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Cognitive Enhancement Drug Use among University Students: The Role of Perfectionism and Perceived Stress.

Bachelor Thesis

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Abstract

Background: The topic of cognitive enhancement (CE) drug use is getting increased attention in media as well as in academic literature. Previous research suggests, that the use of prescription drugs to enhance one's cognitive capacities is particularly common among individuals in cognitively demanding surroundings, such as universities and schools. Research has shown, that work /study-related stress can have a positive relationship with CE drug use. Furthermore, personality traits can have a positive relationship with CE drug use. The personality trait perfectionism is indicated by literature to be positively related to the perceived level of stress and to a positive attitude towards CE drug use. Therefore, the aim of the study is to expand the understanding of how perfectionism can influence students' tendency to use CE drugs, with stress acting as a mediator in this relationship.

Methods: The participants in this study (*n = 244*) were recruited via convenience sampling. In total, 77 percent of the respondents were female, while 23 percent of them were male. The majority of participants were of German nationality (80.7%) followed by the Dutch (11.1%). The age ranged from 18 to 28 with a mean of 20.65. The study was conducted as a quantitative cross-sectional online survey, in which CE drug use, stress, and perfectionism were assessed. Correlation analyses were executed to determine the strength and direction of the relationship between the main study variables. The mediation effect of stress was tested using the PROCESS macro model.

Results: The results showed that neither the overall level of perfectionism nor the perceived level of stress had a significant relationship with students' overall CE drug use. Inferentially, stress is not a mediator in this relationship. Nevertheless, the three dimensions of perfectionism showed different correlations with CE drug use and stress. Furthermore, the results revealed a positive relationship between students' perceived stress and their level of perfectionism.

Conclusion: This study supports perfectionism as a multidimensional construct, as the three global factors showed different relationships to stress and CE drug use. Although the proposed mediation model was rejected, significant relationships were found, that suggest a link between the main study variables and can provide insight and inspiration for future research. Furthermore, it was discovered that more students used illicit drugs for cognitive enhancement than prescription drugs. Future research is needed to investigate illicit and prescription drugs in relation to CE drug use and to identify other possible predictors of CE drug use.

Keywords: Cognitive Enhancement Drug Use, Perfectionism, Stress, Perceived Stress Scale

Introduction

Stress is a well-known phenomenon among students in schools and universities. No matter if they try to get ahead in order to perform at high levels, or only try to keep up with their peers, in school and university life performance pressure is a present aspect, causing distress in many students (Rubin, 2011). Maintaining an active life in the face of study additionally places demands on students and can act as a distressing factor (Partridge, Bell, Lucke, & Hall, 2012). Because of feelings of stress and the pressure to perform, many students start searching for alternative ways to deal with the educational demands and issues they encounter on a day to day basis. This causes some students to get in touch with the issue of cognitive enhancement (CE) drug use (Wiegel, Sattler, Göritz, & Diewald, 2015).

The topic of CE drug use is getting increased attention in media as well as in academic literature. Cognitive enhancement, in general, can be defined as an extension of the main efficiency of the mind, by increasing the performance of internal or external information processing systems (Bostrom & Sandberg, 2009). Cognition is the ability humans possess, to collect and handle the information received from distinct sources and transform it into knowledge. Here, various cognitive processes are involved, for example, attention, memory, learning, decision-making and reasoning (Newen, 2015). Thus, individuals making use of cognitive enhancement aim to increase these cognitive capacities, as well as increase mental alertness and concentration (Teter, Mccabe, Cranford, Boyd, & Guthrie, 2005).

Cognitive enhancement can be attained in multiple ways (Drobisz & Damborská, 2019; Bostrom & Sandberg, 2009). However, this paper will focus on drugs working with chemicals, that change the cellular processes in the brain, also called pharmacological cognitive enhancement (Schelle et al., 2015). Pharmacological cognitive enhancement is a term, describing the use of substances to increase one's cognitive abilities, with the intent to raise performance above baseline levels (Schelle et al., 2015; Sattler & Wiegel, 2013). Substances typically used for cognitive enhancement can be organized in three categories.

The first category contains so-called 'over-the-counter' (OTC) drugs such as coffee, caffeinated drinks, and caffeine tablets but also naturally occurring plants like Gingko (Franke, Bagusat, Rust, Engel & Lieb, 2014). Nicotine belongs to this category as well, since it can relieve stress and increase cognitive abilities (Warburton, 1992). Because of their legality, these substances are widely accepted and consumed, not just among students but among the general population, to facilitate wakefulness, thereby improving cognitive capacities (Olsen, 2013).

The second category contains prescription drugs, formerly generated as a treatment for neuropsychiatric disorders like attention-deficit/hyperactivity disorder (methylphenidate e.g.

Ritalin, Concerta or amphetamines e.g. Adderall), sleep disorders (Modafinil e.g. Provigil) or Alzheimer's disease (e.g. Piracetam, Donepezil). These prescription drugs are often abused by healthy individuals for the purpose of cognitive enhancement, without any need for treatment (Petersen, Lyngsø-Dahl Ølgaard, & Nørgaard, 2018). The third category is contained of illicit drugs such as illicit amphetamines (e.g. Speed), ecstasy, methamphetamine (e.g. crystal meth) and others (Franke et al., 2014; Sattler & Wiegel, 2013).

As research suggested, the use of prescription drugs to enhance one's cognitive capacities is particularly common among individuals in cognitively demanding surroundings, such as universities and schools, thus, student populations are seen at-risk in many studies (Schelle et al., 2015). A study of Sattler and Wiegel (2013) demonstrated a lifetime cognitive enhancement prevalence of 4.56% among German university students. This value is located in the 3 to 11% range, which had been determined previously in a review about cognitive enhancement (Racine & Forlini, 2010).

In one U.S. survey involving 4,580 undergraduate students, a lifetime prevalence for illicit prescription use with the goal of cognitive enhancement of 8.3% was discovered. The use of amphetamine-dextroamphetamine medication was most frequent, followed by the use of methylphenidate. The use of modafinil and other prescription, however, was reported less frequently (Sattler & Wiegel, 2013). Studies in the European population found a lifetime prevalence for illicit prescription drug use, with the purpose of cognitive enhancement, ranging from 4.6 to 16% (Schelle et al., 2015).

Study-related stress

As mentioned earlier, work/study-related stress can have a positive relationship with cognitive enhancement drug use (Wiegel, Sattler, Göritz, & Dienewald, 2015). Stress is defined as any challenge (physical or psychological), that has the potential of jeopardizing or jeopardizes homeostasis, which is a state of steady internal physical and chemical conditions, with the state of equilibrium, being the condition for optimal functioning of an organism (Sarkodie, Zhou, Baidoo & Chu, 2019). Stress can occur in distinct forms (acute or chronic, physical or psychological) with diverse influences on the released stress hormones, inter alia contributing to an increase in susceptibility to infections (Sarkodie, Zhou, Baidoo & Chu, 2019). Furthermore, the direct influence of stress and our compensatory responses can alter our behaviour and physiology regarding future episodes of stress. This can lead to health consequences including an increased tendency towards addiction (Buchanan & Lovallo, 2018). Several negative outcomes have been connected to stress associated with academic activities,

for instance, poor academic performance and mental health, as well as student drop out (Lilleholt, Aaby & Makransky, 2019).

Because students are faced with cognitively demanding, academic environments, they are associated with increased stress, seemingly making them more prone to the use of cognitive enhancement drugs (Misra & McKean, 2000; European Agency for Safety and Health at Work, 2015). A study by Liakoni, Schaub, Maier, Glauser, and Liechti (2015) with a total of 1,139 participants showed, that students perceiving more performance pressure at school, had a greater tendency to have used at least one substance for cognitive enhancement, in comparison to students perceiving no to minimal performance pressure at school. Additionally, students who used a substance for cognitive enhancement at least once before, perceived not only more performance pressure regarding school, family and friends, but they also perceived more stress when compared with non-users.

