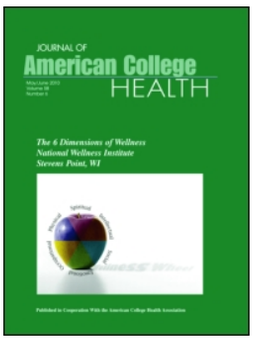

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MAJOR ARTICLE

Study strategies and "study drugs": investigating the relationship between college students' study behaviors and prescription stimulant misuse

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ABSTRACT

Objective: The current study examined the regular use of study strategies between college students who misused prescription stimulants ($N = 36$) and college students who did not misuse prescription stimulants ($N = 298$) in an undergraduate sample. **Participants:** 334 college students at a large, Midwestern university. **Methods:** Using logistic regression, we examined whether students who misused prescription stimulants did so to compensate for poor study strategies and/or a lack of study strategies overall. We hypothesized that regularly spacing studying, using more study strategies, and using more effective study strategies would predict lower odds of prescription stimulant misuse among students. In contrast, we hypothesized that using more *in*effective study strategies would predict higher odds of prescription stimulant misuse. **Results:** Results indicated that a greater number of total study strategies and effective study strategies, and higher importance of school predicted higher odds of prescription stimulant misuse. **Conclusions:** Thus, students may not be misusing prescription stimulants as a substitute for effective studying but, rather, to augment effective study habits.

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Introduction

Prescription stimulants are primarily used to treat symptoms of Attention Deficit Hyperactivity Disorder (attention-deficit/hyperactivitydisorder (ADHD)), Attention Deficit Disorder (ADD) and narcolepsy in children and adults (they are infrequently used in treating several other conditions). The Diagnostic and Statistical Manual of Mental Disorders – fifth edition (DSM-5) defines ADHD as the "persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development."[1] Used correctly, prescription stimulants (e.g., Adderall, Ritalin, Concerta) work by heightening the effects of dopamine and norepinephrine— two neurotransmitters that play a critical role in regulating mood and behavior—in the brain to decrease inattention and restlessness. Used incorrectly (i.e., without a prescription or in excess), prescription stimulants may provide a large boost of dopamine, potentially resulting in a "high" or, at the very least, disrupting neurotransmission of dopamine and norepinephrine in the brain.[2] Although prescription stimulants are approved by the U.S. Food and Drug Administration,[3] and have relatively rare and minor side effects when used correctly (slightly increased body temperature, blood pressure and heart rate, insomnia, or loss of appetite), the Drug Enforcement Agency[4] considers prescription stimulants to be Schedule II drugs given their high potential for physical or psychological dependence if used incorrectly.

Prescription stimulant misuse is defined as taking a stimulant without a prescription or not using the stimulant according to its prescription (e.g., in excess), with the current study focused on non-prescription uses.[5] Since 2000, the non-medical use of prescription stimulants has increased substantially.[6,7] Though prescriptions for drugs such as Adderall, Ritalin, and Vyvanse stabilized in the early 2000s, the non-medical use of the stimulants rose 67 percent from 2006-2011 alone.[7,8] When used illicitly, prescription stimulants have the potential for serious side effects and complications including blurred vision, fever, increased heart rate, depression, high blood pressure, high blood sugar, sleep disruption, elevated body temperature, lack of appetite, anger, paranoia, seizures, heart failure, stroke, and even death.[5,9] Moreover, people who use the drug for non-medical purposes are more likely to overdose, further increasing the risk for adverse physical health consequences (e.g., increased heart rate, seizures).[10] There may be mental health consequences as well. Several studies have found a relationship between prescription stimulant misuse and depressed mood in college students.[11]

Prescription stimulant misuse among college students

The majority of those who misuse prescription stimulants are between the ages of 18 and 25. According to the National Survey on Drug Use and Health,[12] college students are more than twice as likely to misuse prescription

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stimulants (i.e., as cognitive enhancement drugs or study drugs) compared to their same-age, non-student peers. Although prevalence rates vary between universities, several studies suggest that a quarter to a third of college students have misused prescription stimulants in their lifetime, with the risk for misuse associated with more years spent in college.[13–15] Accordingly, most of those who misuse prescription stimulants report taking the drugs for enhanced focus and cognition in an effort to improve academic outcomes during the college years.[2]

