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BRIEF REPORT

Cognitive Enhancement and Coping in an Australian University Student Sample

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Abstract Cognitive enhancement (CE) agents are those purported to improve or augment aspects of cognition such as working memory, creativity, and executive function in healthy individuals. CE by university students looking to improve their academic performance, particularly through the use of pharmacological agents (or *nootropics*), has become an area of increasing interest for researchers. However, studies on the prevalence of, and motivations behind, students' CE use at Australian universities are limited. This study aimed to contribute a new sample of prevalence data, as well as corroborate previous qualitative research that has suggested that emotion-focused and avoidant coping styles may make students more susceptible to utilizing CE drugs. A sample of $N=633$ individuals was recruited to complete the "Cognitive Enhancement and Student Lifestyle Survey" online. The key questions of interest concerned students' enhancement drug usage habits, usage motivations, and coping styles. Analyses found that 6.32% of students indicated lifetime use of prescription CE agents for the purposes of study-related enhancement. Furthermore, dysfunctional coping strategies were associated with an increased likelihood of both lifestyle and prescription CE drug use. Findings from this study refine current understandings of enhancement drug use in Australia and are contextualized in regard to potential avenues for on-campus health interventions and regulatory opportunities. In particular, helping students to maintain manageable stress levels through identifying less harmful coping strategies may prove useful.

Keywords Cognitive enhancement · Coping · Stress · University students · Prescription stimulants · Prevalence

Introduction

In recent years, cognitive enhancement (CE) practices have been the subject of great interest in both the bioethical literature and the wider community. As cognitive neuroscience and psychopharmacology have advanced, so too have the techniques purported to "enhance" the human experience. CE agents are those that are said to improve or augment aspects of cognition such as working memory, creativity, and executive function in healthy individuals (Franke et al. 2012). Of particular interest to researchers is the use of CE drugs (also commonly referred to as nootropics or neuroenhancers) by students seeking to improve their academic performance (Forlini and Racine 2009). Despite the fact that such academic advantage is often cited as a primary reason for engagement in CE, studies often find a negative relationship between CE drug use and academic outcomes (Arria and Compton 2017; McCabe et al. 2005; Munro et al. 2017).

Surveys of student populations around the world have revealed cross-cultural differences in CE drug usage prevalence rates (Franke et al. 2011; Schelle et al. 2015; Wilens et al. 2008). For example, in a systematic review, *past-year* prescription stimulant use for the purposes of study-related CE by college students in the USA was reported to range between 5 and 35% (Wilens et al. 2008). Prevalence rates within Europe appear lower: in a study of high school and university-aged students in Germany, *lifetime* prescription stimulant use for the

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purposes of enhancement was shown to be a mere 1.3% (Franke et al. 2011), while Maier et al. (2015) found that 12% of their sample of Swiss university students had used prescription CEs in their lifetime to enhance their academic performance. In the only current direct prevalence study among university students in Australia, Mazanov et al. (2013) reported a 10% lifetime prevalence rate of prescription stimulant use by students, with 48% of these individuals reporting use specifically for the purposes of study-related enhancement.

More recently, studies have moved beyond simply charting enhancement drug prevalence rates at universities to further understand the related factors that compel students to use CEs (Mazanov et al. 2013; Schelle et al. 2015; Wolff and Brand 2013). This has lead researchers to broaden their understanding of CE and to examine common underlying psychological factors, such as personality (Sattler and Schunck 2016); perfectionism (Stoeber and Hotham 2016); and stress (Ford and Schroeder 2009; Forlini et al. 2015; Maier et al. 2013; Wolff and Brand 2013) as potential predictors of drug use of this type. Adopting health psychology frameworks, some studies (e.g., Jensen et al. 2016) have also considered the role of coping and its relation to CE.

Stress and coping are intimately related, and stress has been found to be most prominent when a particular stressor exceeds an individual's perceived ability to cope (Andersson and Willebrand 2003; Billings and Moos 1981). Therefore, it may be that cognitive enhancement is a coping strategy to deal with the stress and pressure typically associated with university life (Schelle et al. 2015). This is reflected in the literature: CE has been examined extensively as a response to academic-related stress (Ford and Schroeder 2009; Forlini et al. 2015; Sattler et al. 2014; Sattler and Wiegel 2013; Wolff and Brand 2013). Comparatively little is known, however, about the relationship (if any) between enhancement drug use and coping. As is the case in research on users of recreational drugs (Hien and Miele 2003; Staiger et al. 2009; Wong et al. 2013), particular styles of coping may be associated with CE drug use among university students.