The study results of Petersen, Lyngsø-Dahl Ølgaard and Nørgaard (2018) demonstrated, that students experience a great deal of challenges with respect to studying (considered as a distressing factor for many students), which can be connected to motivations for and actual use of cognitive enhancement drugs. Furthermore, the increasing pressure and competition among students can be linked to a more general interpretation of some student's tendency to use cognitive enhancing drugs (Petersen, Lyngsø-Dahl Ølgaard, & Nørgaard, 2018).

Perfectionism

Research further indicates, that besides distressing factors, certain personality traits can have a positive relationship with cognitive enhancement drug use as well. The work of Arria, Caldeira, Vincent, O'Grady and Wish (2008) demonstrated that sensation seeking, referring to the tendency of participating in risky behaviour with the aim of stimulation, leads to greater abuse of stimulants but also for other reasons than cognitive enhancement. Additionally, the results of a study conducted by Sattler and Wiegel (2013) show, that increased cognitive test anxiety leads to higher cognitive enhancement prevalence rates.

A personality trait not extensively investigated in relation to cognitive enhancement drug use, however, positively related to the perceived level of stress, is *Perfectionism* (D'Souza, Egan, & Rees, 2011). Exceedingly high standards of performance characterize the personality disposition perfectionism. While many studies investigating perfectionism discovered a negative impact of perfectionism (Kokkoris, 2019), other studies revealed, that perfectionism can either have a positive or a negative effect on the individual (Slade & Owens, 1998). Hence,

a dual-process model was proposed, containing the concepts *positive perfectionism* and *negative perfectionism.*

While positive perfectionism is described as perfectionistic behaviour, motivated by the aspiration of accomplishing desirable goals, negative perfectionism is defined as perfectionistic behaviour, motivated by the pursuit of preventing mistakes (Slade & Owens, 1998). In a study by Wang and Li (2017) with 386 respondents recruited from a professional website offering paid online tasks, positive perfectionism was negatively correlated with stress, while negative perfectionism was positively correlated with stress. These results point out, that positive and negative perfectionism have different impacts on stress. Positive perfectionism predicts lower stress levels and negative perfectionism is associated with an increase in stress level. This finding supports the duality of the concept perfectionism (Wang & Li, 2017).

Research further suggested that it is essential to consider perfectionism as a multidimensional personality disposition. Smith, Saklofske, Stoeber, and Sherry (2016) conducted an extensive literature review on the construct of perfectionism and found 10 facets to be valuable for inclusion in a measure of multidimensional perfectionism (Big Three Perfectionism Scale). The resulting scales, supposed to deliver a fine-grained analysis of perfectionism, are *self-oriented perfectionism, self-worth contingencies, concern over mistakes, doubts about actions, self-criticism, socially prescribed perfectionism, other-oriented perfectionism, hypercriticism, entitlement, and grandiosity* (Smith, Saklofske, Stoeber, & Sherry, 2016). These 10 facets (scales) constitute the elements of three larger factors, which are considered as global perfectionism factors: rigid perfectionism, self-critical perfectionism, and narcissistic perfectionism.

Rigid perfectionism captures the persistence of extremely high standards concerning one's own performance, meaning that the performance must be perfect and flawless, without any mistakes (Smith, Saklofske, Stoeber, & Sherry, 2016). *Self-critical perfectionism* is characterized by a tendency to respond mainly negative to perceived failures and setbacks, uncertainties regarding performance, the tendency to harshly criticize oneself when performance is not perfect, and the propensity of perceiving others as postulating perfection (Smith, Saklofske, Stoeber, & Sherry, 2016). *Narcissistic perfectionism* describes the harsh derogatory judgment of other peoples' imperfections, the tendency to expect too much from others, the conviction that one deserves special or perfect treatment, and the persistent belief that oneself is superior to others (Smith, Saklofske, Stoeber, & Sherry, 2016). Since perfectionism is a personality disposition, that includes striving for extremely high standards of performance, and because research suggests that it is positively related with stress,

perfectionism seems to constitute a risk factor for cognitive enhancement drug use. However, there is no literature available on the relationship between the global perfectionism factors and CE drug use. Hence, this will be investigated in this study.

Stress, Perfectionism and Cognitive Enhancement drug use

In order to develop successful interventions, targeting the prevention of CE drug use, underlying factors and determinants of students' CE drug use need to be determined, to understand the relationships and processes. Research already provides evidence, that stress is positively related with CE drug use (Wiegel, Sattler, Göritz, & Dienewald, 2015; Petersen, Lyngsø-Dahl Ølgaard, & Nørgaard, 2018; Liakoni, Schaub, Maier, Glauser & Liechti, 2015).

The relationship of the personality trait perfectionism and CE drug use is still unclear; however, research indicates that certain dimensions of perfectionism are associated with positive attitudes toward CE drug use. For instance, one study at the University of Kent, involving 272 university students, found that perfectionist concerns and doubts about one's action, the belief that others demand perfection and parental pressure to be perfect, are positively related to positive attitudes towards CE drug use, and the perception that taking CE drugs is necessary (Stoeber, & Hotham, 2016). This leads to the assumption that perfectionism is a possible risk-factor for CE drug use, even though there is no clear evidence about the relationship between the three global perfectionism factors and CE drug use.

As literature also suggests that negative perfectionism increases the perceived level of stress and perceived stress is positively related to CE drug use, it is investigated whether perceived stress has a mediating role in the relationship between perfectionism and CE drug use (Wang & Li, 2017; Glauser & Liechti, 2015). This mediation effect is expected, because an individual with perfectionist characteristics may perceive a greater level of psychological distress and pressure to perform, due to the exceedingly high standards they want to fulfil. Thus, it is assumed that perfectionism causes an individual to perceive more study-related stress, what in turn can constitute a risk factor for CE drug use. Furthermore, this study aims at dealing with perfectionism as a multidimensional construct and wants to find out more about the relationship between the three global factors with CE drug use and stress.

In conclusion, this paper suggests a positive relationship between perfectionism and stress, stress and CE drug use and perfectionism and CE drug use. Although literature presents evidence for these relationships, it does not contain evidence concerning a possible mediation effect of stress. Hence, this study seeks to examine the relationship among the variables perfectionism and CE drug use, dealing with stress as a mediator (see Figure 1). Due to the lack

of knowledge regarding the relationship between the personality trait perfectionism and the abuse of cognitive enhancement drugs, this study aims to expand the understanding of how perfectionism can influence student's tendency to use cognitive enhancement drugs.

Based on the previous literature review and the above discussed information, the research question this study seeks to answer is: *'Is there a relationship between cognitive enhancement drug use among students and the personality trait perfectionism, which is mediated by their perceived stress levels?'.*
In order to answer this question, ten hypotheses were set up and will be examined in detail:

H1: There is a significant positive relationship between students' perceived level of stress and their level of perfectionism.

H2: The dimension rigid perfectionism has a significant relationship with student's perceived level of stress.

H3: The dimension self-critical perfectionism has a significant relationship with student's perceived level of stress.

H4: The dimension narcissistic perfectionism has a significant relationship with student's perceived level of stress.

H5: There is a significant positive relationship between students' level of perfectionism and their cognitive enhancement drug use.

H6: The dimension rigid perfectionism has a significant relationship with student's cognitive enhancement drug use.

H7: The dimension self-critical perfectionism has a significant relationship with student's cognitive enhancement drug use.

H8: The dimension narcissistic perfectionism has a significant relationship with student's cognitive enhancement drug use.

H9: There is a significant positive relationship between students' perceived level of stress and their cognitive enhancement drug use.

H10: Students' perceived level of stress mediates the relationship between perfectionism and cognitive enhancement drug use.