While prescription stimulant misuse is now widespread, some college students are at greater risk than others. For instance, the majority of college Adderall misusers are White and affiliated with a sorority or fraternity, though this is not always the case.[10,16–18] Men are also at greater risk for misuse, with some studies reporting rates almost twice that of women.[16] Moreover, The Substance Abuse and Mental Health Services Administration[12] reports that, of full-time college students who misuse Adderall, 80% have also used marijuana, 29% have used cocaine, and 32% have used hallucinogens, indicating that prescription stimulant misusers are likely to engage in poly-substance use. Other research suggests that students who score high in resilience to stress are less likely to use.[19] However, the association between matriculation at four-year universities and stimulant misuse remains unexplained.

Many individuals report misusing prescription stimulants to improve or maintain their academic standing by enhancing cognition and focus on schoolwork. However, academic achievement varies among those who misuse. For example, some studies have found that the majority of those who misuse hold an average GPA of 3.0 or lower.[13] Other studies suggest that students attending schools or programs with more competitive admission standards are more likely to misuse prescription stimulants.[16] Indeed, rates of prescription stimulant misuse among medical students, pharmaceutical students, and dental students are of concern, as these groups have prevalence rates of 7% percent, 12%, and 10%, respectively compared to the national, non-student-specific rate of roughly 5%.[20–22] Given the prevalence of prescription stimulant misuse in academics, efforts to curtail stimulant misuse should consider the motive for study or scholarly enhancement.

Study skills and academic pressures

Although being a college student may be associated with greater risk, not all college students are equally likely to misuse prescription stimulants. The present study explored the possibility that prescription stimulant misuse depends on students' knowledge of effective study strategies. Effective study strategies refer to approaches to learning that are associated with sufficient evidence that they are highly likely to lead to durable, long-lasting learning. In contrast, ineffective study habits are those approaches that, based on evidence, are less likely to lead to durable, long-lasting learning.[23,24] If students misuse prescription stimulants to enhance their academic performance, then students with greater knowledge of effective study strategies may be less likely to do so.

Students have imperfect knowledge of the study strategies that have been empirically shown to enhance learning. For instance, nearly a century of research has consistently found that spacing (i.e., distributing studying of a topic over time—the opposite of massing or "cramming") and retrieval practice (i.e., practice testing or self-testing) are two of the most effective study strategies.[23,24] Although more research is necessary, mixing up different types of problems and examples can also dramatically improve learning.[14,25,26] However, students generally underestimate the effectiveness of these strategies.[27,28]

For example, in one experiment, participants studied a set of flashcards eight times in one day (i.e., massed) or twice a day on four separate days (i.e., spaced).[29] Although participants remembered more than twice as many spaced flashcards as massed flashcards on a later test, participants mistakenly predicted that they learned significantly more from massing than spacing. Consistent with these experimental results, participants' self-reported study strategies do not typically incorporate spacing. Multiple surveys reveal that only a small portion of students ($< 21\%$) plan out a study schedule; instead, more than half of students work on whatever is due next and cram their studying.[29–33] Students report unrealized intentions to space studying and also appear to also hold normative misperceptions about the prevalence of massing among their fellow students.[34,35] The current study tested the possibility that individuals engaging in illicit use of prescription stimulants may be more likely to engage in single, intense bouts of studying (i.e., massing) than non-users.

Similarly, hundreds of experiments have established that tests are not only for assessing learning but are also an effective way to enhance learning. Learners are 2.5 times more likely to remember information they practice retrieving rather than rereading while preparing for an exam.[36] However, less than one third of students report that they learn more from retrieval practice than rereading. Instead, approximately two-thirds of students report rereading chapters, articles, notes, etc.[30–33] When students use retrieval practice, it is typically to check their learning, not as a strategy to learn.[29–33,37] One challenge for learners is that effective study strategies like spacing and retrieval practice may feel subjectively more difficult in the moment than the less effective strategies like massing and spacing, potentially deterring effective study behaviors.[28] In addition to favoring less effective study techniques like massing and rereading, many students also endorse other strategies that have little impact on learning.[30–33] For instance, students consistently endorse the value of highlighting while reading and studying in a way that is putatively aligned with their learning style (e.g., verbal, visual, kinesthetic).[38,39]

