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KOGNITÍV FUNKCIÓK NÖVELÉSE CÉLJÁBÓL VÉGZETT SZERFOGYASZTÁS  
AZ ÚJVIDÉKI EGYETEM HALLGATÓI KÖRÉBEN

SUBSTANCES USED TO IMPROVE COGNITIVE FUNCTION AMONG  
STUDENTS OF UNIVERSITY OF NOVI SAD

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## Rezümé

**Bevezetés:** ‘Pharmacological neuroenhancement’ avagy gyógyszeres agyi stimuláció, a hangulat, agyi és érzékszervi funkciók javításá céljából végzett szerek használata, egészséges személyek által. Szerbiában az ilyen típusú szerek fogyasztásának prevalanciája nem ismert. A jelenlegi fogyasztási szokások mélyrehatóbb vizsgálata kulcsfontosságú, különösen a fiatalabb generációk körében, mivel az eredmények ismerete hozzásegít egy hatékony primer prevenciók stratégia kidolgozásához.

**Célkitűzés:** Az agyi működés szerhasználattal történő stimulálásának gyakorlata és a hozzá kapcsolódó szokások feltérképezése az Újvidéki Egyetem hallgatói körében.

**Alkalmazott módszerek:** Az egyetem minden karának hallgatója meghívást kapott az önkéntes, anoním kérdőívben való részvételre, melyet online formában érhettek el. A kutatás során keresztmetszeti vizsgálati módszert alkalmaztunk.

**Eredmények:** A kérdőívet sikeresen kitöltők között 262 fő ( 79.87 % ) állította, hogy használt már valamilyen agyi stimulálószer. 7 személy (2.13 %) vényköteles gyógyszert, 99 fő (30.18%) étrendkiegészítőt , 21 tanuló (6.4 %) függőséget okozó anyagot, 15 diák (4.57 %) alkoholt és 233 hallgató (71.03%) energia italt próbált ki legalább egyszer élete során. Modafinilt, mint vényköteles gyógyszert 2 fő említett. Kiemelendő, hogy 127 hallgatót (38.7%) foglalkoztatott vényköteles gyógyszer használatának gondolata és 36 válaszadó ( 11%) jelezte, hogy tanulmányai során már kínálták vényköteles szerrel. A serkentő szerek használatának vagy kipróbálásának elősegítő tényezői leginkább a koncentrációs képesség javítása (20%), a gondolatok tisztázása (9%), illetve a hatékonyabb és gyorsabb tanulás elérése (9%) voltak.

**Következtetés:** "Bár eredményeink egy kisebb csoport vizsgálatára terjedtek ki, ugyanakkor kiemelendő, hogy pozitív korrelációban állnak hasonló nemzetközi tanulmányok eredményeivel. Az energia italok magasfokú fogyasztása mellett az illegális psychostimuláns szerek fogyasztása dominált, illetve hogy a diákok egy jelentős része elgondolkodott az esetleges használat lehetőségén. Mindezek tükrében megállapíthatjuk további egyeztetések szükségességét egy hatékonyabb hallgatói egészségmegőrző stratégia kialakítása érdekében.

**Kulcsszavak:** neurofarmakológia, nootropikumok, szerfogyasztás, kognitív funkciók javítása

## Abstract

**Background:** Neuroenhancement is the use of substances by healthy individuals to enhance mood or cognitive function. In Serbia the prevalence of such agent consumption is unknown. Investigating this area of research is crucial in mapping the present consumption status among young generations as well as establishing proper preventive care.

**Study aim:** To establish the prevalence of cognitive enhancing agents use among students of University of Novi Sad.

**Method:** Students from all faculties of University of Novi Sad were invited to participate in a voluntary anonymous online survey. A cross-sectional study was carried out.

**Results:** A total of 364 students had agreed to participate, 328 (100%) of students had successfully completed the questionnaire. Among all the subjects who have claimed to have used some type of enhancer (79.87 %) has claimed to have used prescription drugs (7 (2.13 %)), supplements (99 (30.18%)), drugs of abuse (21(6.4 %)), alcohol (15(4.57 %)) or energy drink (233(71.03%)) at least once in their lifetime. Modafinil as a prescription drug was mentioned by 2 students. Interestingly, 127 (38.7%) students have considered trying a prescription drug for the purpose of cognitive enhancement, and 36 (11%) respondents were offered a prescription drug in their life. Incitement factors proved to be to improve concentration (20%), to clear the mind (9%), to learn faster and more efficiently (9%).

**Conclusions:** The prevalence although not representative but is in correlation with similar studies from international research. Besides the high level of energy drink consumption and the high prevalence of illicit drug use, we would like to press on the seemingly rather positive attitude of students towards prescription drug use. Therefore, further discussion about preventive actions, particularly of these substances should be considered.