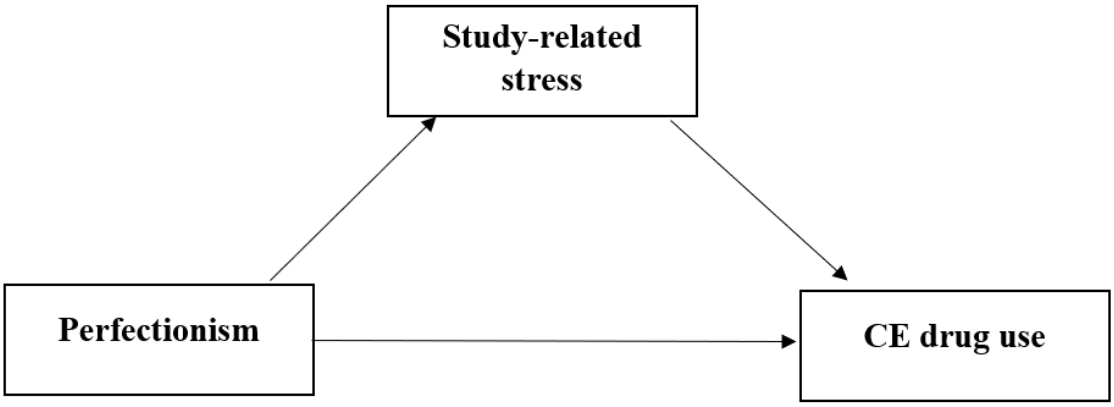

Figure 1. Hypothesized model of the relationship between perfectionism, cognitive enhancement drug use, and study-related stress.

Methods

Design

This study was executed in a quantitative cross-sectional online survey design. This method was chosen, because it is a cost effective, yet widely accepted method for quantitative data collection, resulting in a large amount of data in a short time (Levin, 2006). Furthermore, the design allows to measure several variables and to get a snapshot of the momentary situation, enabling the estimation of prevalence rates (Levin, 2006). The independent variable was perfectionism, while the dependent variable was cognitive enhancement drug use. The perceived level of study-related stress was handled as a mediator. It is assumed that perfectionism has an indirect effect on CE drug use, by directly influencing perceived stress, which then influences CE drug use.

Participants

In total, 263 participants completed the study 'Cognitive enhancement drug use among university students'. Convenience sampling was used, to recruit the participants out of the population of students on university level. The respondents were approached through the researchers' personal networks and via the cloud-based online environment SONA, which is used as a network by universities and students to gather research subjects (Sona Systems, n.d.). When approaching the study on SONA, students were invited through a short recruitment message, summarizing that this study seeks to investigate cognitive enhancement drug use among university students, while investigating Perfectionism as a related factor. The message was written in English, so it appealed to all students.

When inviting participants from the personal networks of the researchers, a WhatsApp message was sent to several fellow students, containing the same recruitment message, adding the information that the study is available on SONA as well and will be compensated with credits. Students filling in the questionnaire via SONA received 0,5 SONA credits as a reward. The inclusion criteria contained that participants (1) should be above 18 years of age, (2) must properly understand the English language, and (3) must be university students. Nineteen participants were excluded from the data analysis, because they either did not complete the survey or were identified as outliers (datapoint that differs significantly from other observations). The remaining dataset contained the responses of 244 participants. In total, 77 percent of the respondents were female, while 23 percent of them were male. The majority of participants were of German nationality (80.7%) and participants age ranged from 18 to 28 years (M = 20.65, SD = 1.79). A more detailed depiction of the participants' demographic characteristics is displayed in Table 1.

Table 1

Demographic Characteristics of Participants (n = 244)

Characteristic	**Frequency**	**Percentage**	**Mean (SD)**
Age	-	-	20.7 (1.8)
Female	188	77.0	
Male	56	23.0	
German	197	80.7	
Dutch	27	11.1	
Other	20	8.2	
First Year Bachelor	173	70.9	
Second Year Bachelor	34	13.9	
Third Year Bachelor	29	11.9	
First Year Master	2	.8	
Second Year Master	4	1.6	
PhD	1	.4	
Other	1	.4	

Measuring instruments

This study was conducted through an online questionnaire, which consisted of different scales, investigating the different constructs of interest. The study was executed in collaboration with another researcher, interested in the relation of other constructs and CE drug use. The following scales were used, to collect information for the present study: A self-developed questionnaire about cognitive enhancement drug use, the Perceived Stress Scale (PSS), the Big Three Perfectionism Scale (BTPS) and a self-developed demographics questionnaire (Cohen, 2010; Smith, Sakloske, Stoeber, & Sherry, 2016).

CE drug use. In order to determine the overall usage and usage patterns of cognitive enhancement drug use among students, 36 self-constructed items were added to the questionnaire (see Appendix A). These items subdivided the CE drugs into three categories, namely over-the-counter drugs (e.g. caffeine, energy drinks, nicotine), illicit drugs (e.g. amphetamines, ecstasy, cocaine, marijuana) and prescription drugs (e.g. Ritalin, Concerta, Adderall). Prior to the items, a short description introduced the three categories and provided examples of drugs for each category.

Subsequently, the survey started with the question "*Have you ever used one of the mentioned substances to enhance motivation or cognitive functions such as alertness, attention, memory, concentration or learning?*". If the participant answered with "*No*" the remaining questions about CE drug use were skipped and the participant automatically continued with questions about the perceived level of stress. However, if the question was answered with "*Yes*" the participant was asked for each category, which substances he/she had used previously (e.g. "*Which of the following over-the-counter substances have you used before with the intention to enhance your cognitive functions?*").

For every substance that was indicated to have been consumed by the respondents, questions about the specific use in the past four weeks and in the past twelve months were asked (e.g. "*In the past 12 months, how often did you use caffeine tablets to enhance your cognitive functions?*"). Here, the answer options ranged from 0, 1-3, 4-10 to more than 10 times, which were scored later in the analysis as 0 = 1, 1-3 = 2, 4-10 = 3 and more than 10 = 4. These items were included, in order to find out which drugs were used by the respondents for cognitive enhancement purposes and how frequently they were used. The questions that asked which drugs have already been used by the participants, were scored by organizing the participants into different groups, based on their indication of the drugs used before. After this arrangement, five groups were established: *non-drug users*, *over-the-counter drug users*, *only prescription*

drug users, only illicit drug users and *illicit and prescription drug users*. The Cronbach's alpha for the total CE scale was calculated and was found to be satisfactory, α = .88.

Perceived Level of Stress. In order to determine participants level of stress, the PSS (Perceived Stress Scale) in its 10-item version was executed. The PSS is a quantitative self-report instrument, widely used for measuring the perception of stress (Cohen, Kamarck, & Mermelstein, 1983). The test contains of 10 items and aims to assess the extent, to which situations in one's life are evaluated as being stressful (Cohen, Kamarck, & Mermelstein, 1983). The items are phrased mostly general and focus on the feelings and thoughts of the participants during the past month (e.g. "*In the last month, how often have you felt that things were going your way?*", "*In the last month, how often have you felt that you were unable to control the important things in your life?*"). The answer options range from "Never = 0" to "Very Often = 4".

For scoring the PSS, the four positively stated items (4,5,7 & 8) are reversed (so that 0 = 4, 1 = 3, 2 = 2, 3 = 1 and 4 = 0) and subsequently all scale items are added up. The resulting scores indicate the perceived level of stress. Here, scores ranging from 0-13 are considered low perceived stress, scores from 14-26 are considered moderate perceived stress, and scores from 27-40 are considered high perceived stress. In conclusion, this means that a high score on the PSS demonstrates a high level of perceived stress during the past month.

Overall, the 10-item PSS was found to have high internal consistency reliability and factorial validity (Lee, 2012). In a review of Lee (2012), the Cronbach's alpha of the PSS-10 was evaluated in all studies to be >.70. In a study with Dutch university students at the University of Leiden, the PSS was found to have a Cronbach's alpha of α = .85 (De Heer, 2017). In this study, the internal reliability of the PSS was found to be above the accepted value of .07, as Cronbach's alpha was α = .90.

