as unique predictors of PSM persistence after graduation. This profile of risk factors may be indicative of selection effects, whereby more impulsive students seek out peers who are more likely to be engaged in PSM and other substance use after college, and socialization effects, whereby PSM and other substance use are more prevalent on account of normative behavior in one's peer group (McCabe et al., 2005b). Since intervening with college graduates presents numerous logistical challenges, it may be most fruitful to reach students while they are still in college. If replicated, findings from this preliminary study suggest that interventions for college seniors that (1) enhance decision-making skills and intentionality, particularly around substance use habits, and (2) correct normative perceptions of college students' and college graduates' substance use, may hold the most promise for positively changing graduates' trajectories of PSM. Fundamentally, understanding changes in post-graduate PSM and imparting strategies for reducing this and other substance use hold significant promise for enhancing emerging adult health and well-being.

REFERENCES

Arria, A. M., Caldeira, K. M., O'Grady, K. E., Vincent, K. B., Johnson, E. P., & Wish, E. D. (2008). Nonmedical use of prescription stimulants among college students: Associations with ADHD and polydrug use. *Pharmacotherapy*, *28*(2), 156–169. https://doi.org/10.1592/phco.28.2.156

Arria, A. M., Caldeira, K. M., Vincent, K. B., O'Grady, K. E., Cimini, M. D., Geisner, I. M., Fossos-Wong, N., Kilmer, J. R., & Larimer, M. E. (2017). Do college students improve their grades by using prescription stimulants nonmedically? *Addictive Behaviors*, *65*, 245–249. https://doi.org/10.1016/j.addbeh.2016.07.016

Baum, M., Sattler, S., & Reimann, M. (2021). Towards an understanding of how stress and resources affect the nonmedical use of prescription drugs for performance enhancement among employees. *Current Psychology*. https://doi.org/10.1007/s12144-021-01873-7

Bavarian, N., Flay, B. R., Ketcham, P. L., & Smit, E. (2013a). Illicit use of prescription stimulants in a college student sample: A theory-guided analysis. *Drug and Alcohol Dependence*, *132*(3), 665–673. https://doi.org/10.1016/j.drugalcdep.2013.04.024

Bavarian, N., Flay, B. R., Ketcham, P. L., & Smit, E. (2013). Development and psychometric properties of a theory-guided prescription stimulant misuse questionnaire for college students. *Substance Use & Misuse*, *48*(6), 457–469. https://doi.org/10.3109/10826084.2013.778283

Bavarian, N., Flay, B. R., Ketcham, P. L., Smit, E., Kodama, C., Martin, M., & Saltz, R. F. (2014). Using structural equation modeling to understand prescription stimulant misuse: A test of the theory of triadic influence. *Drug and Alcohol Dependence*, *138*, 193-201. https://doi.org/10.1016/j.drugalcdep.2014.02.700

Benson, K., Flory, K., Humphreys, K. L., & Lee, S. S. (2015). Misuse of stimulant medication among college students: A comprehensive review and meta-analysis. *Clinical Child and Family Psychology Review*, *18*(1), 50–76. https://doi.org/10.1007/s10567-014-0177-z

Christo, G. (1998). A review of reasons for using or not using drugs: Commonalities between sociological and clinical perspectives. *Drugs: Education, Prevention and Policy*, *5*(1), 59–72.

Curran, P. J., & Bauer, D. J. (2011). The disaggregation of within-person and between-person effects in longitudinal models of change. *Annual Review of Psychology*, *62*, 583-619. http://dx.doi.org/10.3109/09687639809035771

Cyders, M. A., Littlefield, A. K., Coffey, S., & Karyadi, K. A. (2014). Examination of a short English version of the UPPS-P Impulsive Behavior Scale. *Addictive Behaviors*, *39*(9), 1372–1376. 10.1016/j.addbeh.2014.02.013

Emanuel, R. M., Frellsen, S. L., Kashima, K. J., Sanguino, S. M., Sierles, F. S., & Lazarus, C. J. (2013). Cognitive enhancement drug use among future physicians: Findings from a multi-institutional census of medical students. *Journal of General Internal Medicine*, *28*(8), 1028–1034. https://doi.org/10.1007/s11606-012-2249-4

Faraone, S. V., Rostain, A. L., Montano, C. B., Mason, O., Antshel, K. M., & Newcorn, J. H. (2020). Systematic review: Nonmedical use of prescription stimulants: risk factors, outcomes, and risk reduction strategies. *Journal of the American Academy of Child & Adolescent Psychiatry*, *59*(1), 100–112. https://doi.org/10.1016/j.jaac.2019.06.012

Flay, B. R., & Petraitis, J. (1994). A new theory of health behavior with implications for preventive interventions. *Advances in Medical Sociology*, *4*, 19-44.

