Bachelor Thesis

Substance use for cognitive enhancement among university students – What is the role of stress and conscientiousness?

Felix M. Pawlaczyk

s1670271

University of Twente

Supervisor: Inge Zweers

Second Supervisor: Gerben Westerhof

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Abstract

The use of cognitive enhancement drugs is becoming an increasing problem among university students. By using illegal or prescription drugs to enhance their cognitive performance they are exposing themselves to high mental and physical risks. It is well known that, aside from its abuse potential, these substances may aggravate mental illnesses, produce sleeping disorders and can lead to cerebrovascular complications. Although drug use, in general, has been widely examined in literature very little research exists about the possible risk-factors and underlying psychological mechanisms of cognitive enhancement drug use. The aim of this study was to examine the relation between the personality trait conscientiousness and cognitive enhancement drug use and the relation between stress and cognitive enhancement drug use. In addition, the effect of stress on the relation between conscientiousness and cognitive enhancement drug use was analysed. The reason for that is that stress and conscientiousness have been found to be important factors with regard to drug use in general. A cross-sectional study was performed analysing 175 students (126 women, 48 men, 1 other, M_{age} = 20.79) of different fields of study in the Netherlands. The participants were asked to complete an anonymous online survey. The results showed a weak negative correlation between conscientiousness and cognitive enhancement drug use, meaning that students high in conscientiousness reported using less cognitive enhancement drugs. Furthermore, it was found that there is no relation between stress and cognitive enhancement drug use. Students who experienced a high amount of stress did not report to use more cognitive enhancement drugs. Finally, the results indicate that stress does not moderate the relation between conscientiousness and cognitive enhancement drug use. The cognitive enhancement drug use of conscientious students did not increase when they were put under a high amount of stress. These results give an insight into the role of conscientiousness and stress in cognitive enhancement drug use and suggest that in conscientious people the use of such substances is not affected by stress.

Keywords: cognitive enhancement drug use, drug use, conscientiousness, stress

Introduction

The topic of cognitive enhancement drug use has received much attention in recent years (Schwarz, 2012; Shiner, 2013; Monks, 2014). It is becoming an increasing problem among individuals in cognitively demanding environments, such as schools and universities (Herman-Stahl, Krebs, Kroutil & Heller, 2007). Placed in a competitive environment and with several academic, social and financial demands it is especially common among university students (Hall, Irwin, Bowman, Frankenberger & Jewett, 2005; McNiel, Muzzin, DeWald, McCann, Schneiderman, Scofield & Campbell, 2011; Varga, 2012). High rates of students from different fields of study reported to use cognitive enhancing substances (Novak, Kroutil, Williams & Van Brunt, 2007; Repantis, Schlattmann, Laisney & Heuser, 2010). They are much more likely to use these substances than young adults who are not enrolled in university (Herman-Stahl, Krebs, Kroutil & Heller, 2007). Most studies, mainly conducted in the United States, identify a lifetime prevalence among university students ranging from 7 to 9% (Lord, Downs, Furtaw, Chaudhuri, Silverstein, Gammaitoni & Budman, 2009; Weyandt, Janusis, Wilson, Verdi, Paquin, Lopes, Dussault, 2009; Teter, McCabe, Cranford, Boyd & Guthrie, 2005; Carroll, McLaughlin & Blake, 2006). However, healthy individuals who are taking these substances for the purpose of cognitive enhancement instead of treatment expose themselves to high mental and physical risks (Chatterejee, 2006). It is well known that, aside from its abuse potential, substances that improve cognitive function may aggravate mental illnesses, produce sleeping disorders and can lead to cerebrovascular complications (Leonard, McCartan, White & King, 2004).

Definition of cognitive enhancement

In general, cognitive enhancement is defined as the extension of capacities of the mind by improving or augmenting internal or external information-processing systems. This means that a person who is engaged in cognitive enhancement is benefitting from an intervention improving his or her cognitive capacities, without curing a specific pathology that influences these cognitive capacities (Bostrom & Sandberg, 2009). These interventions can be of psychological nature, such as using mental strategies that foster cognitive capacities or by using advanced technology to modulate brain activity, such as deep brain stimulation, while others are medical ones that are based on chemicals that change the processes in the brain (Farah, Illes, Cook-Deegan, Gardner, Kandel, King & Wolpe, 2004). These medical interventions are also called pharmacological cognitive enhancement and refer to increasing one's cognitive capacities by using cognitive enhancing substances (e.g., Bostrom and Sandberg, 2009). The substances that are referred to in the discussion about pharmacological

cognitive enhancement can be divided into three categories. These categories are over-the-counter drugs, prescription drugs, and illicit drugs. Over-the-counter drugs are substances that can be bought legally and without much effort, for instance at the supermarket, like caffeinated drinks or caffeine pills (e.g., Franke, Konrad, Lieb & Huss, 2012; Wolff, Brand, Baumgarten, Lösel & Ziegler, 2014). Prescription drugs are drugs that were originally developed to treat neuropsychiatric disorders that are accompanied by cognitive deficits in affected individuals (Ragan et al., 2013). The most widely used drug of this category is methylphenidate, better known as Ritalin. It was originally developed to treat children with attention deficit hyperactivity disorder (ADHD) (Ragan et al., 2013). In individuals that are not affected by the disorder, the drug increases the accuracy in complex working memory tasks (Leonardo, McCartan, White & King, 2004; Outram, 2010). Other drugs that are often used are Modafinil and Adderall (Ragan et al., 2013). Modafinil improves executive functions and was originally developed to treat sleep disorders and Adderall was developed to treat ADHD and narcolepsy (Förstl, 2009). The category illicit drugs includes substances that are mainly used for recreational purposes but can also be used for cognitive enhancement, like cannabis or cocaine (e.g., Franke, Konrad, Lieb & Huss, 2012; Wolff, Brand, Baumgarten, Lösel & Ziegler, 2014). In table 1 an overview of the different substances that are associated with each category can be seen.