Perfectionism. For identifying respondents' multidimensional level of perfectionism, the Big Three Perfectionism Scale (BTPS) was used. The BTPS is a 45-item self-report questionnaire, designed for assessing three global perfectionism factors. The three global factors are rigid perfectionism, self-critical perfectionism, and narcissistic perfectionism (Smith, Saklofske, Stoeber, & Sherry, 2016). These factors are composed of 10 main perfectionism facets, which can be considered as subscales. The first global factor, rigid perfectionism, is composed of two facets, namely (1) *self-oriented perfectionism* and (2) *self-worth contingencies* (Smith, Saklofske, Stoeber, & Sherry, 2016). Items that assess these two facets

are for instance *"I strive to be as perfect as possible"* and *"My value as a person depends on being perfect"*.

The second global factor that is assessed by the BTPS, self-critical perfectionism, consists of four facets namely, (1) *concern over mistakes*, (2) *doubts about actions*, (3) *self-criticism*, and (4) *socially prescribed perfectionism*. (Smith, Saklofske, Stoeber, & Sherry, 2016). The statements detecting these facets of perfectionism are e.g. *"When I make a mistake, I feel like a failure"*, *"I have doubts about most of my actions"*, *"I have difficulty forgiving myself when my performance is not flawless"* and *"People are disappointed in me whenever I don't do something perfectly"*.

The third global factor, narcissistic perfectionism, is composed of four facets as well: (1) *other-oriented perfectionism*, (2) *hypercriticism*, (3) e*ntitlement*, and (4) *grandiosity* (Smith, Saklofske, Stoeber, & Sherry, 2016). These facets are assessed with statements like *"It is important to me that other people do things perfectly"*, *"I am highly critical of other people's imperfections"*, *"It bothers me when people don't notice how perfect I am"* and *"Other people acknowledge my superior ability".*

The three global factors and their facets are assessed using a 5-point-Likert scale. The possible answer options are "*Strongly disagree* = 1", "*Disagree* = 2", "*Neither agree, nor disagree* = 3", "*Agree* = 4" and "*Strongly agree* = 5".

For scoring the BTPS, the scores of the three global factors have to be determined. In order to determine these, first, all the facet scores have to be assessed. Every facet has its own set of questions, aiming at estimating the level of accordance with that facet. The facet scores are determined by adding up the scores of the items, of which the facet is composed (e.g. self-oriented perfectionism contains the items 1, 10, 27, 29, and 42). The facet scores are then added up, resulting in the respective global factor score (The Big Three Perfectionism Scale, n.d.). Scoring high on the global factors also means high accordance with the respective perfectionism dimension.

In the study of Smith, Saklofske, Stoeber, and Sherry (2016) the BTPS showed good internal consistency with Cronbach's alpha ranging from .83 to .90 for the 10 facets and from .92 to .93 for the three global factors in two university samples (N = 288, N = 290) and one community adult sample (N = 367. In these samples, each of the 10 facets showed clear homogeneity and unidimensionality (Smith, Saklofske, Stoeber, & Sherry, 2016).

The BTPS showed good internal consistency in this study as well, with Cronbach's alpha $\alpha = .95$ for the entire scale. The Cronbach's alpha was also determined for the three global factors, by assessing them individually as different scales, leading to good results, with $\alpha = .91$

for ‘rigid perfectionism’, α = .94 for ‘self-critical perfectionism’ and α = .89 for ‘narcissistic perfectionism’.

Demographics. Lastly, the questionnaire contained self-constructed items about the age, nationality, gender and the current phase of participants’ studies. These questions aim at gathering some demographical information about the participants (e.g. “*How old are you?*”, “*What is your current phase of study?*”).

Procedure

The study was approved by the Behavioural Management and Social Science (BMS) Ethics Committee of the University of Twente. The data was collected from 26th March 2019 until 22nd April 2019 via the platform *Qualtrics*, which is a software for collecting and evaluating participant responses. In this study, it was used to develop the questionnaire and collect the responses. The questionnaire was designed in English, in order to increase the number of respondents. When the participants followed the link they were provided with, they were redirected to the questionnaire on Qualtrics. The participants were first, thanked for their participation and briefed about the guidelines of the survey, followed by an introduction into the topic of cognitive enhancement drug use, which resulted in the purpose of this study. This was followed by the information that the questionnaire will take about 20 minutes to complete, and some information about the kind of questions and the variables under study was given.

Lastly, participants were informed that their data is collected anonymously, treated confidentially and will not be handed to third parties, as well as that they can withdraw at any time without giving a reason. They were also provided with contact details of both researchers, in case they had any more questions about the research. Afterwards, the participants were asked to accept the informed consent statement (see Appendix B), by clicking on “*Yes, I agree to participate*”. Subsequently, the questionnaire was conducted. When this step was completed, gratefulness for participation in the survey and the value of the information provided was expressed. For further questions, the participants were provided with contact details of the researchers once more. Lastly, participants were given the opportunity of leaving their Email address, in case they are interested in receiving information about the results of the study.

Data Analysis

The data was analysed, using the statistical analysis software SPSS v24 (IBM Corp., 2015). Respondents were grouped into five categories: non-drug users, over-the-counter drug users, only illicit drug users, only prescription drug users, and illicit and prescription drug users. The variable CE drug use was analysed for two different time periods, the past 4 weeks and the past 12 months. Perfectionism scores were assessed for the three global factors, and additionally, these were added up to a total perfectionism score.

Foremost, it was checked whether there are outliers in the dataset. Therefore, the Interquartile range (IQR) was computed for the main study variables. The IQR value was then multiplied with 1,5 and subsequently added to the 75^{th} percentile and subtracted from the 25^{th} percentile of one variable. The resulting range includes the values not considered outliers, while all values above or below this range are considered outliers.

One participant was excluded from the dataset because the score on the perfectionism scale was outside the predetermined range. No other outliers could be identified. However, 18 other respondents had to be excluded from the analysis, since they did not complete the survey. Descriptive statistics, such as mean, standard deviation, and Cronbach's alpha were calculated for the main study variables, including Skewness and Kurtosis of the data. For Skewness a cut-off score of < 2 was chosen; for Kurtosis < 7 (Kim, 2013). A value of Cronbach's alpha $\alpha > .70$ was considered acceptable (Tavakol & Dennick, 2011).

To determine direction and strength of the relationship between cognitive enhancement drug use, stress and perfectionism (testing $H_{1\text{-}9}$), correlation analyses were executed using the Pearson correlation coefficient. Here, the effect sizes were pre-determined to range from: *r = 0.00 - 0.19* "very weak", *r = 0.20-0.39* "weak", *r = 0.40-0.59* "moderate", *r = 0.60-0.79* "strong" to *r = 0.80-1.0* "very strong" (Wuensch & Evans, 1996).

In order to test for a mediation effect of Perceived Stress on the relationship between Perfectionism and CE drug use, a mediation analysis was executed using the PROCESS model written by Hayes (Hayes, 2019). PROCESS is an observed variable regression path analysis modelling tool, compatible with SPSS. It is widely used for the estimation of direct and indirect effects in mediation models (Hayes, 2019). The mediation seems to be statistically significant if the confidence interval does not contain zero. The first step of testing for a mediation effect with this model, tries to confirm the significance of the relationship between the independent variable (Perfectionism) and the dependent variable (CE drug use). In the second step, the relationship between the independent variable and the mediator (stress) is tested for its significance (Methodology Shop, n.d.). Step three examines the significance of the relationship

between the mediator and the dependent variable, in presence of the independent variable. Finally, the insignificance of the relationship between independent and dependent variable in presence of the mediator is determined (Methodology Shop, n.d.).