In an initial attempt to distinguish and understand different methods of coping, Lazarus and Folkman (1984) suggest that coping strategies may be classified as "problem-focused" and "emotion-focused." Emotion-focused strategies are those that aim to manage or control the emotions associated with the perception of stressful life experiences. Problem-focused strategies, rather, concern more practical approaches that attempt to directly manage the stressful stimulus (Cooper et al. 2008). Carver et al. (1989) then extended this model further to account for the distinction between helpful and unhelpful (or dysfunctional) coping strategies. As such, the authors developed a coping model reflecting three factors: problem-focused, emotion-focused, and dysfunctional coping strategies.

In a qualitative investigation of coping and its relation to CE, Jensen et al. (2016) found that users of lifestyle and prescription CE drugs commonly reported using avoidant, emotion-focused coping strategies until these no longer minimized stress and problem-focused strategies were employed. This was common to the limited CE users in the sample who rated on average higher levels of stress and lower coping ability and employed CEs as a problem-focused strategy when under pressure to perform. The primary aim of the current study was to use quantitative methods to examine the relationship (if any) between the coping styles proposed by Carver et al. (1989) and students' CE practices.

Given the relatively limited number of Australian studies, a secondary aim was to corroborate prevalence rates of CE drug use among university students for comparison to international trends. The need to understand rates of use and to characterize prototypical users is critical for support providers and regulators as they attempt to implement evidence-based health interventions, particularly for students experiencing problems with CE drug misuse (Arria et al. 2013).

Method

Participants and Recruitment

Six hundred and forty-two participants were recruited through advertisement via the University of Melbourne electronic communications and social media in 2016. Respondents were required to be between ages 18 and 29 and enrolled at an Australian university to be considered eligible for participation. The data from the present study are unique, but based on the format of a larger nationwide Cognitive Enhancement and Student Lifestyle Survey that was approved by both the University of Queensland (#2014001403) and University of Melbourne (#1646924) Human Research Ethics Committees.

Although responses were entirely anonymous, students could provide their email address to (i) enter the prize draw for gift vouchers and Apple iPads provided as an optional incentive for participation, (ii) receive a summary of study findings, and (iii) with additional consent, to indicate their willingness to be contacted in the future for participation in a follow-up interview.

Procedures

The landing page of the online survey provided study information and participation criteria, followed by a consent response item required for the survey to be initiated. Cognitive enhancement was defined as "The non-medical use of prescription stimulants (such as Ritalin®, Adderall®, and modafinil without a prescription from a doctor) by students in an attempt to enhance their alertness, concentration, motivation or overall productivity."

The survey included demographic questions (age, education, general health, etc.). This was followed by a list of various drugs. Based on previous work (e.g., Schelle et al. 2015; Wolff and Brand 2013), we grouped CE agents into three distinct classes, including lifestyle (e.g., caffeine, alcohol, energy drinks), prescription (e.g., Ritalin®, Adderall®, modafinil), and illicit drugs (e.g., cocaine, ecstasy, marijuana) and included an "other" option for substances not listed (see Table 1 for the full list of drugs included). Participants were prompted to indicate any past use. For those drugs for which usage had been indicated, respondents were further prompted to report frequency, patterns, and consequences of use (full survey is available on request).

The 28-item Brief COPE Inventory (Carver 1997) was used to assess coping strategies. Participants indicated the frequency that they engaged in the target behavior on a 4-point scale (*1* = "I have not been doing this at all," *4* = "I have been doing this a lot"). Following recommendations by Cooper et al. (2008), the fourteen sub-scales of this inventory were combined to form three overarching categories: emotion-focused (including items from "acceptance," "emotional support," "humor," "positive reframing," and "religion" sub-scales); problem-focused (including items from "active coping," "instrumental support," and "planning"); and dysfunctional coping scales (included items from "behavioral disengagement," "denial," "self-distraction," "self-blame," "substance use," and "venting").

Results

Participants

The final sample (N = 633) comprised 452 females (71.4%) and 181 males (28.6%) (M_{age} = 21.47, SD = 2.88). Three participants were removed from the initial sample because they were over 29 years of age, and six participants were removed because they were enrolled at a university outside Australia. Within the sample, n = 421 individuals reported studying at an undergraduate level (66.5%), and n = 228 participants were international students (36.0%). Respondents reported studying degrees from a range of disciplines, but Science (21.8%) and Commerce (12.7%) degree students were the most represented.