**Keywords:** neuropharmacology, nootropics, improvement of cognitive function, prescription drugs

## 1. Introduction

The phenomenon of using various 'aids' to improve cognitive function has been around for a long time. These substances have always varied from illicit to legally obtainable products. What has significantly changed though since the early 2000s is the approach and attitude of research community towards this issue. Part of the reason might be that younger generations - particularly college population - seem to be a high-risk group of misusers of these substances. Growing number of studies are published all over the globe - including North America [1,2], United Kingdom [3] and Europe [4-12] , showing insight into consumption habits of cognitive enhancers and giving a basis for comparison internationally.

Use and discussion about Pharmaceutical Cognitive Enhancers (PCE) is becoming a more and more elaborated topic, due to the fact that the above mentioned studies have shown their consumption is generally increasing among young population [1-4]. Lack of universal understanding of the term 'neuroenhancement' in research community as well as among general population creates confusion and complication when comparing data throughout different studies [1-8 ]. This ambiguity is only amplified by the various media platforms and the increasing news value of our subject-matter. Multiple definitions exist of which we will take one as basis of our study - phrased by Hildt & Franke: "Cognitive enhancement is the use of drugs, biotechnological strategies or other means by healthy individuals aiming at the improvement of cognitive functions such as vigilance, concentration or memory without any medical need [13,14]."

Pharmacological Cognitive Enhancement among college population is an area of research that has not or only has poorly been investigated in Southeastern Europe, in Serbia no studies can reflect on pharmacological drug misuse habits of young people. This not only leaves us with unknown patterns of stress coping mechanisms resulting from academic performance demands, but also deprives Serbian epidemiologists and educational professionals from establishing proper preventive programs. In other parts of the world prevalence of PCE use among college populations varies between 0.8% - 25% depending on several factors such as geographical location, educational institute and type of substances used [1–12]. In Europe, neuroenhancement does not appear to be as common as in the United States or Canada [4], furthermore an unofficial online survey conducted by Nature reported that 20% of the 1400 respondents (from 60 countries) admitted to off-label use of pharmaceutical stimulants for the purpose of cognitive enhancement [15]. While these measures are worrisome, we need to mention Partridge's argument which concludes that reported misuse of prescription stimulants is often assumed to mean

that misuse is aimed specifically at cognition enhancement, when the true purpose may instead be recreational [16]. In light of the possible bias of PCE surveys we need to be critical with any published data. In the most extensive study carried out in Switzerland involving 6275 students[4] , published in November 2013, the most frequently mentioned pharmaceuticals used *specifically* for neuroenhancement were methylphenidate (4.1%), modafinil (0.3%), sedatives (2.7%), and beta blockers (1.2%). Among natural supplements or 'soft enhancers', consumption of herbal sedatives (18.2%), and others (Gingko biloba, zinc, vitamins collectively) (18.2%) were indicated. Drugs of abuse including alcohol (5.6%) were used for the purpose of cognitive stimulation primarily cannabis (2.5%), cocaine (0.2%), amphetamines (0.4%). These values all regard *lifetime* prevalence.

As first ones in Serbia, we aimed to create a similar study to those aforementioned by assessing several perspectives of the use of cognitive stimulant substances among students of one Serbian university. We hypothesized that the true measures of PCE consumption outnumbers the expected ones, however we have to bear in mind that availability of PCE agents in Serbia might be even more limited than in better situated countries, so our results should be analyzed considering these limiting factors as well.

## **1. Objectives**

This present study has 3 main objectives. Firstly we aimed to establish prevalence of cognitive stimulant substances consumption for the purpose of improving cognitive function among students of University of Novi Sad. We were interested in the socio-demographic structure and consumption patterns of the involved population. Our third objective was to frame existing attitudes towards particular substances, as well as investigating motivations of such a habit.

## **2. Material and Methods**

We carried out a cross-sectional study involving 364 students. Out of the total of 364 participants who volunteered to fill out the questionnaire, 33 didn't fill out completely the form, 3 declined to agree to fill out the form after reading the introductory part and so 36 participants were excluded from further calculations. A total of 328 students have filled out completely the questionnaire. The respondents were all students of University of Novi Sad, all Faculties were invited to participate. We created a comprehensive anonymous questionnaire in two languages - Serbian and English – since the university has several degree programs in English language. The questionnaire – you may find it in both

languages attached to this work [Attachment 1 and 2] - could be accessed in online form (Google Forms – free version). Although there are drawbacks of online surveys, we settled over this version instead of conventional paper-based form due to its cost and time effectiveness, its ease of access and availability [17]. After obtaining a written approval from the Ethics Committee of the Medical Faculty of Novi Sad we posted the link to the survey in private study

groups. Participation in the study was voluntary and anonymous. Prior to filling out the questions participants were provided with a consent sheet and an informed sheet describing the rationale of the study, also stating that they had the right to withdraw from the study any time. Data was continuously collected over period of one month, from January 15 – February 15. The questionnaire was designed by the authors with the detailed review of other scientific articles [1-4]. First socio-demographic data as well as evaluation of study difficulties of participants was collected including possible existing medical diagnoses. In the following sections non-medical use of prescription stimulant drugs, use of natural supplements, abuse of illicit drugs, alcohol and energy drink consumption was assessed. We aimed to include several materials available in Serbia, consumption prevalence of which is measured in other related studies as well. Following the collection of responses, Microsoft Office Excel 2010 was used to analyze the data. Our results were presented using percent values and correlation methods using tables and visual graphs.