Research has begun to investigate which student characteristics are related to differences in knowledge of effective study strategies. Students with higher GPAs tend to use more effective study strategies, including spacing and retrieval practice.[30–32] In contrast, students who are

particularly motivated by a fear of failure are more likely to cram.[30] Finally, some small, albeit inconsistent, differences in students' study strategies and beliefs have been observed depending on whether they believed intelligence is fixed or can be increased with effort.[40]

The present study added to this growing body of research and is the first to investigate the relationship between study strategies and prescription stimulant misuse; consequently, these findings could have important implications for how to reduce risk. Teaching students about how to study more effectively could provide strategies that promote academic success without engaging in risky substance misuse. Indeed, less than half of students report studying the way a teacher taught them and, critically, teachers do not necessarily know more about effective study strategies than students.[30,33] Accordingly, there is an opportunity to improve students' knowledge about studying, which could have broader health and academic impacts, such as decreased anxiety, better sleep, and higher levels of academic achievement.

Current study

The present study sought to answer four prevailing research questions based on current research and theory. To answer these questions, we modeled study strategies (and an array of controls) as predictor variables in a multivariate logistic regression analysis. Prescription stimulant misuse was coded as a dichotomous, outcome variable. Our research questions were as follows:

1. Are students who space their studying less likely misuse prescription stimulants?
2. Are students who regularly use more study strategies less likely to misuse prescription stimulants?
3. Are students who regularly use more effective study strategies less likely to misuse prescription stimulants?
4. Are students who regularly use more ineffective study strategies more likely to misuse prescription stimulants?

Follow-up analyses (descriptive statistics, bivariate statistics, chi-square tests and *t*-tests) examined key relationships between variables. Specifically, we examined whether students who misused prescription stimulants and students who did not misuse prescription stimulants differed in which specific study strategies they reported using regularly. We also explored if/how self-rated satisfaction with performance in school, self-rated importance of school, self-rated effort in school, and self-rated effectiveness of study habits contributed to students' likelihoods of misusing prescription stimulants. Finally, upon running our logistic regression models, we elected to include a number of additional predictors as covariates: gender (dummy-coded), race/ethnicity (dummy-coded), year in school (dummy-coded), GPA, and the number of credits the student was enrolled in.

Hypotheses

H1. Students who reported using spacing would be less likely to misuse prescription stimulants, holding constant covariates.

H2. Students who reported regularly using more study strategies would be less likely to misuse prescription stimulants, holding constant covariates.

H3. Students who reported regularly using more effective study strategies would be less likely to misuse prescription stimulants, holding constant covariates.

H4. Students who reported regularly using more ineffective study strategies would be more likely to misuse prescription stimulants, holding constant covariates.

Materials and methods

Participants

Following Institutional Review Board (IRB) approval, 334 undergraduate students (76% female) were recruited to take this online survey via a large Midwestern university psychology research pool.[1] The project was described as one exploring study strategies and prescription and illicit drug use among students. Students were made aware that the study was completely anonymous, they could withdraw their participation at any time, and their participation was voluntary and unrelated to their standing in class. On average, students took 30 minutes to complete the survey. Fifty one percent of students were first year college students (21% second year, 13% third year, 9% fourth year, 6% did not identify). On average, students were 19.87 years old ($SD = 3.20$). Most participants identified as White (63%); nine percent identified as Hispanic, Latinx or Spanish Origin of any race; seven percent identified as American Indian or Alaskan Native; seven percent identified as Asian, and one percent identified as Black. The remainder (13%) identified with two or more of the above-mentioned race/ethnicities or chose not to identify. On average, participants were enrolled in 14.8 credits for the semester in which the survey was administered.

Measures

Participants' *stimulant misuse* was measured via a series of questions. First, participants were asked to answer on a four-point scale, "How often, if ever, have you used any of the drugs listed below for study related purposes? Do not include anything you used under a doctor's orders." ("Never", "Used, but not in the past 12 months", "Used, but not in the past 30 days", "Used in the past 30 days"). This wording was used to deter students from reporting any prescription stimulant use that occurred with a valid prescription. Possible prescription stimulants included Adderall, Ritalin, Concerta, Focalin, Vyvanse, Modafinil,

[1]Students in Introduction to Psychology or Research Methods in Psychology I were given class credit for their participation. Students who elected not to participate were given a comparable alternative assignment.