Patterns of Enhancement Drug Use

A total of n = 320 individuals (50.60%) reported having used at least one lifestyle drug for the explicit purpose of CE in their lifetime. The prevalence of prescription enhancement drug use was comparatively lower, with n = 40 individuals (6.32%) reporting lifetime use. Only n = 13 individuals (2.1%) reported lifetime use of illicit substances for the purposes of enhancement. In contrast, recreational drug use (for purposes other than CE) was higher, with n = 182 (28.80%) respondents reporting use of at least one illicit substance listed recreationally. Past-year and lifetime prevalence rates across all classes are displayed in Table 1.

Table 1 Prevalence of the use of prescription, lifestyle, and illicit drugs for the explicit purpose of study-related CE across the total sample

Substance	Lifetime use		Past-year use	
	n	%	*n*	%
Lifestyle				
Alcohol	24	3.79	21	3.32
Caffeine pills	38	6.00	27	4.27
Cola	90	14.22	78	12.32
Energy drinks	133	21.01	98	15.48
Tea	200	31.60	189	29.86
Coffee	286	45.18	269	42.50
Prescription				
Unspecified	1	0.20	1	0.20
Beta-blockers	2	0.32	2	0.32
Benzodiazepines	10	1.58	7	1.12
Adderall	11	1.74	6	0.95
Ritalin	12	1.90	10	1.58
Modafinil	21	3.32	19	3.00
Illicit				
Speed	1	0.16	0	0.00
Ecstasy	1	0.16	1	0.16
GHB	1	0.16	0	0.00
Cocaine	2	0.32	0	0.00
Unspecified	4	0.63	0	0.00
Marijuana	7	1.12	6	0.95

For clarity, only the five most popular substances within each category are shown. The following drugs were also included in the survey: Lifestyle—cold and flu tablets, *Ginkgo biloba*, nicotine (patches, gum, e-cigarettes), Omega-3, tobacco (cigarettes, pipes); Prescription—Aricept, mephedrone, racetam, ketamine, Strattera; Illicit—DMT, heroin, ice, LSD, magic mushrooms

Finally, participants also demonstrated high levels of polydrug use. Chi-square tests found a significant association between the use of both lifestyle and prescription drugs for the purposes of enhancement, and the use of recreational drugs more generally, $\chi^2(1) = 54.74$, $p < .001$; $\chi^2(1) = 54.41$, $p < .001$, respectively.

Coping Strategies and Enhancement Drug Use

Given that only 2.1% of individuals indicated lifetime use of illicit substances for study-related purposes, this group was considered too small for any meaningful statistical investigation. As such, analyses below were performed exclusively between users and non-users of prescription and lifestyle

enhancement agents. A binomial logistic regression was performed to ascertain the effects of emotion-focused, problem-focused, and dysfunctional coping styles on the likelihood that individuals would be users of these CE drugs. Before analyses were undertaken, the assumption of linearity in the logit of the dependent variable was assessed using the Box-Tidwell procedure (1962). To address the issue of multiple comparisons, a Bonferroni correction was applied to the model, and statistical significance (i.e., a violation of this assumption) was accepted when $p < .007$ (Tabachnick and Fidell 2007). Inspection revealed that all continuous independent variables were linearly related to the logit of the dependent variable, and data deemed suitable for logistic regression.

Lifestyle and Prescription Enhancement Drug Use

Logistic regression models with emotion-focused, problem-focused, and dysfunctional coping sub-scales as predictors of lifestyle and prescription enhancement drug use were statistically significant: $\chi^2(3) = 47.44$, $p < .001$; $\chi^2(3) = 25.92$, $p < .001$, respectively. The regression model explained 10.0% (Nagelkerke R^2) of the variance in lifestyle enhancement drug use and correctly classified 60.5% of cases. In the prescription CE drug group, the regression model explained 11.7% (Nagelkerke R^2) of the variance in prescription enhancement drug use and correctly classified 93.7% of cases. In both prescription (Table 2) and lifestyle (Table 3) groups, dysfunctional coping was the only statistically significant predictor of engagement in CE drug use. In short, greater propensity to utilize dysfunctional coping strategies was associated with a significantly increased likelihood of both lifestyle and prescription CE drug use.