Results

Descriptive Statistics and Correlations

The means and standard deviations for each variable and can be found in Table 2. The frequency of CE drug use can be found in the Table in Appendix C. Out of the sample, containing 244 participants, 44.3% indicated to use over-the-counter drugs like coffee and nicotine, while a smaller portion uses prescription and illicit drugs (29.9%). One-quarter of respondents are non-drug users (25.8%). Since the Skewness and Kurtosis values of perfectionism, perceived Stress and CE drug use were below the pre-determined cut-off scores of < 2 and < 7, it was concluded that the data is normally distributed.

The outcomes of the correlation analysis can be found in Table 2. The analysis revealed, that there exists a statistically significant, weak positive relationship between students' perceived level of stress and their overall level of perfectionism ($r = .386$; $p = .001$). Moreover, the results of the analysis demonstrated a statistically significant weak positive relationship between the dimension rigid perfectionism and perceived stress ($r = .258$; $p < .001$) and a statistically significant moderate positive relationship between self-critical perfectionism and perceived stress ($r = .541$; $p < .001$). However, no statistically significant relationship was found between narcissistic perfectionism and student's perceived stress ($r = .038$; $p = .558$).

Furthermore, the correlation showed that there exists no significant positive relationship between students' overall level of perfectionism and their CE drug use in the past 4 weeks ($r = .096$; $p = .208$) and 12 months ($r = .049$; $p = .522$). Moreover, rigid perfectionism was found to have no statistically significant relationship with students' cognitive enhancement drug use in the past 4 weeks ($r = .063$; $p = .409$) and 12 months ($r = .025$; $p = .740$). The dimension self-critical perfectionism showed no significant relation with the overall drug use in the past 4 weeks and 12 months as well but demonstrated a statistically significant very weak positive relationship with the user group only prescription user ($r = .131$; $p = .040$). Only narcissistic perfectionism demonstrated a statistically significant very weak positive relationship with students' drug use in the past 4 weeks ($r = .189$; $p = .013$).

Lastly, the correlation analysis showed that there is no statistically significant positive relationship between students' perceived level of stress and their CE drug use from the past 4

weeks (*r = .060; p = .432*) and 12 months (*r = .068; p = .374*). However, stress showed a statistically significant very weak positive relationship with the user group only illicit user (*r = .159; p = .013*).

Table 2

Descriptive Statistics and Correlations for the Main Study Variables

Variables *(Min. – Max.)*	*Mean (SD)*	*α*	Kurtosis	Skewness	Stress	CE Drug use 4 weeks	Only illicit user	Only prescription user
Total Perfectionism (45 – 225)	112.93 (26.76)	.95	-0.15	0.11	.386**	.096	-.090	.099
Stress (1 – 40)	20,61 (7.58)	.90	-0.39	-0.03	1	.060	.159*	.092
Rigid Perfectionism (10 – 50)	26.28 (8.20)	.91	-0.61	0.17	.258**	.063	-.093	.068
Self-critical Perfectionism (18 – 90)	51.14 (14.51)	.94	-0.59	0.06	.541**	.019	-.047	.131*
Narcissistic Perfectionism (17 – 85)	35.53 (9.52)	.89	.060	.343	0.38	.189*	-.102	.020

*Note. ** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.*

Mediation Analysis

The outcomes of the mediation analysis, using the PROCESS macro model, are described in the following. The mediation analysis was conducted separately, with the 4-week and 12-month frequencies. In the first step of the mediation analysis, the effect of the independent variable, Perfectionism, on the dependent variable, CE drug use, was performed for the 4-week frequency and was found to be not significant, *b = .02, t (181) = 1.55, p = .12*. The effect was found to be not significant for the 12-month frequency as well *b = .01, t (181) = .80, p = .43.*

This outcome already excluded the possibility of a mediation effect, since no significant relationship could be established between the independent and the dependent variable. The second step revealed, that the regression of perfectionism on the mediator, perceived stress, was significant, *b = .11 t (181) = 5.45 p < .001*. In the third step it was confirmed, that the regression of Perceived Stress on CE drug use, when controlled for Perfectionism, is neither significant

for the 4-week frequency, *b = .04, t (181) = .83, p = .41*, nor for the 12-months frequency *b = .03, t (181) = .54, p = .59*.

Step 4 of the analysis demonstrated, that when controlled for the mediator perceived stress, perfectionism is no significant predictor of students' CE drug use in a 4-week period *b = .02, t (181) = 1.13, p = .26* and neither in a 12-month period, *b = .01, t (181) = .54, p = .59*. Furthermore, no significant indirect effect of perceived stress on CE drug use was found, neither for the 4-week frequency *b = .00, SE = .00, CI [-.01, .02]*, nor the 12-month frequency *b = .00, SE = .01, CI [-.01, .02]*.

Discussion

In order to understand underlying psychological factors that increase the tendency of CE drug use, this study aimed at examining the relationship between perfectionism and cognitive enhancement drug use, with perceived stress as a mediator.

Based on the results of the analyses, six out of ten hypotheses could be accepted. Furthermore, the answer to the research question this paper dealt with '*Is there a relationship between cognitive enhancement drug use among students and the personality trait perfectionism, which is mediated by their perceived stress levels?'* is discovered as no, there is no relationship between students' level of perfectionism and their overall CE drug use, which is mediated by perceived stress. However, the analyses revealed some significant correlations, suggesting different relationships of the perfectionism dimensions with CE drug use and stress, which have the potential to provide insight and inspiration for future research.

First of all, the cognitive enhancement drug use prevalence in this study, excluding over-the-counter drugs, was found to be 29.9%. This value was unexpectedly high in comparison to other studies, where a lifetime prevalence of illicit prescription drug use was found to range from 4.6 to 16% (Schelle et al., 2015). This finding may be explained by the fact, that in contrast to many previous studies, this study investigates illicit and prescription drugs. Participants indicated the use of both drug groups for cognitive enhancement purposes, adding up to a higher prevalence rate when compared to previous findings (Sattler & Wiegel, 2013).

When analysing the suggested positive relationship of students' level of perfectionism and their level of perceived stress, a weak, positive relationship was established. This finding indicates, that individuals with perfectionist characteristics, tend to experience a greater level of perceived stress when compared to individuals with low levels of perfectionism (Wang & Li, 2017). This outcome is consistent with other findings in studies investigating the relationship of perfectionism and perceived stress, in which a positive correlation between

perfectionism and stress was found (D'Souza, Egan, & Rees, 2011) and thus, leads to the confirmation of the first hypothesis. However, the various dimensions of perfectionism demonstrated different relationships with students' perceived stress.

The proposed significant relationship between the first dimension, rigid perfectionism, and perceived stress can be confirmed, as a weak positive correlation was found. This dimension describes individuals, that have extremely high standards, think striving for perfection and being perfect is important, and use self-imposed perfectionistic standards as a sign and base for self-worth (Smith, Saklofske, Stoeber, & Sherry, 2016). The results of this study indicate that personality characteristics captured by the concept of rigid perfectionism, increase the perceived level of stress for an individual. This finding is consistent with other studies, which discovered that students' having very high academic standards and hold fears about failing can experience a decrease in wellbeing (Sotardi & Dubien, 2019). A possible explanation could be the constant challenge of meeting the high standards these individuals hold for themselves and their feeling of self-worth, that is based on what they achieve or what they do not achieve (Flett, Sherry, Hewitt, & Nepon, 2014).

Furthermore, the dimension self-critical perfectionism had a moderate positive relationship with students' perceived level of stress, leading to the confirmation of the proposed significant relationship. Individuals with high levels of self-critical perfectionism have overly concerns over their mistakes, are uncertain and doubtful regarding their performance, engage in harsh self-criticism when their performance is imperfect and perceive other people to demand perfection (Smith, Saklofske, Stoeber, & Sherry, 2016). Based on the moderate positive relationship it is suggested, that individuals with high levels of self-critical perfectionism, perceive more stress as well. This could be explained by the distress that is caused by concerns over performance, accompanied by harsh self-criticism and by the pressure, resulting from the belief that others are expecting perfection (Smith et al., 2019).