Franke, A. G., Bagusat, C., Dietz, P., Hoffmann, I., Simon, P., Ulrich, R., & Lieb, K. (2013). Use of illicit and prescription drugs for cognitive or mood enhancement among surgeons. *BMC Medicine*, *11*(1), 1–9. https://doi.org/10.1186/1741-7015-11-102

Gallucci, A., Martin, R., Beaujean, A., & Usdan, S. (2015). An examination of the misuse of prescription stimulants among college students using the theory of planned behavior. *Psychology, Health & Medicine, 20,* 217-226. doi: 10.1080/13548506.2014.913800

Holt, L. J., & McCarthy, M. D. (2020). Predictors of prescription stimulant misuse in US college graduates. *Substance Use & Misuse*, *55*(4), 644–657. https://doi.org/10.1080/10826084.2019.1692867

Judson, R., & Langdon, S. W. (2009). Illicit use of prescription stimulants among college students: Prescription status, motives, theory of planned behaviour, knowledge and self-diagnostic tendencies. *Psychology, Health & Medicine*,*14*(1), 97–104. https://doi.org/10.1080/13548500802126723

Kirby, J. R., Delva, M. D., Knapper, C., & Birtwhistle, R. V. (2003). Development of the Approaches to Work and Workplace Climate Questionnaires for Physicians. *Evaluation & the Health Professions*, *26*(1), 104–121. https://doi.org/10.1177/0163278702250097

Leon, M. R., Harms, P. D., & Gilmer, D. O. (2019). PCE use in the workplace: The open secret of performance enhancement. *Journal of Management Inquiry*, *28*(1), 67–70.

Looby, A., & Earleywine, M. (2010). Psychometric evaluation of a Prescription Stimulant Expectancy Questionnaire. *Experimental and Clinical Psychopharmacology*, *18*(4), 375-383. https://doi.org/10.1037/a0019347

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the Depression Anxiety Stress Scales* (2nd ed.). Sydney: Psychology Foundation.

McCabe, S. E., Knight, J. R., Teter, C. J., & Wechsler, H. (2005a). Non-medical use of prescription stimulants among US college students: Prevalence and correlates from a national survey. *Addiction*, *100*(1), 96–106. http://dx.doi.org/10.1111/j.1360-0443.2005.00944.x

McCabe, S. E., Schulenberg, J. E., Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Kloska, D. D. (2005b). Selection and socialization effects of fraternities and sororities on US college student substance use: A multi-cohort national longitudinal study. *Addiction*, *100*(4), 512–524. http://dx.doi.org/10.1111/j.1360-0443.2005.01038.x

McCabe, S. E., Veliz, P. T., Dickinson, K., Schepis, T. S., & Schulenberg, J. E. (2019). Trajectories of prescription drug misuse during the transition from late adolescence into adulthood in the USA: A national longitudinal multicohort study. *The Lancet Psychiatry*, S2215036619302998. https://doi.org/10.1016/S2215-0366(19)30299-8

McCabe, S. E., West, B. T., Teter, C. J., & Boyd, C. J. (2014). Trends in medical use, diversion, and nonmedical use of prescription medications among college students from 2003 to 2013: Connecting the dots. *Addictive Behaviors*, *39*(7), 1176–1182. http://dx.doi.org/10.1016/j.addbeh.2014.03.008

McNiel, A. D., Muzzin, K. B., DeWald, J. P., McCann, A. L., Schneiderman, E. D., Scofield, J., & Campbell, P. R. (2011). The nonmedical use of prescription stimulants among dental and dental hygiene students. *Journal of Dental Education*, *75*(3), 365–376. https://doi.org/10.1002/j.0022-0337.2011.75.3.tb05050.x

Sales, P., Murphy, F., Murphy, S., & Lau, N. (2019). Burning the candle at both ends: Motivations for non-medical prescription stimulant use in the American workplace. *Drugs: Education, Prevention and Policy*, *26*(4), 301–308. https://doi.org/10.1080/09687637.2019.1606895

Schepis, T. S., Teter, C. J., & McCabe, S. E. (2018). Prescription drug use, misuse and related substance use disorder symptoms vary by educational status and attainment in US adolescents and young adults. *Drug and Alcohol Dependence*, *189*, 172–177. http://dx.doi.org/10.1016/j.drugalcdep.2018.05.017

Schwarz, A. (2015, April 18). Workers seeking productivity in a pill are abusing A.D.H.D. drugs. *The New York Times*. https://www.nytimes.com/2015/04/19/us/workers-seeking-productivity-in-a-pill-are-abusing-adhd-drugs.html