Table 3. Study strategy use between stimulant users and non-stimulant users.

Study strategy	Non-stimulant users ($N = 278–298$)	Stimulant users ($N = 30–36$)	All respondents ($N = 308–334$)
Effective strategies			
Test with questions or practice problems	81%	73%	80%
Use flashcards	51%**	80%	54%
Make outlines	35%	30%	34%
Make diagrams, charts, or pictures	25%	20%	24%
Ineffective strategies			
Underline or highlight while reading	57%	73%	58%
Reread chapters/articles/notes	57%**	80%	59%
Recopy notes	40%*	60%	42%
"Cram" lots of information the night before the test	51%	60%	52%
Other strategies			
Study with friends	53%	67%	54%
Ask questions or verbally participate during class	31%	30%	31%
Other	37%	23%	36%

*$p < .05$.
**$p < .01$.

Adrafinil, and Phenylpiracetam. Participants were then prompted to report how many times in the last thirty days they used any of the aforementioned drugs on a 0-30 sliding scale. We modeled use as a dichotomous variable (1 = Did use in the last 12 months, 0 = Did not use in the last 12 months) in two multivariate logistic regression models.

Questions were taken from Kornell and Bjork,[41] Hartwig and Dunlosky,[31] and Morehead et al.,[27] to understand students' study strategies. To assess participants' *spacing of study habits*, a dichotomous variable, participants were asked, "Which pattern best describes your pattern of study?" (1 = "I most often space out my study sessions over multiple days/weeks", 2 = I most often do my studying in one session before the test"). Participants' regular *study habits* were measured as a quantitative variable via the following question: "Which of the following study strategies do you use regularly? Check all that apply." (Test yourself with questions or practice problems; Use flashcards; Recopy your notes; Reread chapters/articles/notes, etc.; Make outlines; Underline or highlight while reading; Make diagrams, charts, or pictures; Study with friends (have a conversation about material); "Cram" lots of information the night before the test; Ask questions or verbally participate during class; Other).

For each participant, we calculated three scores (see Table 3). The *number of total study strategies* was calculated as a quantitative variable denoting the number of study strategies that the student checked that they used regularly. The *number of effective study strategies* was calculated as a quantitative variable denoting the number of the following strategies that the student checked that they used regularly: test with questions or practice problems; use flashcards; make outlines; make diagrams, charts, or pictures. The *number of ineffective study strategies* was calculated as a quantitative variable denoting the number of the following strategies that the student checked that they used regularly: recopy notes; reread chapters/articles/notes; underline or highlight while reading; "cram" lots of information the night before the test. Studying with friends, participating in class, and "other" were not included in the count of effective or ineffective study strategies because there is not enough empirical evidence regarding their effectiveness for enhancing learning. The reported use of these three other strategies are included for completeness.

Participants also self-rated *their satisfaction with performance in school.* This variable was assessed via one question answered on a seven-point Likert scale ranging from 7 = "Extremely Satisfied" to 1 = "Extremely Dissatisfied." Participants self-rated their *importance of school, effort in school, and effectiveness of study habits in school* via four questions answered on a five-point Likert scale ranging (respectively) from 5 = "Extremely Important" to 1= "Not at all Important"; 5 = "I put all possible effort into school," 1 = "I put minimal effort into school"; and 5 = "Extremely effective" 1 = "Not effective at all." Each was modeled as a quantitative variable.

Descriptive and bivariate analyses

Descriptive and bivariate analyses were conducted in R. We calculated descriptive statistics for our other dependent variables as a function of participants' prescription stimulant misuse in the last 12 months. Therefore, we conducted *t*-tests for difference in means or chi-square tests for difference in proportions for each variable across stimulant misuse status.

Multiple logistic regression

To test our hypotheses, we used multiple logistic regression in which *gender* (dummy coded where Male = reference group; Female, Other = 1), *year in school* (dummy coded where First Year = reference group; Second Year, Third Year, Fourth Year = 1), *race/ethnicity* (dummy coded where White = reference group; Hispanic, Latinx or Spanish Origin of any race; American Indian or Alaskan Native; Asian; Black; One or more races; Choose not to identify = 1), *GPA, number of credits, importance of school, satisfaction with performance in school, effort in school, effectiveness of study habits in school, spacing* (0 = do not space studying over multiple days/weeks; 1 = space studying over multiple

Table 1. Descriptive statistics by student's prescription stimulant use ($N = 334$).