### 3. Results

A total of 328 (100%) have filled out successfully the questionnaire. Distribution of gender was not even, female respondents were represented in a higher number (30.7% male, 69.2% female). The mean age of students was 22 (SD=2.55) [Figure 1.], the mean semester students were enrolled in was 5, ie. the 3<sup>rd</sup> year of study. Full-time employment during studies was indicated by 4.26% (14) people during studies and part-time by 7.92% (26). Among respondents 5.48% (18) reported being medically diagnosed with a central nervous system condition, whereas 4.57% (15) indicated existing cardiovascular conditions.

Total	328 (100%)
Gender	
Male	101 (30.7%)
Female	227 (69.2%)
Mean of age(years)	22 (SD=2.55)
Number of semesters	5 (SD=2.8)
Employment during studies	
Yes	14 (4.26%)
No	288 (87.8%)
Partly	26 (7.92%)
CVS disorder diagnosis	
Yes	15 (4.57%)
CNS disorder diagnosis	
Yes	18 (5.48%)

*Table 1. Demographic characteristics of students of University of Novi Sad*

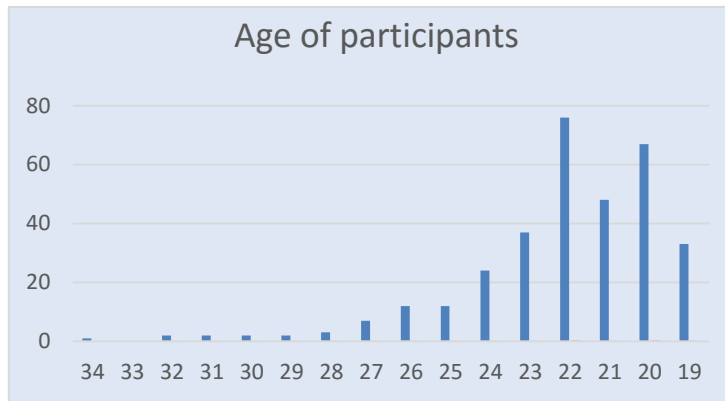


Figure1. Age distribution of participants

Students were asked to evaluate possible difficulties in their abilities of concentration and efficiency of learning [Figure 2.]. Increased frequency in difficulties was present in 16% (52) of the students.

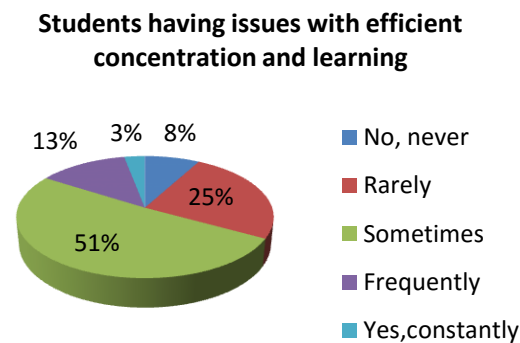


Figure2. Difficulties of learning and concentration noted by the students

Responses were collected from all of the faculties but Faculty of Medicine (35%), Faculty of Philosophy (17%), Faculty of Mathematical Sciences (14%) and Faculty of Technology (13%) dominated [Figure 3.].