Discussion

This study sought to investigate CE drug prevalence rates and usage patterns of Australian university students. In order to better conceptualize the motives that underlie students' CE drug use, and using work by Jensen et al. (2016) as a justification for further analyses, this study also sought to identify the relationship (if any) between the coping styles proposed by Carver et al. (1989) and students' CE practices.

Overall, the prevalence of prescription enhancement drug use was relatively low and consistent with the limited previous studies on Australian samples (Mazanov et al. 2013; Partridge et al. 2012). In this study, 6.32% of individuals reported lifetime use of one or more prescription CE drugs listed for the purposes of study-related enhancement. Modafinil was the most popular nootropic, with a total of $n = 19$ individuals (3.00%) reporting its use for the purposes of study-related enhancement in the last 12 months. Although this overall finding is similar to that found in the paper by Mazanov et al. (2013), among their sample of modafinil users, only 49% of individuals reported using this substance exclusively for the purposes of study-related CE. This increase in use may be a consequence of recent research highlighting the lower abuse potential of modafinil in comparison to stimulant medications, such as methylphenidate and other mixed-amphetamine salts (Mereu et al. 2013, for review). It will be important to monitor whether this trend towards increasing use of modafinil continues in the future.

As expected, the use of lifestyle drugs for CE was comparatively much higher, with 50.60% of students reporting lifetime use of at least one of the substances listed (commonly coffee, tea, and energy drinks). Contrastingly, the use of illicit drugs for CE was the lowest of all the substance categories: only 2.1% of individuals reported use of one or more listed illicit substances for CE. For perspective, 28.8% of the sample reported the use of illicit substances for recreational purposes. This finding is in accordance with previous estimates on recreational drug use in Australian university-aged samples (Australian Institute of Health and Welfare 2013). Similarly, polydrug use in our sample was high: a significant relationship was found between the use of both prescription and lifestyle drugs for the purposes of enhancement and the use of recreational drugs more generally. This result is consistent with previous research on the positive relationship between recreational and enhancement drug use in overseas samples (Eickenhorst et al. 2012; McCabe et al. 2005; Schelle et al. 2015).

Indeed, contrary to reports in the media, the use of prescription CE agents by students is not "as common as coffee" (Partridge et al. 2011). In fact, our data suggest that consumption of prescription drugs for enhancement by Australian university students is lower than that in the USA (McCabe et al. 2005; Weyandt et al. 2009; Wilens et al. 2008) and more similar to that in Europe (Franke et al. 2011; Mache et al. 2012; Schelle et al. 2015). Importantly, the results from this study also support previous CE usage prevalence estimates in Australian university student populations derived by Mazanov et al. (2013).

While previous studies have focused on CE as a coping strategy for dealing with excessive academic demands (Sattler et al. 2014; Sattler and Wiegel 2013), this study was the first to quantitatively consider CE and its relation to coping styles more generally. Results found that, in both lifestyle and prescription drug groups, greater reported use of dysfunctional coping strategies was associated with a significantly increased likelihood of engagement in CE drug use.

Conversely, a tendency to use emotion-focused coping styles was not a significant predictor of lifestyle and prescription enhancement drug use. While our findings do not support emotion-focused coping as a strategy correlated with engagement in CE, or the Lazarus model of coping as in Jensen et al. (2016), it does support the observation of Jensen et al. (2016) that coping may be an influential factor in students' use of CE

Table 2 Logistic regression model predicting likelihood of prescription CE use based on the three brief COPE sub-scales

Sub-scale	*B*	*SE*	Wald	*df*	*p*	Odds ratio	95% CI for odds ratio	
							Lower	Upper
Emotion-focused	− .01	.04	.05	1	.82	.99	.91	1.08
Problem-focused	− .01	.06	.05	1	.87	.99	.88	1.12
Dysfunctional coping	.15	.03	23.52	1	.00**	1.16	1.09	1.23
Constant	− 6.24	1.29	23.57	1	.00**	.00		

**$p < .001$

drugs. While we consider these findings an important contribution to the literature, our comparatively smaller sample of users in comparison to non-users (in both prescription and illicit drug groups) undoubtedly limits the strength of conclusions that can be drawn from our data. Using a revised coping model by Cooper et al. (2008), we found that dysfunctional coping was related to CE use; however, this is unlikely to be the only factor related to students' enhancement practices. Previous studies have emphasized illicit drug use (Eickenhorst et al. 2012; McCabe et al. 2005; Schelle et al. 2015); availability and association to other CE users (Desantis et al. 2010; Vrecko 2015); and attitudes (Partridge et al. 2012) as important drivers. It will therefore be important for future research to both replicate our main finding and to further explore the relationship between coping styles and the range of other factors known to impact CE use.