The dimension narcissistic perfectionism was found to have no significant relationship with student's perceived stress. This outcome suggests, that characteristics like harshly judging other peoples' imperfections, expecting too much from others, being convinced that one deserves special treatment and persistently believing that one is superior to others, do not significantly influence the perceived stress of students. This finding is in line with existing literature, where narcissistic perfectionism characteristics were found to not manifest in high levels of stress for the affected person itself but rather causing distress for the persons close to them (Smith, Sherry, & Saklofske, 2018).

Furthermore, the suggested positive relationship between students' overall level of perfectionism and the total cognitive enhancement drug use of students in the past 4 weeks and 12 months was rejected, as the analyses revealed no significant correlation. This finding contradicts with existing literature on this topic. In a sample of 272 university students, Stoeber and Hotham (2016) found that perfectionist concerns and doubts about one's action, the belief that others demand perfection, and parental pressure to be perfect, are positively related to positive attitudes towards CE drug use, and the perception that taking CE drugs is necessary. Furthermore, in a sample of 204 Korean athletes, Bae, Yoon, Kang, and Kim (2017) found that perfectionism is positively related to attitudes towards doping.

However, when analysing the correlations of the three global perfectionism factors with the total cognitive enhancement drug use of students in the past 4 weeks and 12 months, only narcissistic perfectionism showed a significant very weak positive correlation with the CE drug use in the past 4 weeks. This suggests, that individuals with high levels of narcissistic perfectionism might be more prone to use CE drugs, especially in the past month. This effect could be explained by considering the fact, that narcissistic perfectionists cannot tolerate any flaw in the perfection of oneself. Their self-worth is based on being perfect and seeming perfect; if they are not perfect, they are nothing (Flett, Sherry, Hewitt, & Nepon, 2014). This view may mislead some individuals in taking drugs to fulfil their self-imposed standards.

In addition, the suggested significant relationship between self-critical perfectionism and CE drug use was confirmed, as self-critical perfectionism and the user group 'only prescription user' showed a very weak positive correlation. This finding is similar to the findings of Bahrami, Yousefi, Kaviani, and Ariapooran (2014), where perfectionistic strivings and concerns, were also positively correlated with positive attitudes towards doping. The outcomes of this and previous studies suggest, that self-critical perfectionism might predispose certain students to consume performance-enhancing drugs, especially prescription drugs, in order to perform on the highest level and deliver perfect results. This predisposition can possibly be explained, by feelings of insufficiency when performance falls of perfection and feeling under pressure to perform better, which in turn leads to an increased level of stress (Ye, Wang, & Guo, 2016).

A study by Sotardi and Dubien (2019) claims, that university students' wellbeing can be predicted based on perfectionistic dimensions, and it is possible that the wellbeing decreases when students have very high academic standards and hold fears about failing. These findings support the idea, that perfectionist individuals are faced with high self-imposed standards, which can lead to feelings of pressure and stress. Moreover, these feelings can impair the

performance of an individual, resulting in disappointment (Sotardi & Dubien, 2019), which can possibly make some students more prone to use substances for cognitive enhancement. However, the dimension rigid perfectionism demonstrated no significant relationship with CE drug use, which is why this suggested significant relationship was rejected.

When analysing the proposed positive relationship between students' perceived stress and their cognitive enhancement drug use in the past 4 weeks and 12 months, no significant relationship could be established. This was an interesting finding, as it contradicts with the existing literature on the relationship of stress and CE drug use (Misra & McKean, 2000; Pighi et al., 2018; Sinha, 2008). One paper of Ruisoto and Contador (2019), reviewing 130 articles that focus on stress and addiction, concluded, that stress contributes to setting up and increasing drug addiction. The contradictory results of this study could be explained by the fact, that most of the drugs used by participants were OTC drugs. OTC drugs like coffee, caffeinated drinks, and caffeine tablets have limited pro-cognitive effects in healthy subjects but are used frequently among students (Franke & Bagusat, 2015). Because of these limited effects, caffeine consumption may not be related to dealing with stress but rather to enhance mood and performance and feel more awake (Mahoney et al., 2019).

Moreover, when analysing the relationship of the different CE user groups and perceived stress, a significant very weak, positive relationship between only illicit drug users and perceived stress was found. This finding suggests, that students' perceived stress can increase the tendency of using illicit drugs for the purpose of cognitive enhancement. As most of the illicit users indicated to use marijuana, it is assumed, that this drug is not only used for cognitive enhancement purposes but also for dealing with and relieving stress symptoms (Rusznák, et al., 2018). This outcome might be explained by missing coping strategies when it comes to stress, and it is assumed, that certain students might think of CE drugs as a coping strategy, to deal effectively with stress (Crutchfield & Gove, 1984).

The proposed mediation effect of stress on the relationship between perfectionism and CE drug use was rejected, as the analysis revealed, that perfectionism does not act as a predictor of CE drug use. However, the proposed positive relationships between CE drug use and perfectionism, and CE drug use and stress could possibly be discovered as not significant, because of the limitations of this study and might be investigated in future research.

Limitations and Strengths

When evaluating this study, there are several strengths and limitations that need to be taken into account. This study faces its first weak point when considering the representativeness of the study. As the study sample was relatively homogeneous, the generalizability of the study results is restricted to a similar homogeneous population and the generalization of the study results to other populations is limited. Moreover, as 77% of the respondents were female and 70.9% were first-year students, this study does not give a detailed insight in the CE drug use behaviour of male students and students in higher years of study. This could be improved by investigating these populations more specifically, for instance, studying the CE drug use behaviour of male Master students, to find out, if gender and phase of study are influencing factors in students' CE drug use behaviour.

Another weak point of the study is, that the participants' responses may have been influenced by the *social desirability principle* (Schermer & Holden, 2019). The social desirability principle suggests, that participants have the tendency to present themselves in a favourable light, taking social norms into account. Some people, especially perfectionists, probably do not want others to know if they ever used cognitive enhancement drugs to increase their performance, or what kind of drugs they used. This idea is supported by the finding that perfectionist individuals may also have a perfectionistic self-presentation style, which focuses on proclaiming one's perfection, avoiding behavioural demonstrations of one's imperfections and nondisclosure of imperfection (Flett & Hewitt, 2014). This could imply that students with especially high levels of perfectionism, might have answered in a dishonest and self-promoting way.

This issue could be addressed by future research, through measuring perfectionism indirectly by not asking the participants directly. For instance, the participants are instructed to watch video clips, showing how people with high levels of perfectionism react in certain situations, in contrast to the reactions of individuals with low levels of perfectionism. The participants are not informed that the personality characteristic perfectionism is measured. After watching the video clips, the participants receive a questionnaire, asking them to indicate how much they could comprehend each reaction of the actors and to which degree they would have acted the same way or differently. This probably results in a more reliable estimate of people's level of perfectionism.

Another limitation is the questionable reliability of the CE drug use scale, measuring the frequency of consumption in the past 4 weeks. Here, Cronbach's alpha was tightly below

the accepted value of α = .7. This problem could be resolved by future research, through pilot testing.

However, a noteworthy strength of this study is the good reliability of all other scales, with values ranging from .73 to .95. This suggests that the scale items are closely related as a group, meaning they have good internal consistency. Another strength of the study is, that while in other studies it is often unclear for what purposes the drugs are used, this study focused specifically on drug use with the aim of enhancing cognitive performance. By this it was discovered, that illicit drugs have an important role in cognitive enhancement as well. Furthermore, since students are considered as an at-risk group for CE drug use (Misra & McKean, 2000), the sample that was collected focused on a relevant population, among which it is important to examine the risk factors and determinants that encourage CE drug use.