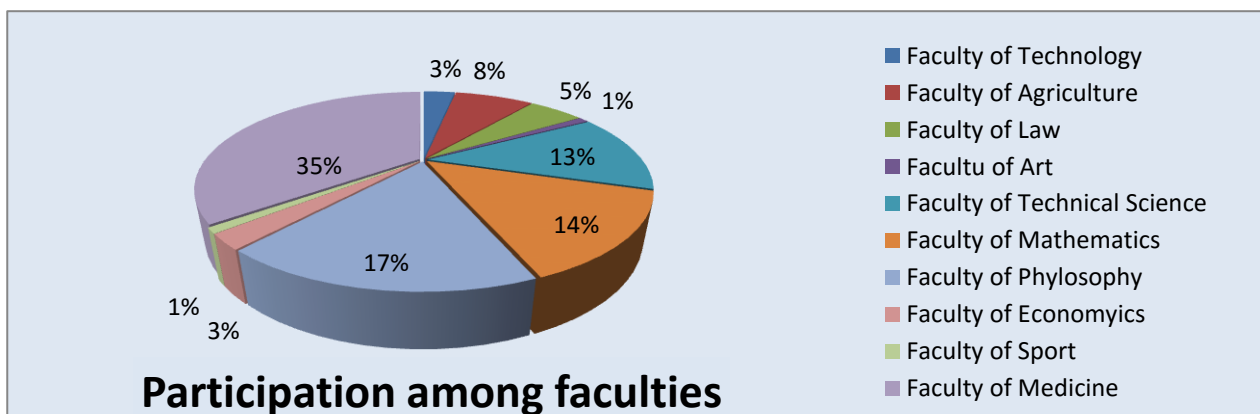


Figure1. Distribution of faculty participation



Overall 79.87 % (262) of students reported some type of cognitive stimulant use when including energy drinks. Excluding energy drink this value was 12.5% (41). Of the 7 (2.13%) students who admitted to off-label use of one or more pharmaceutical prescription stimulants for cognitive enhancement (lifetime prevalence) [Table 2.], 2 students had used non-medical use stimulants 1-5 times, the other 5 has tried it only once. The most relevant drug in was modafinil used by 2 students. Besides modafinil, piracetam, methylphenidate, vinpocetine, rivastigmine, donezepil were used. Use was mainly associated with self-initiative or a non-colleague friend. 5 of the 7 students indicated the use in the exam period. Female students constituted 85% of prescription drug users (6). Of the 7 users 5 attended the Medical faculty and most of the students were senior. Expectations in relation to the drug were reported not to be fulfilled in 71% of the students, though it was not specified what they meant by that.

	Lifetime prevalence
Prescription drugs	
Methylphenidate	1 (14.2%)
Modafinil	2 (28.5%)
Vinpocetin	1 (14.2%)
Donezepil	1 (14.2%)
Rivastigmin	1 (14.2%)
Piracetam	1 (14.2%)
Other	1 (14.2%)

Table 2 Prescription drug consumption prevalence

	328 (100%)
Prescription drugs	
Male	1 (0.99%)
Female	6 (2.64%)
Total	7 (2.13%)
Drugs of abuse including alcohol	
Male	17 (16.83%)
Female	16 (7.04%)
Total	33 (10.03%)
Prescription drugs AND drugs of abuse including alcohol	
Male	0 (0%)
Female	2 (0.88%)
Total	2 (0.60%)
Prescription drugs OR drugs of abuse including alcohol	
Male	18 (17.82%)
Female	20 (8.81%)
Total	38 (11.58%)

Table 3. Gender distribution of PCE consumption (normalized to gender %)

We found no correlation between concentration problems and misuse of prescription neuroenhancers, on the other hand there was a positive correlation between medication misuse and alcohol consumption. What is significant in our results is the attitude of students towards trying such a substance. All together 127 students, 38.7%, have considered trying a prescription drug for the purpose of cognitive enhancement, and 36 respondents, 11% of the students were offered a prescription drug in their life.

In the second group dietary supplements were investigated. In total 99 (30.18%) students have claimed to have used some type of supplement in their lifetime. The list of substances can be found in Table 4. Most prevalent products were vitamins (65.65%), as expected, and a significant portion of students reported use of some derivative product of ginko biloba root (43.43%). Worth to mention that 42% of users could not determine whether the supplements they have used worked or no. Memoryn and Memoaktiv was used by 16 students (4.8%). Fish oil consumption prevalence was 3.3%.

When asked about duration of use, 53 students (16.4%) said to have used supplements for less than 6 months and 54 (16.4%) students purposefully used supplements in the exam period. Only 14 (4.26%) said to use supplements all year long in regard with learning needs. Regarding initiatives of dietary supplement consumption, 55% of the students said to have decided to consume supplements on own initiative and 16% for the advice of a non-colleague friend. Considering the attitude, 67 students (20.4%) have thought about consuming supplements for the purpose of cognitive enhancement and 24 (7.3%) students were offered to take some.

Supplements	Lifetime prevalence
Ginko biloba	43 (43.43%)
Memoryn	1 (1.01%)
Acetil karnitin	1 (1.01%)
Zen sen	4 (4.04%)
Omega-3 fish oil	11 (11.11%)
Memoaktiv	15 (15.15%)
Akutil fosfor	2 (2.02%)
Vitamins	65 (65.65%)
Total	99 (30.18%)

*Table 4. Consumption of supplements*

Illicit drug consumption including alcohol was observed in 33 participants (10%). In total 16 males and 17 females reported either or both types of substance use. Based on the pure numbers gender distribution seems to be surprisingly equal, but if we have a look at gender percentiles it is visible that men have consumed illicit drugs in higher ratios (Males 15.8%, Females 7.48%).