Table 1.

Different Categories of Substances for Cognitive Enhancement

Over-the-counter-drugs	caffeine pills, caffeinated drinks, cigarettes, alcohol and legally bought cannabis
Prescription Drugs	Methylphenidate (e.g. Ritalin, Concerta), Modafinil (e.g. Provigil), β-Blocker (e.g. Beloc), Amphetamine (e.g. Adderal, Desoxyn, Dexedrine), Fluoxetine (e.g. Prozac), Piracetam (e.g. Nootropil, Qropi, Myocalm, Dinagen, Synaptine) and medically prescribed Cannabis
Illicit Drugs	Amphetamine (e.g. Speed/Pep), Cocaine, Methylenedioxymethamphetamine/MDMA (Ecstasy), Heroin and illicitly bought Cannabis

Conscientiousness

Although the association between personality and cognitive enhancement drug use has not been examined before, research shows that a certain personality trait plays an important role in predicting general drug use. General drug use describes drug use that is not mainly aimed at increasing one's cognitive performance. Especially the trait conscientiousness of the well-validated Five-Factor-Model of personality (McCrae and John, 1992) has been found to be an important predictor of drug use (Terracciano, Löckenhoff, Crum, Bienvenu, & Costa, 2008). People who are low in conscientiousness are more likely to take light drugs such as cigarettes as well as hard drugs such as cocaine and heroin more regularly than people average or high in this trait (Terracciano, Löckenhoff, Crum, Bienvenu, & Costa, 2008). Booth-Kewley and Vickers (1994) were among the first to document the robust effect of conscientiousness against substance use. Since then, various investigations utilizing diverse samples have shown a strong connection between conscientiousness and substance use behaviour (Kashdan, Vetter, & Collins, 2005; Malouff, Thorsteinsson, Rooke, & Schutte, 2007; Malouff, Thorsteinsson, & Schutte, 2006; Terracciano, Lockenhoof, Crum, Bienvenu, & Costa, 2008). Furthermore, a meta-analysis of 194 studies showed that conscientiousness was negatively associated with tobacco use, alcohol use and the use of illicit drugs (Bogg & Roberts, 2004). When people low in conscientiousness abuse drugs they are mostly lacking the subparts competence, achievement-striving, and deliberation of conscientiousness (Terracciano, Löckenhoff, Crum, Bienvenu, & Costa, 2008).

The five-factor model of personality, also called the Big Five, is a model from personality psychology. It states that personality consists of 5 dimensions and the personality of every human being can be classified by looking at their scores on the different dimensions. These personality dimensions or traits are openness to experience, extraversion, agreeableness, neuroticism, and conscientiousness (McCrae and John, 1992). The dimension conscientiousness is characterized by the tendency to be organized, self-disciplined and aiming for achievement. High conscientiousness can be perceived as obsession while low conscientiousness is associated with spontaneity, which can eventually lead to a lack in reliability. Also, conscientious individuals are more disciplined, persistent and goal-oriented. By this they can stay focused and do everything it takes to complete tasks, making them more effective. Furthermore, conscientiousness is the trait that correlates the most with academic motivation and success in university students (Komarraju, Karau & Schmeck, 2009).

Stress

Another factor that plays a crucial role in general drug use but has not been examined with regard to cognitive enhancement drug use before is stress. There is substantial literature on the significant association between stress and the use of drugs. Many of the major theories of drug abuse and addiction state that stress plays a crucial role in the motivation to use drugs (Sinha, 2008). These models range from psychological models of drug use that view drug use as a coping strategy to deal with stress and to reduce tension (Russell and Mehrabian, 1975; Leventhal and Cleary, 1980; Shiffman, 1982; Sher and Levenson 1982; Marlatt and Gordon, 1985; Wills and Shiffman 1985; Khantzian 1985; Baker, Piper, McCarthy, Majeskie & Fiore, 2004) to neurobiological models that state that stress leads to changes in the brain reward system that result in a higher sensitivity to the reinforcing properties of drugs, which increases the risk for problematic use of addictive substances (Koob and Le Moal, 1997*; Hyman & Malenka, 2001; Robinson & Berridge 2008).* It was found that stress, among other risk factors such as parental substance use, peer pressure, and positive expectancies over the potential benefits of using substances, was associated with the greatest risk of drug use (Marlatt and Gordon 1985). Furthermore, experiencing a high number of stressful life events over time is related to a significant increase of drug use, even after controlling for an increase due to age or peer relations (Hoffmann, Cerbone & Su, 2000). Hereby, the term ‘’stress’’ is mostly defined as a process that involves the perception, interpretation, response, and adaption to challenging or threatening events (Lazarus and Folkman, 1984).

Stress and Conscientiousness

Given that stress is associated with an increased risk of drug use it is worthwhile to mention that the character trait conscientiousness has been found to have an influence on the appraisal of stress. People high in conscientiousness are more likely to evaluate a stressor as manageable instead of seeing it as a threat (Gartland, O’Connor, & Lawton, 2012). This means that the stress that they are experiencing is perceived as not that intensive. It is even indicated in the literature that conscientiousness might act as a protective factor against stressful experiences and perceived stress (Murphy, Miller, & Wrosch, 2013; Penley & Tomaka, 2002). The question arises if the drug use behaviour of conscientious people is influenced by stress or if their personality does indeed act as a protective factor against the effects of stress. With regard to cognitive enhancement drug use, it is interesting to investigate if the cognitive enhancement drug use behaviour of conscientious people increases if they are put under a high amount of stress.