A last strength of the study is that also illicit drugs were investigated as potential drugs for cognitive enhancement. While other studies in European countries discovered a lifetime prevalence of 4.6 to 16% for illicit prescription drug use (Schelle et al., 2015), this study found that 13.1 % of respondents, used illicit prescription drugs before. However, also 16.8% of respondents used illicit drugs like ecstasy, amphetamines or marijuana for the purpose of cognitive enhancement. That means, that more students use illicit drugs for cognitive enhancement purpose than prescription drugs. This could be an interesting insight for future research, as not only the illicit prescription drug use but also the illicit drug use seems to be relevant, in studying and understanding students' cognitive enhancement drug use behaviour.

Implications for Future Research

This study contributes to the existing knowledge on the relationship of cognitive enhancement drug use and certain factors that increase the likelihood of using drugs to enhance their performance. In this study, perfectionism was supported as a multidimensional construct. These different dimensions have a different impact on students' perceived stress and their CE drug use. For future research, it would be interesting to investigate, whether some dimensions have a negative relationship with CE drug use and stress, as it is suggested by research that perfectionism can have positive and negative influences on individuals (Slade & Owens, 1998). This could mean that some perfectionism dimensions make people less susceptible to CE drug use, while other dimensions make people more prone to CE drug use (Stoeber & Hotham, 2016).

With this knowledge, interventions could be created, targeting behaviour change or education, concerning the perfectionism dimensions positively related to CE drug use, as well

as addressing and working with the dimensions that are negatively related to CE drug use. Furthermore, as perceived stress and perfectionism were discovered to have a positive relationship, stress was positively related to the user group illicit drug user, and two of the perfectionism dimensions were related to CE drug use as well, the relationship between these three variables and a possible mediation effect should further be investigated.

Another implication for future research would be to conduct the study in a qualitative design. This alternative offers the possibility of getting some deeper and less generalized knowledge of the personality trait and its influence on CE drug use from the participants. Thereby, also motives or connections could be uncovered, that have not been considered so far in relation to CE drug use. This information could contribute to the prevention of CE drug use in students with perfectionist characteristics, by developing interventions that target the motives and demonstrate alternative ways to act upon them and to deal with the situation.

Lastly, future research could develop interventions, that target overly self-critical and perfectionistic beliefs and show students the irrationality of perfection and of always being perfect, as self-critical perfectionism demonstrated the strongest relationship with stress and was related to the use of prescription drugs. This intervention should offer a feeling of unconditional community and identity, by working with students on the view of themselves. Furthermore, this feeling of belongingness is thought to enlighten students about the fact that they are also appreciated without unusually high achievements and without performing perfect, ideally leading to an unconditional feeling of self-worth (Civitci, 2015). Moreover, the intervention could teach students coping strategies, which help them to effectively cope with stress and to reduce their performance pressure.

Conclusion

This study examined the effect of students' level of perfectionism and their perceived stress, on their use of cognitive enhancement drugs. Perfectionism was studied as a multidimensional construct. The results of this study supported the multidimensionality and the different impacts of the perfectionism dimensions. The total stress and perfectionism scores were found to have no influence on the overall CE drug use of students. However, perfectionism and perceived stress were detected to have a positive relationship, whereas two perfectionism dimensions were positively correlated with different measures of CE drug use. Perceived stress demonstrated a weak correlation with the user group only illicit users. These outcomes suggest, that there exists some link between perfectionism, stress and CE drug use, that is not fully explained yet. Furthermore, this study revealed that more students use illicit drugs for the purpose of cognitive

enhancement than prescription drugs. Thus, an implication for future studies is to take illicit drugs into account when investigating students' cognitive enhancement drug use and find out more about the influencing motives and factors that lead students to cognitive enhancement drug use.

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Appendix A: Items CE drug use

In the following, you will be asked about your use of Cognitive Enhancement (CE) drugs.

CE-drugs include any type of substance that is used by **healthy individuals** to **enhance motivation or cognitive functions** such as **alertness, attention, memory, concentration or learning**.

CE-drugs can be divided into three groups:

1) **Over-the-counter (OTC) CE-drugs** include any cognition enhancing substance that can be bought without a doctor's prescription, such as caffeine, energy drinks, nicotine, or herbal extracts.
2) **Prescription CE-drugs** include the **nonmedical** use of medicines (without a doctor's prescription) for diseases such as ADHD, dementia, narcolepsy or shift work sleep disorder.
3) **Illicit CE-drugs** include drugs such as amphetamines, ecstasy, cocaine or illicit marijuana, **used with the purpose of enhancing cognition.**

1. Have you ever used one of the mentioned substances to enhance motivation or cognitive functions such as alertness, attention, memory, concentration or learning?

- ○ Yes
- ○ No

2. Which of the following **over-the-counter substances** have you used before with the intention to enhance your cognitive functions?

- ☐ Caffeinated drinks (e.g. coffee, tea, energy drinks)
- ☐ Caffeine tablets
- ☐ Nicotine/ cigarettes
- ☐ Herbal extracts (e.g. Ginkgo biloba, Ashwagandha)
- ☐ Other, namely
- ☐ ⊗ None of these

3. In the past 12 months, how often did you use **caffeinated drinks (e.g. coffee, tea, energy drinks)** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times
- ○ 4-10 times
- ○ More than 10 times

4. In the past 4 weeks, how often did you use **caffeinated drinks (e.g. coffee, tea, energy drinks)** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times

- 4-10 times
- More than 10 times

5. In the past 12 months, how often did you use **caffeine tablets** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

6. In the past 4 weeks, how often did you use **caffeine tablets** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

7. In the past 12 months, how often did you use **cigarettes/nicotine** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

8. In the past 4 weeks, how often did you use **cigarettes/nicotine** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

9. In the past 12 months, how often did you use **herbal extracts (e.g. Ginkgo Biloba, Ashwagandha)** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

10. In the past 4 weeks, how often did you use **herbal extracts (e.g. Ginkgo Biloba, Ashwagandha)** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times

- ○ More than 10 times

11. In the past 12 months, how often did you use **the over-the-counter substance you referred to as other** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times
- ○ 4-10 times
- ○ More than 10 times

12. In the past 4 weeks, how often did you use **the over-the-counter substance you referred to as other** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times
- ○ 4-10 times
- ○ More than 10 times

13. Which of the following **prescription drugs** have you used before with the intention to enhance your cognitive functions?

- ☐ Methylphenidate (e.g. Ritalin, Concerta)
- ☐ Amphetamines (e.g. Adderall)
- ☐ Modafinil (e.g. Provigil)
- ☐ Antidementia drugs (e.g. Piracetam, Donepezil)
- ☐ Other, namely
- ☐ ⊗ None of these

14. In the **past 12 months**, how often did you use **Methylphenidate (e.g. Ritalin, Concerta)** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times
- ○ 4-10 times
- ○ More than 10 times

15. In the **past 4 weeks**, how often did you use **Methylphenidate (e.g. Ritalin, Concerta)** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times
- ○ 4-10 times
- ○ More than 10 times

16. In the **past 12 months**, how often did you use **amphetamines (e.g. Adderall)** to enhance your cognitive functions?

- ○ 0 times

- 1-3 times
- 4-10 times
- More than 10 times

17. In the **past 4 weeks**, how often did you use **amphetamines (e.g. Adderall)** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

18. In the **past 12 months**, how often did you use **Modafinil (e.g. Provigil)** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

19. In the **past 4 weeks**, how often did you use **Modafinil (e.g. Provigil)** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

20. In the **past 12 months**, how often did you use **Antidementia drugs (e.g. Piracetam, Donepezil)** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

21. In the **past 4 weeks**, how often did you use **Antidementia drugs (e.g. Piracetam, Donepezil)** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

22. In the **past 12 months**, how often did you use **the prescription drug you referred to as other** to enhance your cognitive functions?

- 0 times
- 1-3 times

- ○ 4-10 times
- ○ More than 10 times

23. In the **past 4 weeks**, how often did you use **the prescription drug you referred to as other** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times
- ○ 4-10 times
- ○ More than 10 times

24. Which of the following **illicit drugs** have you used before with the intention to enhance your cognitive functions?