Drugs of abuse including alcohol	
Cannabis	18 (41%)
Hashish	4 (11.1%)
Amfetamines	3 (8.3%)
Speed	4 (11.1%)
Ecstasy	2 (7.69%)
LSD	1 (2.77%)
Energy drinks	233 (71.03%)
Alcohol	15 (4.57%)

*Table 4. Consumption of illicit drugs including alcohol and energy drinks*

Drugs of abuse use alone constituted 6.4% of the whole sample by 21 respondents. Alcohol use for cognitive enhancement was mentioned by 4.6% (15) of participants. The most used drug was cannabis by 18 (41%) respondents. Hashish and speed equally presented with 11.1% (4) followed by amphetamines (8.3%). Ecstasy and LSD use was not prevalent. However this report is not too informative since apart from few exceptions illicit drugs were used regardless of the learning needs (80.9%). Most of the students tried the drug for a suggestion of a friend (71.4%). Internet or media was not among the inciting factors. Among non-users 34 students (10.3%) have thought about trying an illicit substance for the purpose of neuroenhancement and 45 students (13.7%) of the students have been offered a drug of abuse in their lifetime.

Data about alcohol consumption for the purpose of neuroenhancement is more informative seeing that 13 people (86%) have claimed to have consumed alcohol in relation with learning needs. Interestingly lifetime prevalence to having had used both illicit drugs *and* alcohol was reported by 15 respondents (48.5%). Energy drink consumption had very significant (71.03%) lifetime prevalence. This maybe is a more expected percentage than the fact that 72 participants, (31%) of the students weren't satisfied with the results and 15 students, 6.4% of consumers has had a "bad" experience with consumption of energy drinks.

	Consumption rate in faculty subsamples
Faculty of Medicine	90% (104)
Faculty of Technical Sciences	84% (36)
Faculty of Philosophy	84% (48)
Faculty of Agriculture	80% (20)
Faculty of Mathematics	78% (36)
Faculty of Law	76%(13)
Faculty of Technology	90%(9)
Faculty of Art	100%(3)
Faculty of Sport	66%(2)
Faculty of Economy	0%

*Table 5. Observed consumption rates of cognitive enhancers across faculties*

When we compared percent values of cognitive enhancer consumption among different faculties we created our measures by taking the sample size of each particular faculty into account. This was needed because of the highly varying sizes of responses in each respective faculty (Art and Sport faculty only had 3 respondents) .We concluded that students of the Faculty of Medicine have presented with the highest prevalence of enhancer use (90%), when not taking into account Faculty of Art with its 3 out of 3 positive report. Faculty of Technical Sciences and Philosophy both had 84% even though the number of responses has differed. They were followed by Faculty of Agriculture (78%), Faculty of Mathematics (76%) and Faculty of Law (76%). We did not receive any positive response from Faculty of Economics. When comparing genders, male students were more likely to present a positive attitude towards the hypothetical use of cognitive enhancers. Whereas junior students showed 83% prevalence of use, senior students reported at a level of 76%.

As a last question we asked students what inspired them to use the particular substances they have checked in the previous questions. The most prevalent reasons proved to be to improve concentration (20%),to clear the mind (9%),to learn faster and more efficiently (9%) [Table 6.]

To improve concentration	126	20%
To clear mind	58	9%
To improve memory	40	6%
To cope with competitive pressure	39	6%
To learn faster and more effectively	54	9%
To reduce my appetite	7	1%
For better motivation	31	5%
To experiment, satisfy curiosity	1	0%
For insomnia	38	6%
To improve sexual life	4	1%
For fun	40	6%
To increase self esteem	7	1%
For relaxing and more qualitative sleep	29	5%
To improve digestive function	6	1%
To reduce anxiety	36	6%
No, I have not checked or listed any substances mentioned in the survey	111	18%

*Table 6. Indications for substance use*

#### **4. Discussion**

The most fundamental aim of this work was to conduct a study about use of PCE agents among young generations in Serbia so that the results later can be drawn into parallel with other international studies, finding out where Serbia stands in the global picture. In order to implement a well-planned, systematically monitored prevention program we need to be aware of the status of the population of interest, specifically with regard to pharmacological ways to improve cognitive function.

Among American medical students a prevalence of 10.1% was found for lifetime non-medical pharmaceutical stimulant use (methyphenidate or amphetamine salts) [18]. Just to mention few examples, in Switzerland prescription drugs was used by 7.6% and drugs of abuse including alcohol were used by 7.8% of the students [3]; in Germany these percentages were 1.55% and 2.6% [7]. When

our results are paralleled with the previously mentioned studies we can conclude that overall lifetime prevalence use of prescription drugs (2.3%) in Serbia is in the lower range compared to other countries but prevalence rate of drugs of abuse including alcohol consumption (10%) is higher in our country.