	Students who did not misuse prescription stimulants ($N = 278$–298)		Students who misused prescription stimulants ($N = 30$–36)	
	Mean or %	SD	Mean or %	SD
Age	19.97	3.33	18.97	1.25
# Credits	14.81	2.10	14.60	1.83
Race/ethnicity				
Asian	8%		0%	
Black/African American	1%		0%	
White	67%**		89%	
Hispanic/Latino/Spanish Origin	10%		3%	
American Indian/Alaskan Native	1%		0%	
Other/prefer not to respond	13%		8%	
Gender				
Male	28%**		10%	
Female	72%**		90%	
Year in school				
First year	54%		57%	
Second year	21%		33%	
Third year	15%		7%	
Fourth year	10%		3%	
# Low effective study habits	1.94	1.00	2.03	0.81
# High effective study habits	2.01**	1.07	2.73	0.87
# Total study habits	3.71†	1.81	4.33	1.90

Note. Significance reflects results from t-tests for difference in means or chi-squared tests for difference in proportions for each variable across stimulant misuse status.
†$p < .10$.
*$p < .05$.
**$p < .01$.

days/weeks), *number of total study strategies, number of effective study strategies,* and *number of ineffective study strategies* were predictors and *prescription stimulant misuse in the last 12 months* was the outcome variable (0 = did not misuse prescription stimulants in the last 12 months; 1 = did misuse prescription stimulants in the last 12 months).[2] Because the number of total study strategies was collinear with number of effective strategies and number of ineffective strategies, we ran two logistic regression models. The first model included the number of effective study strategies and number of ineffective study strategies (and all other predictors, except for the number of total study strategies). The second regression model included the number of total study strategies (and all other predictors except for the number of effective and ineffective study strategies). We refer to these models as the "Effective/Ineffective Strategies Model" and the "Total Strategies Model", respectively. Importantly, the above-mentioned chi-square tests of independence were used to supplement our hypothesis testing.

Power analysis

To determine whether we had a large enough sample size to detect an effect using the aforementioned models, we used Agresti's (2007) recommendations for multiple logistic and linear regression.[42] Agresti argues that an N of 10 is required for each predictor in the model to have sufficient power to detect a small effect. Thus, with 11-12 predictors and an N of 334, we determined that we had sufficient power with $(1 - \beta)$ set at .80 and $\alpha = .05$.

[2]Unless otherwise noted, predictor variables were modeled continuously.

Results

Prescription stimulant misuse

Of the 334 participants, 36 reported misusing prescription stimulants within the last year (11%; participants who had used, but not in the last 12 months, were not considered to be misusers). Among those who had misused prescription stimulants in the last year, the most frequently used prescription stimulants were Adderall (determined by average days used in the last month $M = 2.80$ days, $SD = 5.90$ days), Ritalin ($M = 0.63$ days, $SD = 2.76$ days), and Vyvanese ($M = 3.43$ days, $SD = 8.91$ days). Students who misused prescription stimulants were more likely to be White and female (see Table 1). Bivariate statistics can be found in Table 2.

Study strategies

Among all participants, students reported regularly using an average of 3.73 ($SD = 1.86$) out of a possible 10 study strategies. Students regularly used slightly more effective strategies ($M = 2.08$, $SD = 1.08$) than ineffective strategies ($M = 1.96$, $SD = 0.98$). Forty seven percent of students reported using spacing (i.e., "I most often space out my study sessions over multiple days/weeks").

Group differences in study strategies

A full list of study strategies, including frequencies for students who misused prescription stimulants and students who did not misuse prescription stimulants, can be found in Table 3. To test Hypothesis 1, we used the aforementioned set of multiple logistic regression models and chi-square

Table 2. Means, standard deviations, and correlations with confidence intervals.