Research questions and hypotheses

Overall, the topic of drug use has been widely researched in literature. Conscientiousness has been found to be the character trait that has the strongest connection with drug use behaviour (Kashdan, Vetter, & Collins, 2005; Malouff, Thorsteinsson, Rooke, & Schutte, 2007; Malouff, Thorsteinsson, & Schutte, 2006; Terracciano, Lockenhoof, Crum, Bienvenu, & Costa, 2008) and stress, among other risk-factors such as parental substance use, peer pressure, age, and positive expectancies over the potential benefits of using substances, is associated the most with problematic use of substances (Marlatt and Gordon 1985; Hoffmann, Cerbone & Su, 2000; Sinha, 2008). However, research on the underlying psychological mechanisms of cognitive enhancement drug use seems to be in its infancy. The relations between possible risk-factors and cognitive enhancement drug use either have not been confirmed consistently or have not been examined yet (Schelle, Olthof, Reintjes, Bundt, Gusman-Vermeer & Van Mil, 2015). There are no studies investigating the relation between conscientiousness and cognitive enhancement drug use or stress and cognitive enhancement drug use. Also, the role of stress in the relation between conscientiousness and cognitive enhancement drug use has not been examined, yet. This leads to the following three research questions of this study:

What is the relation between Conscientiousness and Cognitive Enhancement Drug Use?

What is the relation between Stress and Cognitive Enhancement Drug Use?

How is Stress affecting the relation between Conscientiousness and Cognitive Enhancement Drug Use?

Drug use, in general, can best be explained by low conscientiousness, because people high or average in this trait are less likely to abuse drugs (Terracciano, Löckenhoff, Crum, Bienvenu, & Costa, 2008). This makes it worthwhile to investigate if the same relationship between conscientiousness and drug use can also be seen with regard to cognitive enhancement drug use. People high in conscientiousness are the ones that are the most striving for academic success and achievement, which demands high cognitive performance (Komarraju, Karau & Schmeck, 2009). Interestingly, the motives for cognitive enhancement drug use were identified as the will to increase concentration and cognitive performance (Rabiner, Anastopoulos, Costello, Hoyle, McCabe & Swartzwelder, 2009; Peterkin, Crone, Sheridan & Wise, 2011). The question arises if conscientious people might want to stimulate their aim for success and achievement by using performance-enhancing substances. Compared to that, the motives for general drug use differ crucially. They are identified as the will to relax, become

intoxicated, stay awake when socializing, make an activity more enjoyable and suppress depressive mood (Boys, Marsden & Strang, 2001; Mache, Eickenhorst, Vitzthum, Klapp., & Groneberg, 2012). It is reasonable to assume that the cognitive enhancement drug use behaviour of conscientious people differs from their general drug use behaviour, since the motives differ crucially. This makes it reasonable to assume that the negative relation between conscientiousness and cognitive enhancement drug use will be weaker than the relation between conscientiousness and drug use in general. To test this the following hypothesis was formulated:

There is a negative correlation between Conscientiousness and Cognitive Enhancement Drug Use.

Stress highly increases the risk of drug use (Sinha, 2008). If people experience a high amount of stress they are more likely to abuse drugs. Though, it is questionable if this relation can also be seen with regard to cognitive enhancement drugs, since it has not been examined before. To test this the following hypothesis was formulated:

There is a positive correlation between Stress and Cognitive Enhancement Drug Use.

People, high in the character trait conscientiousness generally are subject to a smaller risk of drug abuse. Stress increases the risk of drug abuse. Though, it was found that conscientiousness might act as a protective factor against stress (Murphy, Miller, & Wrosch, 2013; Penley & Tomaka, 2002). The question arises if the cognitive enhancement drug use of conscientious people increases if they are put under a high amount of stress or if stress has no effect on their drug use behaviour. Since the moderating effect of stress on the relation between conscientiousness and cognitive enhancement drug use has not been examined before and the protective function of conscientiousness against stress has not been confirmed consistently in literature it has to be assumed that stress has an effect on the cognitive enhancement drug use of conscientious people. To test this the following hypothesis was formulated:

Stress moderates the relationship between Conscientiousness and Cognitive Enhancement Drug Use.

Methods

Design and participants

This research was part of a bigger study. In this bigger study, the use of cognitive enhancement drugs among university students was measured and the participants answered several other questionnaires. The study had a cross-sectional study design, with students from different fields and stages of study as participants. In total 249 respondents started the study.

Prior to analysis 74 respondents were excluded. The exclusion criteria were not specifying the age, being underage or not completing all questionnaires. This resulted in a final sample of 175 respondents (126 women, 48 men, 1 other, M_{age} = 20.79, SD_{age} = 2.42 years, age range: 8-30). 132 of these participants indicated to have the German nationality, 22 the Dutch nationality and 21 indicated to have another nationality. Furthermore, 130 participants reported studying Psychology, 29 communication sciences, 2 economics and 10 other studies than that.

Procedure

The students replied voluntarily to a participation request on Facebook and to direct, personal invitations by the researchers. Furthermore, they were able to find the study on the SONA test subject website of the BMS faculty of the University of Twente, where they were granted SONA-points for participating. The data collection started on 26 March 2018 and ended on 4 May 2018. The survey was an anonymous online survey in English, which could only be accessed after signing a digital informed consent. This informed consent was followed by several questionnaires. All questions had a forced response format, meaning that respondents could not skip questions. The data was stored in an online database for later analysis. The procedure and questionnaires were approved by the Ethics Committee of Behavioural, Management and Social Sciences (BMS) of the University of Twente, Enschede, in the Netherlands.

Materials

The whole study consisted of several questionnaires, measuring demographics, cognitive enhancement drug use, lifestyle characteristics, stress-coping behaviour, perceived stress, conscientiousness, perceived peer pressure and perceived self-efficacy. The ones that were of interest for the present study were the ones measuring demographics, cognitive enhancement drug use, conscientiousness and perceived stress and are described in the next section.

Demographics

The first section of the survey assessed demographics and background characteristics by asking about age, gender, the field of study, nationality, years of studying at a university and the phase of the current study.