One key finding in our study involves the attitude towards PCE use. Among those of non-users 38.7% of the respondents have considered trying a prescription drug for the purpose of cognitive enhancement, and 36 respondents, 11% of the students were offered a prescription drug in their life. The level of positive attitude towards drugs of abuse was 10.3 %. Overall 46.9% of students have considered trying either or both ways of stimulation. Similarly to our results Singh *et al.* also observed a significant proportion of students showing interest in PCE. Students who had considered using PCEs consisted 20.4% [3]. Whereas our study due to its limitations could not gain proof why this high rate of student interest does not end in ongoing use of these stimulants, the UK study can reflect on this issue. Based on their observations an obvious answer from that study is lack of availability of PCEs. In Serbia the actual concept of lack of availability might not only include the difficult access or absence of personal relations - as in more developed countries - , but also financial constraint may be an inflicting factor. A further interesting aspect of PCE drug consumption is its correlation with Attention Deficit Hyperactive Disorder, although this question we could not investigate deeply. In Canada 53% of male students and 33% of female students presented a positive attitude towards trying several pharmacological substances in order to improve cognitive function. Our results similarly found that 48.5% of Serbian male students and 38.3% of female students have claimed to have considered trying such a substance to improve academic performance. Regarding the use of supplements, lifetime prevalence of supplement use of our sample was 30.18%, while the Swiss study has found this value was only 18.2% among their respondents. This might be due to the lack of availability of other substances in Serbia and concomitant easier access of particular over the counter herbal products and preparations.

As McCabe *et al.* has proposed, the use of cognitive enhancers in a health care student setting is higher than use among general student populations (6.9%) [1]. Kudlow' *et al.* in their Canadian study put forward the thought that increased use of cognitive enhancers in this population may be fueled by increased levels of knowledge around the availability and utility of these substances [2]. This proposition is contradicted by the largest UK study published last year by Singh *et al.* saying that awareness of PCE use in the peer group strongly predicted personal use in a negative manner. Although they also stated that resilience noted in the their study cannot be fully attributed to a lack of interest in

cognitive enhancement, but low lifetime prevalence of PCE and very low levels of consistent use of PCEs was observed in a setting in which there is awareness and interest in PCEs [3]. This remark should be further investigated in later studies. In the Medical faculty of Novi Sad overall substance use was 90%, but prescription and illicit drug use was 50% of the small sample including all faculty users. This correlates with the above mentioned examples.

Our study has several limitations. The first one being the small sample size, which does not give us enough info to permit subgroup analysis of individual faculties or in general makes comparison with other studies less representative. Furthermore our study was carried out in a single institution. Regarding the methods of the study, this work cannot provide information on response rate. The voluntary-participation method by which the survey was conducted may lead us to positive bias, also self-selection means that the study is not based on a random sample. During the response process 33 participants has left the survey. We are not aware of the cause but this high non-response rate may have introduced potential bias to the study. The designers of the study also had to be reliant on honest reporting of the respondents. Furthermore, data on peer-use consumption habits can be concluded only indirectly, through students' responses whether they have been offered a substance of interest. We would like to point out that in our research no objective academic performance measure is provided to the observer. In other studies average grade point or USMLE score had to be indicated [1, 4] which possibly could lead to showing correlation between use of PCEs and their good efficacy resulting in higher academic performance. In some previous studies lower grade points were positively linked to PCEs consumption [1], but the case of identical prevalence among population with high or low as test scores stood as well [19].

Subsequent research in Serbia should be carried out seeing that many respects of this topic have remained unfolded, let them be prevalence of use in general population, their side effects and efficacy or other coping mechanisms of students to avoid consuming such stimulating substances. One of such mechanisms could be physical activity. Analyzing data about physical activity and its correlation to use of PCEs has resulted in discrepant results in previous studies. In Germany sports students presented with higher prevalence of PCE use compared with other study majors [6, 20]. Meanwhile, Swiss sports students' use of prescription drugs or drugs of abuse was the lowest among all majors (7%) (overall average 14.08%). Other studies also mention the need of continuing investigation regarding this topic. In a study conducted in Serbia in 2014 showed that those medical students who carried out less than 1 hour of physical activity per week presented with 1.4 times increased frequency of self-medication than

their fellow students [21]. Based on fundamental physiological principles physical activity aids stress release and eases accompanying strained situations, which situations later indirectly might result in decrease of concentration and studying abilities. If extensive research would show negative correlation of PCE consumption in physically active population it could contribute to support of regular physical exercise programs among all faculties.