Variable	*M*	*SD*	1	2	3	4	5	6
1. Stimulant users	0.10	0.30						
2. Age	19.87	3.20	−.09 [−.20, .02]					
3. # Credits	14.80	2.08	−.03 [−.14, .08]	−.18** [−.29, −.07]				
4. Days used stims	0.95	5.26	.37** [.26, .48]	−.05 [−.18, .08]	.02 [−.11, .15]			
5. # Ineffective strategies	1.96	0.98	.03 [−.09, .14]	−.07 [−.18, .04]	.10 [−.01, .21]	−.03 [−.16, .10]		
6. # High effective strategies	2.08	1.08	.20** [.09, .30]	−.01 [−.12, .10]	.02 [−.10, .13]	.10 [−.03, .22]	.17** [.06, .27]	
7. Total # strategies	3.73	1.86	.10 [−.01, .21]	−.06 [−.17, .06]	.08 [−.04, .19]	.05 [−.08, .18]	.74** [.68, .78]	.79** [.74, .83]

Note. *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014).
*$p < .05$.
**$p < .01$.

tests of independence. Contrary to Hypothesis 1, spacing was not a significant predictor for prescription stimulant misuse in the Effective/Ineffective Strategies Model ($b = -0.28$, $p = .59$), nor the Total Strategies Model ($b = -0.09$, $p = .85$). Additional analyses indicated that use of spacing was similar across students who misused and students who did not misuse: 59% of those who reported misusing and 55% of those who did not report misusing reported studying in multiple sessions across days/weeks before the test ($X^2(1) = 0.21$, $p = .65$).

To test Hypotheses 2-4, we ran the pair of logistic regression models and additional chi-square analyses. Contrary to Hypothesis 2, we found that the number of total study strategies significantly and *positively* predicted prescription stimulant misuse ($b = 0.31$, $p = .06$), such that with each additional study strategy a student reported, the odds of the student misusing prescription stimulants were 1.36 times higher. We found a similar pattern with Hypothesis 3: the number of effective study strategies significantly and *positively* predicted prescription stimulant misuse ($b = 0.56$, $p = .03$), such that with each additional effective study strategy reported, the odds of the student misusing prescription stimulants were 1.75 times greater. Additional chi-square analyses indicated that students who misused prescription stimulants were significantly more likely to report using flashcards (an effective study strategy) than students who did not misuse prescription stimulants ($X^2(1) = 8.19$, $p = .00$). Finally, we did not find support for Hypothesis 4, as the number of ineffective study strategies did not significantly predict stimulant misuse ($b = 0.04$, $p = .88$). However, additional chi-square analyses indicated that students who misused prescription stimulants were significantly more likely to use the ineffective study strategies of rereading ($X^2(1) = 5.91$, $p = .01$), and recopying notes ($X^2(1) = 4.43$, $p = .04$; see Table 3).

Last, we tested our exploratory hypotheses via our regression models. We found that importance of school significantly and positively predicted prescription stimulant misuse (Effective/Ineffective Strategies Model: $b = 0.49$, $p = .06$; Total Strategies Model: $b = 0.51$, $p = .05$), such that with each one unit increase in self-rated importance of school (with higher values indicating more importance), the odds of the student misusing prescription stimulants were 1.63-1.65 times greater. Participants' self-rated satisfaction with performance in school (Effective/Ineffective Strategies Model: $b = -0.16$, $p = .28$; Total Strategies Model: $b = -0.14$, $p = .31$) effort in school (Effective/Ineffective Strategies Model: $b = 0.02$, $p = .93$; Total Strategies Model: $b = -0.02$, $p = .91$), and effectiveness of study strategies in school (Effective/Ineffective Strategies Model: $b = -0.07$, $p = .67$; Total Strategies Model: $b = -0.07$, $p = .66$) did not significantly predict stimulant misuse.