The fact that higher dysfunctional coping strategies were associated with an increased likelihood of lifestyle and prescription enhancement drug use is consistent with previous recreational drug use research, particularly in adolescent populations (Windle and Windle 1996). However, the lack of extant research on differences between users and non-users of CE drugs in terms of their coping strategies makes possible interpretation largely speculative. Regardless, it is perhaps possible that the present relationship reflects the maladaptive nature of both dysfunctional coping and CE drug use. Although the use of CE drugs (particularly prescription drugs) may be perceived by students as an effective short-term means to cope with academic stress, data suggest that this behavior is unlikely to be a healthy short- or long-term strategy (Dussault and Weyandt 2013). Similarly, although dysfunctional coping strategies (e.g., denial, behavioral disengagement, and avoidance) may provide students with short-term relief from overwhelming demands, these behaviors do not address the cause of the stressor and are likely to be similarly maladaptive (Cooper et al. 2008).

Ultimately, the motives that underlie students' use of CE drugs are complex: attempting to attribute causal primacy to any one predictor is naïve. Regardless, this study adds to a wealth of existing research that suggests that students' use of CE agents to improve their study-related performance cannot be understood without first acknowledging how this behavior is embedded within multifaceted life contexts (Hildt et al. 2014). Although enhancement enthusiasts often consider this field simplistically (i.e., 'smart pills used by smart students'), students' true motives are evidently diverse.

A lack of research points to a need for further exploration of the relationship between enhancement drug use, coping, and health psychology more generally, with this study contributing to discussions regarding the underlying psychological coping mechanisms involved in CE behavior. Present findings suggest that while prevalence is low, the risks associated with use warrant better characterization of usage profiles to better assist interventions and support public health campaigns generally.

Limitations and Future Directions

Although this study provides some valuable insights into the CE drug use that occurs at Australian universities, there are some clear limitations that ought to be considered. Specifically, results should be interpreted in light of the convenience and cross-sectional sampling methods used. Students studying science degrees, women, and undergraduates were

Table 3 Logistic regression model predicting likelihood of lifestyle CE use based on the three brief COPE sub-scales

Sub-scale	*B*	*SE*	Wald	*df*	*p*	Odds ratio	95% CI for odds ratio	
							Lower	Upper
Emotion-focused	.02	.02	1.05	1	.31	1.02	.98	1.07
Problem-focused	−.04	.03	1.64	1	.20	.96	.91	1.02
Dysfunctional coping	.10	.02	35.64	1	.00**	1.10	1.07	1.14
Constant	−2.43	.61	15.78	1	.00**	.08		

**$p < .001$

also oversampled. As a result, the distribution of participants in the current study may not be an accurate representation of the entire student population at Australian universities. The number of illicit CE drug users was also so low that statistical analyses were deemed inappropriate for this group. Therefore, caution should be exercised in interpreting the results, given the constraints of our sample. As per previous work (Arria and Compton 2017; McCabe et al. 2005; Munro et al. 2017), future studies may consider examining the academic outcomes of Australian students that use CE drugs, particularly contextualized in regard to coping.

Conclusion

This study was designed in order to gauge the prevalence of enhancement drug use occurring at Australian universities. In addition, we used a health psychology framework to examine the relationship between coping styles and CE use. This evidence is vital in order to derive sounder public policy, and possible regulation of this type of drug use, particularly if enhancement drug acceptability and accessibility increase. In addition, this is the first study to quantitatively consider coping and its relation to students' enhancement drug use. Despite reports in the wider community, pharmacological neuroenhancement is not commonplace, but given the dangers inherent in some forms of enhancement drug use (Caplan et al. 2007), these behaviors must be monitored with aims of promoting student health and welfare.

In line with previous recommendations concerning regulatory opportunities for universities (Singh et al. 2014), education would appear critical to curb any proliferation in enhancement drug use within student populations. More specifically, preventative measures may center on empowering students to develop more effective coping strategies that address the root cause of their concerns *before* they turn to enhancement drug use (Maier and Schaub 2015; Wolff and Brand 2013). Furthermore, as Jensen et al. (2016) recommend, helping students to maintain manageable stress levels through identifying less harmful coping strategies may prove useful.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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