Cognitive Enhancement Drug Use

This was followed by a questionnaire measuring cognitive enhancement drug use. This questionnaire was developed by the group of researchers of this study and its goal was to measure the participants' frequency of cognitive enhancement drug use and what drugs they

used exactly. The design of the questionnaire was the following: First of all the participants were given a definition of cognitive enhancement drug use. This definition was:

> First of all, we would like to give you a definition of cognitive enhancement drugs. Cognitive enhancement drugs are psychoactive substances that are used to increase one's cognitive performance. This includes improving memory, vigilance, attention, and concentration within healthy individuals, who have no prescription for these drugs. Regarding the various substances used for this purpose a distinction can be made between three categories:
>
> 1) **Over-the-counter drugs** like coffee or energy drinks. These substances can be bought at the supermarket without much effort and are therefore very easy to obtain.
>
> 2) **Prescription drugs** initially designed for the treatment of disorders like ADHD or sleep disorders that are being misused for cognitive enhancement. Examples are Methylphenidate (e.g. Ritalin) or Modafinil.
>
> 3) **Illicit drugs** like ecstasy or methamphetamine that are mainly used for recreational purposes but can also enhance cognition.

After this definition, they were shown 3 lists of substances and were asked to indicate which of these substances they made use of in the past 12 months for the purpose of cognitive enhancement. These lists were named over-the-counter-drugs, prescription drugs and illicit drugs. In table 1 the substances that were shown in each list can be seen. In each list, the participants also had the chance to choose a substance that was not listed by simply adding it. If they indicated to have made use of a substance they were in each case routed to a specific question about the frequency of use of this substance. In the case of over-the-counter drugs, they were either asked how often they made use of the chosen substance in the past week or in the past month. In the case of prescription drugs and illicit drugs they were always asked to indicate how often they had made use of the respective substance in the past 12 months. The answers on the frequency of over-the-counter-drugs were later multiplied by 12 (when they asked about the last month) or by fifty-two (when they asked about the last week) to adapt them to the answers on the other two categories. The purpose of the questionnaire was to give an insight in the frequency of cognitive enhancement drug use in general and within the different categories. A reliability analysis was conducted and the cognitive enhancement drug use measurement was found to be acceptable (18 items, $\alpha = 0.71$). The over-the-counter drugs subscale consisted of 6 items ($\alpha = 0.64$), the prescription drugs subscale consisted of 8 items ($\alpha = 0.41$) and the illicit drugs subscale consisted of 6 items ($\alpha = 0.64$).

Stress

To measure the degree of perceived stress Cohen, Kamarck and Mermelstein's (1994) Perceived Stress Scale was used. The Perceived Stress Scale (PSS) is the most widely used psychological instrument for measuring the perception of stress. It is a measure of the degree to which situations in one's life are appraised as stressful. The scale measures perceived stress by asking about feelings and thoughts in the last month. The participant's task is to indicate on a 4-point scale from 0 (Never) to 4 (Very Often) how often he or she felt a certain way during this time. An example item is: ''In the last month, how often have you been upset because of something that happened unexpectedly?''. The internal consistency and test-retest reliability of the scale was acceptable in previous studies (Lee, 2012). In the present study, a reliability analysis was conducted and the measurement was found to be excellent (10 items, $\alpha = 0.91$).

Conscientiousness

The personality trait conscientiousness was measured with the help of a subscale of The Big Five Inventory (John and Srivastava, 1999). The Big Five Inventory is a self-report inventory designed to measure the Big Five dimensions. These personality dimensions or traits are openness to experience, extraversion, agreeableness, neuroticism and conscientiousness (McCrae and John, 1992). Originally it has 44 items but for this research only the subscale that measures conscientiousness was used. At the beginning of the scale, it says: ''I see myself as someone who:'', followed by nine items such as: ''Tends to be lazy'' or ''Does a thorough job''. The respondents' task is to indicate on a 5-point scale from 1 (Disagree strongly) to 5 (Agree strongly) in how far they agree with these statements about them as a person. In U.S. and Canadian samples, the alpha reliabilities of the Big Five Inventory scales typically range from .75 to .90 and average above .80; three-month test-retest reliabilities range from .80 to .90, with a mean of .85 (John and Sirvastava, 1999). In the present study a reliability analysis was conducted and the conscientiousness scale was found to be acceptable (9 items, $\alpha = 0.79$).

Data analysis

The dependent variable Cognitive Enhancement Drug Use will be calculated by combining the scores of the subscales: Over-the-counter Drugs, Prescription Drugs and Illicit Drugs. These scores of the subscales will be calculated by summing up the frequencies of use of the different drugs of each category.

The moderating variable Stress will be obtained by reversing responses (e.g., 0 = 4, 1 = 3, 2 = 2, 3 = 1 & 4 = 0) to the four positively stated items of the Perceived Stress scale (items 4, 5, 7, & 8) and then summing across all scale items.

The independent variable Conscientiousness will be obtained by reversing responses to the four negatively formulated items (items 2, 4, 5 and 9 of the subscale) and then summing across all scale items.

A Pearson Correlation Test will be done to analyse the correlation between Conscientiousness and Cognitive Enhancement Drug use and Stress and Cognitive Enhancement Drug Use. To test if Stress has a moderating effect on the relationship between Conscientiousness and Cognitive Enhancement Drug Use a hierarchical multiple regression analysis will be conducted.

Results

Descriptives

The main results of the cognitive enhancement drug use measurement, conscientiousness measurement and stress measurement can be seen in Table 2.