Discussion

Consistent with previous surveys, students reported using a mix of effective and ineffective study strategies.[30–33,39,40] For example, retrieving information from memory is a highly effective strategy and most students (80%) reported testing themselves.[29–31] In contrast, highlighting and rereading are study strategies that do not significantly improve learning, but over half of students reported using these strategies frequently.[38,43]

Critically, this study examined students' regular use of effective study strategies as a function of whether the student illicitly used/uses prescription stimulants. Specifically, we predicted that students who spaced their studying would be less likely to misuse. We also hypothesized that students who reported using more study strategies, and likewise, more effective study strategies, would be less likely to misuse prescription stimulants. Finally, we expected that students who used more ineffective study strategies would be more likely to misuse prescription stimulants. We found that spacing and number of ineffective study strategies were not

significant predictors of prescription stimulant misuse. Contrary to our predictions, our results indicated that the number of total study strategies was a significant and positive predictor of prescription stimulant misuse. Likewise, number of effective study strategies was a significant and positive predictor of prescription stimulant misuse. Interestingly, the prescription stimulant misusers did not appear to be more knowledgeable about effective study strategies relative to the students who did not misuse. Although the students who misused prescription stimulants were more likely to use effective study strategies such as testing, they were also more likely to use ineffective strategies such as rereading and highlighting.

Consistent with existing research, it appears that prescription stimulant misuse is widespread on college campuses, with other samples reporting anywhere from 2-38% annual prevalence rates (in the current study, roughly 10% of students reported using in the last year).[39] Also congruent with previous literature, White students were more likely to use prescription stimulants compared to Students of Color (see Table 1), though our sample contained very few Students of Color. However, contrary to existing literature documenting increased prevalence among males,[5] females comprised a significantly greater proportion of stimulant misusers (90%) than non-stimulant misusers (72%) in this sample.

Importantly, the current results suggest that students in this sample do not use prescription stimulants as a substitute for effective studying. The students who misused prescription stimulants appeared to regularly practice more effective study strategies, suggesting that students may misuse prescription stimulants *in addition* to effective studying to further augment their academic efforts. Indeed, students' self-rated importance of school significantly predicted prescription stimulant misuse in this study; thus, it may be that students who feel pressured to excel academically misuse prescription stimulants to aid in this goal. Therefore, teaching students about effective study strategies may not mitigate prescription stimulant misuse among college students as students may continue to be motivated to supplement effective studying with stimulants.

One concerning possibility is that the belief that prescription stimulant misuse can enhance academic performance may spread via study groups. If students discuss their stimulant misuse with peers, it may establish a faulty belief that more students misuse prescription stimulants, leading to increased stimulant misuse.[35,41] In contrast, students tend to underestimate the number of effective study strategies their peers use.[35] Future research should examine whether prescription stimulant misuse could be reduced by teaching students that few of their peers misuse stimulants, but many of their peers use a range of effective study strategies to be successful in school.

Preliminary studies suggest that rates of misuse may also be high at competitive schools and in fields where pressure to study and excel academically supports the conclusion that students are misusing in an effort to enhance their study habits or maintain their edge in school (rather than make up for poor study habits).[9,20–22] Cohen[44] even suggests that, "Adderall has become to college what steroids are to baseball: an illicit performance enhancer for a fiercely competitive environment." Still, whether stimulants actually enhance academic performance remains inconclusive.[4] Students may misuse stimulants to aid their poor time management or procrastination.[45] Students who engage in other substance misuse and/or risky behavior are also more likely to misuse stimulants,[12,27,46] and thus, students may misuse prescription stimulants to compensate or mitigate the ill effects of their other substance use. Future research should examine study behaviors in conjunction with behavioral and emotional tendencies to capture a fuller picture of stimulant misuse.

Prescription stimulant misuse among college students has dangerous consequences for the newest generation of employees. A recent study on 11 million U.S. workers indicated that positive workplace drug tests have peaked with prescription-stimulant drugs being the second most prevalent drug found in tests behind marijuana.[47] Alarmingly, students and young employees report that misusing prescription stimulants allowed them to keep their edge and stay competitive in their work while maintaining life duties outside of work.[47] Experience, education, and the need for sustainable income all contribute to increased competition for today's college students upon entering the workforce. It may be that college students are turning to drugs to enhance their cognitive repertoire and get a "leg up" on the competition before/while entering the workforce.