Despite the limitations of our study resulting from its size and relative lack of diversity among faculties, we managed to initiate the investigation of neuroenhancer consumption habits in Serbia. Based on our results current PCE consumption habits cannot be said to put an immediate threat to Serbian college population, still the measures are statistically significant and further elaboration on the topic should be conducted. Education and monitoring of such practices seem to be fundamental in order to establish an efficient prevention program in Serbia, also bearing in mind proper international collaboration is just as significant. In order to have a well-functioning international co-operation among countries, a systematic, consistent method of PCE use-assessment should be set up with clear terminology to reduce potential biases and increase value of comparability.

## **5. Conclusion**

Our study, which investigated three areas of interest: prevalence, practices and motivations, proved that the prevalence of cognitive enhancer agent, illicit drug and alcohol consumption among university students are higher than the low expected results. Of the population involved in our study 79.87 % of the students have used some kind of cognitive neuroenhancer at least once in their lifetime. Prescription drugs were used by 2.13% of students, 30.18% consumed supplements, 6.4% of participants indicated use of drugs of abuse, 4.6% used alcohol and 71.03% consumed energy drink at least once in their lifetime for the purpose of cognitive enhancement. Modafinil as a prescription drug was mentioned by 2 students. As motivations improvement concentration (20%), to clear the mind (9%) and to learn faster and more efficiently (9%) were listed most commonly. The outcome of our study points to the importance of raising awareness to the ethics and risks of pharmacological ways of cognitive enhancement.



## 6. References

1. McCabe SE, Knight JR, Teter CJ, Wechsler H. Non-medical use of prescription stimulants among US college students: prevalence and correlates from a national survey. *Addiction*, 2005 99, 96–106
2. Kudlow PA, Treurnicht Naylor K, Xie B, McIntyre R S. Cognitive Enhancement in Canadian Medical Students. *Journal of Psychoactive Drugs*. 2013.09-10 45(4): 360-5.
3. Singh I, Bard I, Jackson J. Robust Resilience and Substantial Interest: A Survey of Pharmacological Cognitive Enhancement among University Students in the UK and Ireland. *PloS One*. 2014.10 9(10): e105969
4. Maier LJ, Liechti ME, Herzig F, Schaub MP. To Dope or Not to Dope: Neuroenhancement with Prescription Drugs and Drugs of Abuse among Swiss University Students. *PloS One*. 2013.11;8(11): e77967
5. Micoulaud-Franchi JA, Macgregor A, Fond G. A preliminary study on cognitive enhancer consumption behaviors and motives of French Medicine and Pharmacology students. *Eur Rev Med PharmacolSci* 2014; 18(13):1875-8.
6. Dipl.-Sportwiss PD, Striegel H, Franke AG, Lieb K, Simon P, Ulrich R. Randomized Response Estimates for the 12-Month Prevalence of Cognitive-Enhancing Drug Use in University Students. *Pharmacotherapy* 2013; 33(1):44-50.
7. Franke AG, Bonertz C, Christmann M, Huss M, Fellgiebel A, et al. Non-medical use of prescription stimulants and illicit use of stimulants for cognitive enhancement in pupils and students in Germany. *Pharmacopsychiatry* 2011; 44(2):60–6.
8. Eckenhorst P, Vitzthum K, Klapp BF, Groneberg D, Mache S. Neuroenhancement among German university students: Motives, expectations, and relationship with psychoactive lifestyle drugs. *Journal of Psychoactive Drugs*. 2012; 44(5): 418–27.
9. Castaldi S, Gelatti U, Orizio G, Hartung U, Moreno-Londono AM, et al. Use of cognitive enhancement medication among northern Italian university students. *Journal of Addiction Medicine* 2012; 6(2): 112–7.
10. Humle T, Friislund M. 'Study drugs' vinder frem på universiteter. 2010. Information. <http://www.information.dk/236139>. Accessed 2014 February 23.
11. Holloway K, Bennett T. Prescription drug misuse among university staff and students: A survey of motives, nature and extent. *Drugs: education, prevention and policy*. 2012; 19(2): 137–44.
12. Ott R, Biller-Andorno N. Neuroenhancement among Swiss students – A comparison of users and

non-users. *Pharmacopsychiatry* 2014; 47(1): 22–8.

**13.** Hildt E . Cognitive enhancement - A critical look at the current debate. In E Hildt, AG Franke, eds. *Cognitive enhancement: An interdisciplinary perspective*. London: Springer 2013 1–14.

**14.** AAP Stress of study leads some to try 'academic doping', *The Australian*, 2013.20 August. <http://www.theaustralian.com.au/higher-education/stress-of-study-leads-some-to-try-academic-doping/story-e6frgcjx-1226699737256>. Accessed 23 February 2014.

**15.** Maher B. Poll results: Look who's doping. *Nature* 2008; 452 (7188): 674–5.

**16.** Partridge B. A bubble of enthusiasm: How prevalent is the use of prescription stimulants for cognitive enhancement? In Hildt E, Frank AG (eds) *Cognitive enhancement: An interdisciplinary perspective*. 2013. Springer Netherlands: 39–47.