Table 2

Descriptive statistics of the used measurements

Scale	Subscale	*M*	*SD*	Minimum	Maximum
Cognitive Enhancement Drug Use	Total	143.65	127.19	0	474
	Over-the-counter Drugs	142.74	126.46	0	467
	Prescription Drugs	0.32	1.1	0	7
	Illicit Drugs	0.59	1.82	0	9
Conscientiousness		3.58	0.64	1.89	4.89
Stress		18.66	7	2	34

Cognitive enhancement drug use

The results of the cognitive enhancement drug use measurement showed that substances of the category over-the-counter-drugs were reported to be used the most. On average, people used them 142.73 times in the past 12 months. Illicit drugs were used on average 0.59 times and prescription drugs were used on average 0.31 times in the past 12 months. In total, over-

the-counter-drugs were used by 174 (94%), illicit drugs by 61 (34.95%) and prescription drugs by 57 (32.4%) of the participants at least once in the past 12 months. The total score for Cognitive Enhancement Drug Use is 143.65.

Conscientiousness

The score on the conscientiousness measurement had a mean of 3.58 (SD 0.64) in the current study sample. The norm-score for people at the age of 21 is 3.4 (SD 0.73) (Srivastava, John, Gosling & Potter, 2003), which shows that the score on the conscientiousness measurement is similar to the norm-score.

Stress

The score on the Perceived Stress Scale had a mean of 18.66 (SD 7.0). The norm score for people between the age of 18-29 is 14.2 (SD 6.2) (Cohen & Williamson, 1988). The score on the Perceived Stress Scale appears to be rather higher than the norm-score.

Main Analysis

Hypothesis 1

A Pearson Correlation Test was computed to test the hypothesis that there is a negative correlation between Conscientiousness and Cognitive Enhancement Drug Use. A weak negative correlation was found between the two variables, $r = -0.20$, $n = 175$, $p = 0.008$. This means that students high in conscientiousness reported slightly lower levels of cognitive enhancement drug use. Though, the correlation was not very strong. Therefore, the hypothesis that there is a negative correlation between Conscientiousness and Cognitive Enhancement Drug Use can be confirmed.

To test if there are differences between the total score for Cognitive Enhancement Drug Use and the different subscales a Pearson Correlation Test was computed to test the correlation between Conscientiousness and each subscale. A weak negative correlation was found between Conscientiousness and Illicit Drugs, $r = -0.17$, $n = 175$, $p = 0.025$ as well as between Conscientiousness and Prescription Drugs, $r = -0.16$, $n=175$, $p=0.032$ and between Conscientiousness and Over-the-counter Drugs, $r=-0.20$, $n=175$, $p=0.008$. This means that students high in conscientiousness reported slightly lower levels of use for every category of cognitive enhancement drugs.

Hypothesis 2

To test the hypothesis that Stress positively correlates with Cognitive Enhancement Drug Use, a Pearson Correlation Test was computed. The results of the correlation test showed that there is no significant correlation between Stress and Cognitive Enhancement Drug Use, $r = 0.08$, $n = 175$, $p = 0.29$, which is not in line with the hypothesis. The results suggest that students who

experienced a high amount of stress did not use significantly more cognitive enhancement drugs.

To test if there are differences between the total score for Cognitive Enhancement Drug Use and the different subscales a Pearson Correlation Test was computed to test the correlation between Stress and each subscale. The results show that there is no significant correlation between Stress and Over-the-counter Drugs, $r = 0.08$, $n = 175$, $p = 0.287$, as well as between Stress and Prescription Drugs, $r = 0.01$, $n = 175$, $p = 0.907$ and between Stress and Illicit Drugs, $r = 0.04$, $n = 175$, $p = 0.624$. This indicates that students who experienced a high amount of stress did not use significantly more substances of any category of cognitive enhancement drugs.

Hypothesis 3

To test the hypothesis that Stress moderates the relationship between Conscientiousness and Cognitive Enhancement Drug Use, a hierarchical multiple regression analysis was conducted. The results can be found in Table 3. In the first step, one variable was included: Conscientiousness. This variable accounted for a significant amount of variance in Cognitive Enhancement Drug Use, $R^2 = 0.04$, $F(1, 173) = 7.32$, $p = 0.008$. In the second step the variable Stress was added, which did not account for a significant amount of variance in Cognitive Enhancement Drug Use, R^2 change $= 0.00$, $F(1,172) = 0.26$, $p = 0.613$. After that an interaction term between Stress and Conscientiousness was created. In the third step the interaction term was added to the regression model, which did not account for a significant proportion of the variance in Cognitive Enhancement Drug Use, R^2 change $= 0.01$, $F(1, 171) = 0.80$, $p = 0.371$, indicating that there is no potentially significant moderation between Conscientiousness and Stress on Cognitive Enhancement Drug Use. This means that stress does not act as a moderating variable. Therefore, the hypothesis that Stress moderates the relationship between Conscientiousness and Cognitive Enhancement Drug Use cannot be confirmed. Overall, the results indicate that when conscientious students are put under a high amount of stress their cognitive enhancement drug use does not increase.

To test if Stress moderates the relationship between Conscientiousness and any of the subscales of Cognitive Enhancement Drug Use, the procedure was repeated with each subscale as the dependent variable. Though, adding the interaction term to the model did not account for a significant proportion of variance in any of the subscales.

Table 3

Results of the hierarchical multiple regression analysis

	B	*SE B*	*β*	*t*	Sig.
Step 1					
Constant	285.83	53.34		5.35	.00
Conscientiousness	-39.75	14.69	-0.20	-2.71	.008
Step 2					
Constant	266.70	65.50		4.07	.00
Conscientiousness	-38.07	15.09	-0.19	-2.522	.013
Stress	0.70	1.39	0.04	0.51	.613
Step 3					
Constant	151.25	144.53		1.05	.297
Conscientiousness	-6.44	38.38	-0.03	-0.17	.867
Stress	7.16	7.34	0.39	0.98	.331
Interaction term	-1.80	2.01	-0.36	-0.90	.371

Discussion

This cross-sectional study was performed to examine the relation between the personality trait conscientiousness and cognitive enhancement drug use and between stress and cognitive enhancement drug use. In addition, the role of stress in the relation between conscientiousness and cognitive enhancement drug use was analysed.