Silvestri, M. M., & Correia, C. J. (2016). Normative influences on the nonmedical use of prescription stimulants among college students. *Psychology of Addictive Behaviors*, *30*(4), 516-521. https://doi.org/10.1037/adb0000182

Thiel, A. M., Kilwein, T. M., De Young, K. P., & Looby, A. (2019). Differentiating motives for nonmedical prescription stimulant use by personality characteristics. *Addictive Behaviors*, *88*, 187–193. http://dx.doi.org/10.1016/j.addbeh.2018.08.040

Tuttle, J. P., Scheurich, N. E., & Ranseen, J. (2010). Prevalence of ADHD diagnosis and nonmedical prescription stimulant use in medical students. *Academic Psychiatry*, *34*(3), 220–223.

Underhill, B., & Langdon, S. (2013). Licit and illicit use of prescription psychostimulants in upperclassmen and alumni. *Journal of Alcohol and Drug Education*, *57*(2), 7-26. https://www.jstor.org/stable/48506378

Wilens, T., Zulauf, C., Martelon, M., Morrison, N. R., Simon, A., Carrellas, N. W., Yule, A., & Anselmo, R. (2016). Nonmedical stimulant use in college students: Association with attention-deficit/hyperactivity disorder and other disorders. *The Journal of Clinical Psychiatry*, *77*(07), 940–947. https://doi.org/10.4088/JCP.14m09559

Vahratian, A. (2021). Symptoms of anxiety or depressive disorder and use of mental health care among adults during the COVID-19 pandemic—United States, August 2020–February 2021. *MMWR. Morbidity and Mortality Weekly Report*, *70*. https://doi.org/10.15585/mmwr.mm7013e2

Verdi, G., Weyandt, L. L., & Zavras, B. M. (2016). Non-medical prescription stimulant use in graduate students: Relationship with academic self-efficacy and psychological variables. *Journal of Attention Disorders*, *20*(9), 741–753. http://dx.doi.org/10.1177/1087054714529816

Table 1

Demographic and Descriptive Statistics at All Time Points

	Time Point		
Variable	Baseline	Year 1	Year 2
Gender (*n*, %)			
Female	67 (65%)		
Male	34 (33%)		
Gender Non-Conforming/Gender Fluid/ Genderqueer/Did Not Identify	2 (2%)		
Race/Ethnicity (*n*, %)			
Asian/Asian American/Pacific Islander	7 (7%)		
African American/Black	3 (3%)		
Hispanic/Latino	5 (5%)		
White/non-Hispanic	85 (83%)		
Other/Mixed Race/Ethnicity	3 (3%)		
Age [*M*(*SD*)]	21.96 (1.51)		
History of ADHD Diagnosis	27 (26%)		
Current Stimulant Prescription (*n*, %)	20 (19%)		
Employment/Student Status (*n*, %)			
Employed full-time		70 (77%)	72 (82%)
Employed part-time		9 (10%)	9 (10%)
Unemployed, looking for work		6 (7%)	2 (2%)
Unemployed, not looking for work		2 (2%)	0 (0%)
Graduate student		11 (12%)	13 (15%)
Multidimensional Impulsivity (SUPPS-P) [*M*(*SD*)]			
Lack of Perseverance	1.86 (0.52)		
Lack of Premeditation	1.91(0.56)		
Negative Urgency	2.34 (0.79)		
Positive Urgency	1.90 (0.60)		
Sensation Seeking	2.72 (0.63)		
Media Exposure (BEACH-Q) [*M*(*SD*)]	3.32 (1.26)	---	---
Negative Affect (DASS-21) [*M*(*SD*)]			
Anxiety	10.18 (9.13)	8.46 (6.99)	7.39 (7.67)
Depression	12.09 (10.45)	12.70 (10.99)	10.61 (10.78)
Stress	15.07 (9.70)	14.48 (9.30)	13.66 (9.78)
Social Norms around PSM (BEACH-Q) [*M*(*SD*)]			
Descriptive Norms	40.49 (23.33)[a]	21.24 (19.12)	18.89 (17.86)
Injunctive Norms	2.14 (0.55)	2.17 (0.52)	2.07 (0.54)
Expectancies (PSEQ-II) [*M*(*SD*)]			
Positive Expectancies	2.25 (0.53)	2.14 (0.53)	2.18 (0.48)
Negative Expectancies	2.21 (0.52)	2.18 (0.53)	2.28 (0.51)