- ☐ Amphetamines
- ☐ Methamphetamines
- ☐ Ecstasy
- ☐ Cocaine
- ☐ Marijuana
- ☐ Other, namely
- ☐ ⊗ None of these

25. In the **past 4 weeks**, how often did you use **amphetamines** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times
- ○ 4-10 times
- ○ More than 10 times

26. In the **past 12 months**, how often did you use **methamphetamines** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times
- ○ 4-10 times
- ○ More than 10 times

27. In the **past 4 weeks**, how often did you use **methamphetamines** to enhance your cognitive functions?

- ○ 0 times
- ○ 1-3 times
- ○ 4-10 times
- ○ More than 10 times

28. In the **past 12 months**, how often did you use **ecstasy** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

29. In the **past 4 weeks**, how often did you use **ecstasy** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

30. In the **past 12 months**, how often did you use **cocaine** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

31. In the **past 12 months**, how often did you use **cocaine** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

32. In the **past 4 weeks**, how often did you use **cocaine** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

33. In the **past 12 months**, how often did you use **marijuana** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

34. In the **past 4 weeks**, how often did you use **marijuana** to enhance your cognitive functions?

- 0 times

- 1-3 times
- 4-10 times
- More than 10 times

35. In the **past 12 months**, how often did you use **the illicit substance you referred to as other** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

36. In the **past 4 weeks**, how often did you use **the illicit substance you referred to as other** to enhance your cognitive functions?

- 0 times
- 1-3 times
- 4-10 times
- More than 10 times

Appendix B: Informed consent form

Dear Participant,

thank you for participating in this online study about the use of cognitive enhancement drugs among university students.

With increasing competition, societal expectations and pressure, students' use of cognitive enhancement drugs (CE-drugs) has strongly increased during the last years. Cognitive enhancement is defined as the use of a substance by a healthy individual to improve motivational functions and cognition such as memory, concentration, attention, and learning. Dependent on the choice of drug, these can lead to negative consequences such as addiction and side effects. Even though insight on the motives for using CE-drugs is needed to develop targeted interventions, research on these factors is still in its infancy. The purpose of the current study is to address this gap by **investigating factors leading to CE-drug use, particularly stress, perfectionism, and procrastination.**
The survey will take about 20 minutes to complete. To complete this survey, you will need a laptop/computer/mobile device and a working internet connection. The study includes multiple-choice questions about your use of CE-drugs (frequency, type of CE-drug), a questionnaire on your perfectionism level, tendency to procrastinate and lastly, some demographical questions.

We kindly ask you to **read the questions carefully** and to **answer all questions honestly**. All data is kept **anonymously** and personal information will not be passed on to third parties under any condition. Under no circumstances will any personal data or identifying information be included in the report of this research. Nobody, except the two researchers and the two supervisors, will have access to the anonymized data in its entirety. Participation in this study is entirely voluntary and you can **withdraw at any time.**

If you have any questions about the study, please contact the researchers Lisa-Marie Andres (l.andres@student.utwente.nl) or Nastassja Volkov (n.volkov@student.utwente.nl).

By clicking on 'Yes, I agree to participate', you declare the following:

I hereby declare that I have been informed in a clear manner about the aim and method of this study. Furthermore, I participate in my own free will and I am aware that I can withdraw from this research at any time without having to mention a reason. Information about anonymity and how to get in contact with the researchers in case of questions or comments are clear to me.

Do you agree to participate in this study?

- ○ Yes, I agree to participate
- ○ No, I do not agree

Appendix C

Frequency of CE drug use over the last 12 months and 4 weeks

Category	Substance	Intake in last 12 month	Frequency (%)	Intake in last 4 weeks	Frequency (%)
Over-the-counter-drugs	Caffeinated drinks	0 times	2 (.8)	0 times	18 (7.4)
		1-3 times	18 (7.4)	1-3 times	26 (10.7)
		4-10 times	15 (6.1)	4-10 times	43 (17.6)
		More than 10	140 (57.4)	More than 10	88 (36.1)
	Caffeine tablets	0 times	14 (5.7)	0 times	25 (10.2)
		1-3 times	11 (4.5)	1-3 times	7 (2.9)
		4-10 times	8 (3.3)	4-10 times	2 (.8)
		More than 10	2 (.8)	More than 10	1 (.4)
	Nicotine/ cigarettes	0 times	7 (2.9)	0 times	17 (7)
		1-3 times	5 (2)	1-3 times	10 (4.1)
		4-10 times	11 (4.5)	4-10 times	9 (3.7)
		More than 10	44 (18)	More than 10	31 (12.7)
	Herbal Extracts	0 times	6 (2.5)	0 times	13 (5.3)
		1-3 times	9 (3.7)	1-3 times	10 (4.1)
		4-10 times	6 (2.5)	4-10 times	2 (.8)
		More than 10	5 (2)	More than 10	1 (.4)
	Other	0 times	4 (1.6)	0 times	5 (2)
		1-3 times	1 (.4)	1-3 times	3 (1.2)
		4-10 times	5 (2)	4-10 times	7 (2.9)
		More than 10	7 (2.9)	More than 10	2 (.8)
Prescription drugs	Methylphenidate	0 times	8 (3.3)	0 times	15 (6.1)
		1-3 times	6 (2.5)	1-3 times	4 (1.6)
		4-10 times	3 (1.2)	4-10 times	3 (1.2)
		More than 10	7 (2.9)	More than 10	2 (.8)
	Amphetamines	0 times	3 (1.2)	0 times	6 (2.5)
		1-3 times	3 (1.2)	1-3 times	4 (1.6)
		4-10 times	3 (1.2)	4-10 times	2 (.8)
		More than 10	4 (1.6)	More than 10	1 (.4)
	Modafinil	0 times	-	0 times	3 (1.2)
		1-3 times	2 (.8)	1-3 times	1 (.4)
		4-10 times	1 (.4)	4-10 times	-
		More than 10	1 (.4)	More than 10	-
	Antidementia drugs	0 times	-	0 times	-
		1-3 times	-	1-3 times	-
		4-10 times	-	4-10 times	-
		More than 10	-	More than 10	-
	Other	0 times	-	0 times	2 (.8)
		1-3 times	1 (.4)	1-3 times	1 (.4)
		4-10 times	2 (.8)	4-10 times	1 (.4)

		More than 10	2 (.8)	More than 10	1 (.4)
Illicit drugs	Amphetamines	0 times	4 (1.6)	0 times	8 (3.3)
		1-3 times	5 (2)	1-3 times	7 (2.9)
		4-10 times	6 (2.5)	4-10 times	1 (.4)
		More than 10	2 (.8)	More than 10	1 (.4)
	Methamphetamines	0 times	-	0 times	1 (.4)
		1-3 times	-	1-3 times	-
		4-10 times	1 (.4)	4-10 times	-
		More than 10	-	More than 10	-
	Ecstasy	0 times	1 (.4)	0 times	6 (2.5)
		1-3 times	5 (2)	1-3 times	6 (2.5)
		4-10 times	6 (2.5)	4-10 times	1 (.4)
		More than 10	1 (.4)	More than 10	-
	Cocaine	0 times	1 (.4)	0 times	4 (1.6)
		1-3 times	8 (3.3)	1-3 times	5 (2.0)
		4-10 times	1 (.4)	4-10 times	1 (.4)
		More than 10	-	More than 10	-
	Marijuana	0 times	2 (.8)	0 times	18 (7.4)
		1-3 times	15 (6.1)	1-3 times	15 (6.1)
		4-10 times	11 (4.5)	4-10 times	4 (1.6)
		More than 10	22 (9)	More than 10	13 (5.3)
	Other	0 times	-	0 times	1 (.4)
		1-3 times	1 (.4)	1-3 times	2 (.8)
		4-10 times	3 (1.2)	4-10 times	1 (.4)
		More than 10	-	More than 10	-