It was found in the present research that there is a weak negative correlation between conscientiousness and cognitive enhancement drug use, meaning that students high in conscientiousness reported lower levels of cognitive enhancement drug use. This finding is only partly in line with the literature about conscientiousness and drug use. Conscientiousness has been found to be the character trait that has the strongest negative correlation with drug use among all other personality traits (Kashdan, Vetter, & Collins, 2005; Malouff, Thorsteinsson, Rooke, & Schutte, 2007; Malouff, Thorsteinsson, & Schutte, 2006; Terracciano, Lockenhoof, Crum, Bienvenu, & Costa, 2008). Even though the present research supports this negative correlation between conscientiousness and drug use, it has to be mentioned that the found correlation was weak. In comparison to that, the negative correlation between conscientiousness and general drug use was found to be strong. It is reasonable to

assume that the striving for academic success and achievement, associated with conscientiousness (Komarraju, Karau & Schmeck, 2009), might have intruded on this relationship. It might be that conscientious students are more likely to use cognitive enhancement drugs than drugs in general, because cognitive enhancement drugs can help them to increase cognitive performance, which is demanded to achieve academic success (Komarraju, Karau & Schmeck, 2009). However, since a negative correlation was found between conscientiousness and cognitive enhancement drug use, it can be assumed that conscientious students are still not exposed to major risks with regard to cognitive enhancement drug use.

Furthermore, it was found in the present research that there is no significant correlation between stress and cognitive enhancement drug use, meaning that students who reported high levels of stress did not use more cognitive enhancement drugs. This finding is not in line with literature about stress and drug use in general. Many of the major theories of drug abuse and addiction state that stress plays a crucial role in drug use behaviour (Sinha, 2008). It was found that stress, among other risk factors such as parental substance use, peer pressure, age and positive expectancies over the potential benefits of using substances, is associated with the greatest risk for problematic use of addictive substances (Marlatt & Gordon 1985; Hoffmann, Cerbone & Su, 2000). However, the results of the present research suggest that this strong relation between stress and drug use cannot be seen with regard to cognitive enhancement drug use.

Lastly, the results of the present research suggest that stress does not moderate the relation between conscientiousness and cognitive enhancement drug use. The cognitive enhancement drug use behaviour of conscientious students did not increase when they were facing a high amount of stress. There was no effect of stress on this relation at all. This finding is in line with the literature about the way conscientious people experience stress. It has been found that conscientiousness has an influence on the appraisal of stress. People high in conscientiousness are more likely to evaluate a stressor as manageable instead of seeing it as a threat (Gartland, O'Connor, & Lawton, 2012). This means that the stress they are experiencing is not that intensive. Overall, it is indicated in the literature that the trait conscientiousness might act as a protective factor against stressful experiences and perceived stress (Murphy, Miller, &Wrosch, 2013; Penley & Tomaka, 2002). This helps to explain why the relation between conscientiousness and cognitive enhancement drug use was not affected by stress. Even though conscientious students reported to experience stress they might have perceived it as unchallenging and did not suffer from it, which in turn did not lead to an

increase in their use of cognitive enhancement drugs. The results of the present study suggest that conscientiousness is indeed a protective factor against the effects of stress.

Strengths and limitations

A strong point of this study is the fact that its participants were students. The topic of cognitive enhancement drug has received much attention in recent years and it is especially becoming an increasing problem among university students. They are much more likely to use such substances than people in their age that are not enrolled in a university and show high prevalence rates across different fields of study. This makes it especially important to investigate the cognitive enhancement drug use behaviour of this population, because they are the ones that are exposed to the greatest risk of abuse of such substances.

Another strong point is the fact that research on the risk-factors and underlying psychological mechanisms of cognitive enhancement drug use seems to be in its infancy. The relation between conscientiousness and cognitive enhancement or stress and cognitive enhancement drug use and the effect of stress on the relation between conscientiousness and cognitive enhancement drug use have not been confirmed consistently or have not been examined yet (Schelle, Olthof, Reintjes, Bundt, Gusman-Vermeer & Van Mil, 2015). The results of the present study deliver important results to better understand the psychology behind cognitive enhancement drug use.

However, there are still some limitations to this research. Even though the study had an adequate response rate a limitation to this study is the sample. Due to convenience-sampling it is only an approximate representation of the student population worldwide. Women, for example, were oversampled and most of the participants reported to study Psychology. Furthermore, there may have been some bias concerning the survey-collection method. The sample may include mostly students who were interested in the topic of cognitive enhancement drug use. Though, people were granted credit points in the SONA system, which acted as a motivation to participate for people who were not interested in the topic. Future studies could eradicate this issue by following a sampling method that allows a more representative sample of the whole student population.

The results of the cognitive enhancement drug use measurement indicated that 32,6% of the sample made use of prescription drugs, 34,95% made use of illicit drugs and 94% made use of over-the-counter-drugs to enhance their cognitive performance at least once in the past 12 months. Though, previous studies have shown much lower rates of students that try to enhance their performance by taking substances. They identified a lifetime prevalence among university students ranging from 7 to 9% (Lord, Downs, Furtaw, Chaudhuri, Silverstein,

Gammaitoni & budman, 2009; Weyandt, Janusis, Wilson, Verdi, Paquin, Lopes, Dussault, 2009; Teter, McCabe, Cranford, Boyd & Guthrie, 2005; Carroll, McLaughlin & Blake, 2006). A reason for that might be the overrepresentation of certain groups in the sample. However, this high prevalence rate might have influenced the results of the present study by leading to over- or underestimations of certain correlations. The overrepresentation of certain groups and the high prevalence rate have to be kept in mind when looking at the results of this study.