Workload (WCQ) [*M*(*SD*)]	---	2.99 (1.15)[b]	3.40 (1.08)
Substance Use			
Prescription Stimulant Misuse*	52 (51%)	28 (31%)	14 (16%)
Tobacco/Nicotine*	78 (76%)	64 (70%)	54 (61%)
Alcohol	99 (97%)	91 (100%)	86 (98%)
Marijuana*	93 (91%)	73 (80%)	70 (80%)
Cocaine*	41 (40%)	22 (24%)	18 (21%)
Hallucinogens	24 (23%)	15 (17%)	20 (23%)
Prescription Opioid Misuse	8 (8%)	3 (3%)	6 (7%)
Prescription Anti-Anxiety Misuse*	20 (19%)	8 (9%)	5 (6%)

Note. N=103 Baseline; N=91 Year 1; N=88 Year 2. [a]N=102. [b]N=87. Demographics, impulsivity, and media exposure measured at baseline only. Workload and employment status measured at Years 1 and 2 only. Participants could endorse more than one response for the employment/student status question. SUPPS-P= Short Urgency Premeditation Planning Sensation Seeking Impulsivity Scale; DASS-21=Depression, Anxiety, Stress Scale; BEACH-Q=Behaviors, Expectancies, Attitudes, and College Health Questionnaire; PSEQ-II=Prescription Stimulant Expectancies Questionnaire-II; WCQ=Workplace Climate Questionnaire. *Denotes statistically significant difference (p<.05) between time points.

Table 2

Timeline of Study Assessments

Measure	Time Point		
	Baseline	Year 1	Year 2
Demographic characteristics	■		
Employment/student status		■	■
Multidimensional Impulsivity Measure (SUPPS-P)	■		
Media exposure to drug advertisements (BEACH-Q)	■		
Depression, Anxiety, and Stress (DASS-21)	■	■	■
Prescription Stimulant Expectancies (PSEQ-II)	■	■	■
Social norms (descriptive/injunctive)(BEACH-Q)	■	■	■
Substance use in the previous year	■	■	■
Workload (WCQ)		■	■

Note. SUPPS-P= Short Urgency Premeditation Planning Sensation Seeking Impulsivity Scale; BEACH-Q=Behaviors, Expectancies, Attitudes, and College Health Questionnaire; DASS-21=Depression, Anxiety, Stress Scale; PSEQ-II=Prescription Stimulant Expectancies Questionnaire-II; WCQ=Workplace Climate Questionnaire.

Table 3

Prescription Stimulant Misuse Motivations, Sources, and Routes of Administration at All Time Points

	Time point		
Variable	Baseline *n*=64	Year 1 *n*=28	Year 2 *n*=14
Motivation			
To improve focus	63%	54%	64%
To make studying more enjoyable	13%	14%	21%
To stay awake for a long time	52%	46%	57%
To improve concentration	53%	39%	50%
To lose weight	8%	4%	7%
To party longer	39%	54%	57%
To experiment	25%	25%	21%
To perform better academically	47%	21%	21%
To perform better athletically	2%	4%	7%
To counteract the effects of other drugs	6%	11%	14%
Other	0%	7%	7%
Source			
My own prescription	17%	36%	29%
Friend	81%	75%	71%
Family member	2%	7%	0%
Friend of a friend	31%	14%	21%
Internet	2%	0%	0%
Other	2%	0%	0%
Route of Administration			
Swallow	89%	71%	86%
Snort	45%	46%	36%
Inject	2%	0%	0%
Smoke	5%	11%	14%

Note. These data are from the subset of students who reported any PSM during the study. Participants could endorse multiple responses for each variable. Sample size for baseline is larger than sample size for senior year PSM only (*n*=64 vs. *n*=52) because participants reported on motivations, sources, and routes of administration for all years of college, not just senior year.

Table 4

Multivariate Model Predicting Prescription Stimulant Misuse

Predictor	Coefficient	SE	OR	95% CI	*p*-value
Time Point	-2.02	.559	0.13	0.05 – 0.40	<.001
Lack of Premeditation (SUPPS-P)					
Conditional Main Effect	-.442	.355	0.64	0.32 – 1.29	.213
Interaction with Time	.639	.249	1.90	1.16 – 3.09	.010
Descriptive Norms (BEACH-Q)					
Within Person	.023	.010	1.02	1.00 – 1.04	.016
Number of Other Substances Used					
Within Person	.503	.211	1.65	1.09 – 2.50	.017
Between Person	1.17	.196	3.24	2.20 – 4.75	<.001

Note. Lack of premeditation subscale was from the multidimensional impulsivity measure Short Urgency Premeditation Planning Sensation Seeking Impulsivity Scale (SUPPS-P). Descriptive norms measure was a subscale of the Behaviors, Expectancies, Attitudes, and College Health Questionnaire (BEACH-Q).