Limitations

The participants in this study came from a psychology research pool and thus it is possible that this sample does not fully demonstrate the attitudes and behavior of all undergraduate students, including those who have not been exposed to psychology-related material relevant to this study (cognition, drug use). Likewise, it is important to acknowledge that the attitudes and behaviors of ~300 students at one university do not generalize to students across the nation. Moreover, this sample primarily identified as White and female, further limiting the generalizability of these results. Existing research suggests that students' risk for prescription stimulant misuse increases with additional years in college;[15] in the current study, 72% of students were in their first or second years of school. Thus, it is possible that our results underestimate stimulant misuse on this campus. Prescription stimulant misuse is, formally, a Schedule II-level drug possession offense punishable by a minimum fine of $1,000 and up to one year in jail.[4] Thus, while we ensured anonymity and confidentiality of study results, it is probable that self-report biases may have deterred students from honestly reporting their prescription stimulant misuse, potentially limiting generalizability. Finally, the present study focused on non-prescription stimulant misuse. Importantly, students can misuse stimulants even with a prescription (e.g., by using in excess). The methods in current study did not capture these misusers, nor did they capture students who responsibly used a prescription stimulant under a

doctor's orders; thus, these results do not encompass the full spectrum of those who misuse prescription stimulants.

Future directions

Lakhan and Kirchgessner[9] maintain that prescription stimulants do not provide any sort of intellectual enhancement to non-medical users; rather, the chemical boost of dopamine and epinephrine in the brain may contribute to increased concentration and ability to study. However, the utility of prescription stimulants for cognition, memory, and mood vary according to the pharmacological literature; scholars should continue this line of work.[48,49] Reported symptoms of the non-medical use include improved focus, alertness, reading comprehension, processing speed, interest, and memory—though some of this may be misattributed feelings of increased arousal as some studies have found.[13,50,51] Future research should examine influences on college students' attention, energy, and brain functioning as they relate to prescription stimulant misuse. Similarly, researchers should consider external pressures to misuse including increased parental involvement in students' academic affairs, greater pressure to succeed for post-college endeavors, and the rising costs of college (e.g., students may use stimulants to effectively complete their schooling and work a demanding part-time job), perhaps through motivational interviewing techniques.[52–54]

Past efforts to reduce prescription stimulant misuse have traditionally targeted misusers.[55] However, college students' patterns of use and misuse can vary. Future studies should examine differences among misusers (those who misuse stimulants without a prescription), users (those with a prescription who only use stimulants as prescribed), users/misusers (those with a prescription who use as prescribed and also misuse their prescription), and non-users/misusers (those who do not have a prescription they use and do not misuse). Additionally, 62% of those with a prescription for stimulants (to treat their ADHD, etc.) sell their medication to misusers and relatively few know the consequences of distributing (the legal penalty for distributing any amount of Schedule II level drugs is a 1–5 million dollar fine and up to 20 years in prison).[4] College-based interventions centering on the risks of sharing and selling prescriptions may effectively curtail distribution and use across college campuses. Campus health personnel should disseminate the risks and consequences to students with stimulant prescriptions, especially when prescriptions are administered after adulthood. First year orientation may also be an excellent place to make college students aware of the risks associated with selling and/or illegally obtaining the drugs on college campuses. Notably, impediments to large-scale intervention efforts include students perceiving misuse as normal or commonplace, which could have reverse effects (e.g., Project Drug Abuse Resistance Education 'DARE').[56] College campuses should carefully consider the potential harms associated with campaigns meant to reduce prescription stimulant misuse.

Conclusion

College is a time that many young adults develop effective work and time management strategies that they will use for the completion of their degree and eventual workplace successes. Many college students are unaware of the dangers of misusing prescription stimulants from both legal and health standpoints,[57] and thus may be at greater risk for deteriorating their mental and physical health during these critical years. In examining the use of spacing and effective and ineffective study strategies in an undergraduate sample, this study is the first to provide additional insight on the demographic of college students most at risk for misuse from a studying perspective. It suggests that prescription stimulants may not be misused as a substitute for effective studying, but rather misused as a means to study more and/or increase concentration. Replication studies are a necessary first step to best answer this research question. Nonetheless, universities should further consider students' motivations to enhance their academic endeavors at the expense of their health. Such efforts have the potential to better the health and wellbeing of today's college students and, ultimately the newest generation of U.S. workers.

Conflict of interest disclosure

The authors have no conflicts of interest to report. The authors confirm that the research presented in this article met the ethical guidelines, including adherence to the legal requirements of the United States and received approval from the Institutional Review Board of Colorado State University.

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Data availability statement

Derived data supporting the findings of this study are available from the corresponding author on request.

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