Conclusion

To sum up, the present study indicates that students high in conscientiousness make slightly less use of cognitive enhancement drugs than students average or low in this trait. Though, this negative relation between conscientiousness and cognitive enhancement drug use was not strong. Future research could further investigate the motives of conscientious students for cognitive enhancement drug use to check to what extent their use is influenced by their striving for academic achievement and success. Furthermore, the results suggest that stress does not correlate with cognitive enhancement drug use. Future research could focus on other important risk factors of drug use such as availability of drugs, peer influence, parental substance use, and positive expectancies over the potential benefits of using substances. The relations between these factors and cognitive enhancement drug use either have not been confirmed consistently or have not been examined yet (Schelle et al., 2015). This would help to clarify the importance of these factors with regard to cognitive enhancement drug use. Lastly, the results indicate that stress has no effect on the relation between conscientiousness and cognitive enhancement drug use. As indicated in the literature conscientiousness might have acted as a protective factor against stress, which in turn prevented conscientious people from increasing their cognitive enhancement drug use when facing stress. Though, future research could further investigate the way conscientious people experience stress and in how far their personality does indeed act as a protective factor against stress.

References

Baker, T. B., Piper, M. E., McCarthy, D. E., Majeskie, M. R., & Fiore, M. C. (2004). Addiction motivation reformulated: an affective processing model of negative reinforcement. *Psychological review*, *111*(1), 33.

Bogg, T., & Roberts, B. W. (2004). Conscientiousness and health-related behaviors: a meta-analysis of the leading behavioral contributors to mortality. *Psychological bulletin*, *130*(6), 887.

Booth-Kewley, S., & Vickers, R. R. (1994). Associations between major domains of personality and health behavior. *Journal of personality*, *62*(3), 281-298.

Bostrom, N., & Sandberg, A. (2009). Cognitive enhancement: methods, ethics, regulatory challenges. *Science and engineering ethics*, *15*(3), 311-341.

Boys, A., Marsden, J., & Strang, J. (2001). Understanding reasons for drug use amongst young people: a functional perspective. *Health education research*, *16*(4), 457-469.

Carroll, B. C., McLaughlin, T. J., & Blake, D. R. (2006). Patterns and knowledge of nonmedical use of stimulants among college students. *Archives of pediatrics & adolescent medicine*, *160*(5), 481-485.

Chatterjee, A. (2006). The promise and predicament of cosmetic neurology. *Journal of medical ethics*, *32*(2), 110-113.

Cohen, S., & Williamson, G. (1988). Perceived Stress in a Probability Sample of the United States. In S. Spacapan, & S. Oskamp (Eds.), The Social Psychology of Health: Claremont Symposium on Applied Social Psychology (pp. 31-67). Newbury Park, CA: Sage.

Cohen, S., Kamarck, T., & Mermelstein, R. (1994). Perceived stress scale. *Measuring stress: A guide for health and social scientists*.

Farah, M. J., Haimm, C., Sankoorikal, G., & Chatterjee, A. (2009). When we enhance cognition with Adderall, do we sacrifice creativity? A preliminary study. *Psychopharmacology*, *202*(1-3), 541-547.

Farah, M. J., Illes, J., Cook-Deegan, R., Gardner, H., Kandel, E., King, P., ... & Wolpe, P. R. (2004). Neurocognitive enhancement: what can we do and what should we do?. *Nature reviews neuroscience*, *5*(5), 421.

Förstl, H. (2009). Neuro-enhancement. *Der Nervenarzt*, *80*(7), 840-846.

Franke, A. G., Konrad, A., Lieb, K., & Huss, M. (2012). Stimulant and non-stimulant medication in current and future therapy for ADHD. *Fortschritte der Neurologie-Psychiatrie*, *80*(3), 130-140.

Gartland, N., O'connor, D. B., & Lawton, R. (2012). The effects of conscientiousness on the appraisals of daily stressors. *Stress and Health*, *28*(1), 80-86.

Hall, K. M., Irwin, M. M., Bowman, K. A., Frankenberger, W., & Jewett, D. C. (2005). Illicit use of prescribed stimulant medication among college students. *Journal of American College Health*, *53*(4), 167-174.

Herman-Stahl, M. A., Krebs, C. P., Kroutil, L. A., & Heller, D. C. (2007). Risk and protective factors for methamphetamine use and nonmedical use of prescription stimulants among young adults aged 18 to 25. *Addictive behaviors*, *32*(5), 1003-1015.

Hoffmann, J. P., Cerbone, F. G., & Su, S. S. (2000). A growth curve analysis of stress and adolescent drug use. *Substance use & misuse*, *35*(5), 687-716.

Hyman, S. E., & Malenka, R. C. (2001). Addiction and the brain: the neurobiology of compulsion and its persistence. *Nature reviews neuroscience*, *2*(10), 695.

John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement, and theoretical perspectives. *Handbook of personality: Theory and research*, *2*(1999), 102-138.

Kashdan, T. B., Vetter, C. J., & Collins, R. L. (2005). Substance use in young adults: Associations with personality and gender. *Addictive Behaviors*, *30*(2), 259-269.

Khantzian EJ (1985) The self-medication hypothesis of addictive disorders: focus on heroin and cocaine dependence. Am J Psychiatry 142:1259–1264

Komarraju, M., Karau, S. J., & Schmeck, R. R. (2009). Role of the Big Five personality traits in predicting college students' academic motivation and achievement. *Learning and individual differences*, *19*(1), 47-52.

Koob GF., Le Moal, M. (1997). Drug abuse: hedonic homeostatic dysregulation. Science 278:52

Lazarus RS, Folkman S (1984) Stress, appraisal, and coping. Springer, New York

Lee, E. H. (2012). Review of the psychometric evidence of the perceived stress scale. *Asian nursing research*, *6*(4), 121-127.

Leonard, B. E., McCartan, D., White, J., & King, D. J. (2004). Methylphenidate: a review of its neuropharmacological, neuropsychological and adverse clinical effects. *Human Psychopharmacology: Clinical and Experimental*, *19*(3), 151-180.

Leventhal H, Cleary PD (1980) The smoking problem: a review of the research and theory in behavioral risk modification. Psychol Bull 88:370–405

Lord, S., Downs, G., Furtaw, P., Chaudhuri, A., Silverstein, A., Gammaitoni, A., & Budman, S. (2009). Nonmedical use of prescription opioids and stimulants among student pharmacists. *Journal of the American Pharmacists Association*, *49*(4), 519-528.

Mache, S., Eickenhorst, P., Vitzthum, K., Klapp, B. F., & Groneberg, D. A. (2012). Cognitive-enhancing substance use at German universities: frequency, reasons and gender differences. *Wiener Medzinische Wochenschrift, 162,* 262-271.

Malouff, J. M., Thorsteinsson, E. B., & Schutte, N. S. (2006). The five-factor model of personality and smoking: A meta-analysis. *Journal of Drug Education*, *36*(1), 47-58.

Malouff, J. M., Thorsteinsson, E. B., Rooke, S. E., & Schutte, N. S. (2007). Alcohol involvement and the Five-Factor Model of personality: A meta-analysis. *Journal of drug education*, *37*(3), 277-294.

Marlatt GA, Gordon JR (1985) Relapse prevention: maintenance strategies in the treatment of addictive behaviors. Guilford Press, New York

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of personality*, *60*(2), 175-215.

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.

Murphy, M. L., Miller, G. E., & Wrosch, C. (2013). Conscientiousness and stress exposure and reactivity: A prospective study of adolescent females. *Journal of Behavioral Medicine*, *36*(2), 153-164.

Novak, S. P., Kroutil, L. A., Williams, R. L., & Van Brunt, D. L. (2007). The nonmedical use of prescription ADHD medications: results from a national Internet panel. *Substance abuse treatment, prevention, and policy*, *2*(1), 32.

O'cleirigh, C., Ironson, G., Weiss, A., & Costa Jr, P. T. (2007). Conscientiousness predicts disease progression (CD4 number and viral load) in people living with HIV. *Health Psychology*, *26*(4), 473.

Outram, S. M. (2010). The use of methylphenidate among students: the future of enhancement?. *Journal of medical ethics*, *36*(4), 198-202.

Penley, J. A., & Tomaka, J. (2002). Associations among the Big Five, emotional responses, and coping with acute stress. *Personality and individual differences*, *32*(7), 1215-1228.

Peterkin, A. L., Crone, C. C., Sheridan, M. J., & Wise, T. N. (2011). Cognitive performance enhancement: misuse or self-treatment?. *Journal of attention disorders*, *15*(4), 263-268.

Rabiner, D. L., Anastopoulos, A. D., Costello, E. J., Hoyle, R. H., McCabe, S. E., & Swartzwelder, H. S. (2009). Motives and perceived consequences of nonmedical ADHD medication use by college students: are students treating themselves for attention problems?. *Journal of Attention Disorders*, *13*(3), 259-270.

Repantis, D., Schlattmann, P., Laisney, O., & Heuser, I. (2010). Modafinil and methylphenidate for neuroenhancement in healthy individuals: a systematic review. *Pharmacological research*, *62*(3), 187-206.

Robinson, T. E., & Berridge, K. C. (2008). The incentive sensitization theory of addiction: some current issues. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1507), 3137-3146.

Russell JA, Mehrabian A (1975) The mediating role of emotions in alcohol use. J Stud Alcohol 36:1508–1536

Schelle, K. J., Olthof, B. M., Reintjes, W., Bundt, C., Gusman-Vermeer, J., & van Mil, A. C. (2015). A survey of substance use for cognitive enhancement by university students in the Netherlands. *Frontiers in systems neuroscience*, *9*, 10.

Sher KJ, Levenson RW (1982) Risk for alcoholism and individual differences in the stress-response-dampening effect of alcohol. J Abnorm Psychol 91:350–368

Shiffman S (1982) Relapse following smoking cessation: a situational analysis. J Consult Clin Psychol 50:71–86

Sinha, R. (2008). Chronic stress, drug use, and vulnerability to addiction. *Annals of the new York Academy of Sciences*, *1141*(1), 105-130.

Srivastava, S., John, O. P., Gosling, S. D., & Potter, J. (2003). Development of personality in early and middle adulthood: Set like plaster or persistent change?. *Journal of personality and social psychology*, *84*(5), 1041.

Terracciano, A., Löckenhoff, C. E., Crum, R. M., Bienvenu, O. J., & Costa, P. T. (2008). Five-Factor Model personality profiles of drug users. *BMC psychiatry*, *8*(1), 22.

Teter, C. J., McCabe, S. E., Cranford, J. A., Boyd, C. J., & Guthrie, S. K. (2005). Prevalence and motives for illicit use of prescription stimulants in an undergraduate student sample. *Journal of American College Health*, *53*(6), 253-262.

Varga, M. D. (2012). Adderall abuse on college campuses: A comprehensive literature review. *Journal of Evidence-Based Social Work, 9(3),* 293-313.

Weyandt, L. L., Janusis, G., Wilson, K. G., Verdi, G., Paquin, G., Lopes, J., ... & Dussault, C. (2009). Nonmedical prescription stimulant use among a sample of college students: relationship with psychological variables. *Journal of Attention Disorders*, *13*(3), 284-296.

Wills TA, Shiffman S (1985) Coping and substance abuse: a conceptual framework. In: Shiffman S, Wills TA (eds) Coping and substance use. Academic Press, Orlando, pp 3–24

Wolff, W., Brand, R., Baumgarten, F., Lösel, J. and Ziegler,M. (2014). Modelling students instrumental (mis-use of substances to enhance cognitive performance:

neuroenhancement in the light of job demands-resources theory. *Biopsychosoc.Med.* 8:12. doi:10.1186/1751-0759-8-12