**17.** Reips UD. Standards for Internet-based experimenting. *Experimental Psychology* 2002; 49 (4): 243–56.

**18.** Tuttle JP, Scheurich NE, Ranseen J, Prevalence of ADHD diagnosis and nonmedical prescription stimulant use in medical students. *Academic Psychiatry* 2010; 34 (3): 220–3

**19.** Webb JR, Valasek MA, North CS. Prevalence of stimulant use in a sample of US medical students. *Annals of Clinical Psychiatry*. 2013; 25(1):27-32.

**20.** Middendorff E, Poskowsky J, Isserstedt W. *Formen der Stresskompensation und Leistungssteigerung bei Studierenden*. 2012. Hannover: HIS.

**21.** Adzic Lukovic J, Miletic V, Pekmezovic T, Trajkovic G, Ratkovic N, Aleksic D, Grgurevic A. Self-Medication Practices and Risk Factors for Self-Medication among Medical Students in Belgrade, Serbia. *PloS ONE*. 2014.; 9(12): e114644. doi:10.1371/ journal.pone.0114644

## 7. Annex

### The questionnaire – English version

The questionnaire you can read below is printed version of an online form, which can be accessed on the following link:

<https://docs.google.com/forms/d/1j9tNWrpKIDgTiG26mczmINWWVgqhaVHtaAUka89wTuM/viewform>

Dear participant,

Thank you for being part of this study. The aim of this research is to assess consumption of substances used to improve cognitive function ( e.g working memory, motivation, and attention) among students of University of Novi Sad. The survey will take 3-8 minutes and it is entirely anonymous. Your answers are confidential and the results will only be used for the purpose of this research work. We appreciate your contribution to the study.

Vanja Dudas and Emoke Csernus

When you fill out the page , press Continue .

#### **1. Do you agree to participate in the study?\***

- Yes /Skip to question 2. /
- No /Skip to " Thank You for completing the survey...." /

#### **Page break**

**Thank you for taking your valuable time to fill out the questionnaire.**

#### **2. Year of birth: \***

- 1980
- 1981
- 1982
- 1983
- 1984
- 1985

- 1986
- 1987
- 1988
- 1989
- 1990
- 1991
- 1992
- 1993
- 1994
- 1995

**3. Gender: \***

- Male
- Female

**4. Faculty \***

- Faculty of Arts
- Faculty of Sport and Physical Education
- Faculty of Technical Sciences
- Faculty of Philosophy
- Faculty of Economics
- Faculty of Medicine
- Faculty of Law
- Faculty of Science
- Faculty of Technology
- Faculty of Engineering management

**5. Year of study : \***

- Bachelor studies
- Master studies
- Integrated academic studies
- PhD studies

Other:

**6. Status: \***

- Regular studies
- Exchange studies
- Other:

**7. Current semester: \***

- |                           |                            |                           |
|---------------------------|----------------------------|---------------------------|
| <input type="radio"/> I   | <input type="radio"/> V    | <input type="radio"/> IX  |
| <input type="radio"/> II  | <input type="radio"/> VI   | <input type="radio"/> X   |
| <input type="radio"/> III | <input type="radio"/> VII  | <input type="radio"/> XI  |
| <input type="radio"/> IV  | <input type="radio"/> VIII | <input type="radio"/> XII |

**8. Are you employed beside school?\***

- Employed / Full-time
- Employed / Part-time
- Unemployed / Only student
- Other:

**9. Are you medically diagnosed with any condition involving the nervous system? \***

e.g Attention Deficit/Hyperactive Disorder, Depression, Sleeping disorders, Bulimia

- Yes
- No

**10. Are you medically diagnosed with any condition involving the cardiovascular system? \***

\*

e.g. Hypertension, Congenital anomalies, Cardiomyopathies, Dysrhythmias

- Yes

- No

**11. Do you have any problems with concentration and learning? \***

- No, never
- Rarely
- Sometimes
- Frequently
- Yes, constantly

**Page break**

**12. Have you ever tried a stimulating substance to improve your studying capacity?\***

(e.g. medications, supplements such as vitamins, illicit drugs, energy drinks, alcohol)

- Yes /Skip to question 13. /
- No /Skip to "" Thank You for completing the survey.." /

**Page break**

**13. Have you ever tried a medication for the purpose of faster learning and better concentration?\***

- Yes /Skip to question 16. /
- No /Skip to question 14. /

**Page break**

**14. Have you ever given a thought to try a medication (over the counter/ prescription/ online bought)for the purpose of faster learning and better concentration ?\***

- Yes
- No

**15. Have you ever been offered a medication (over the counter/ prescription/ online bought) to try for the purpose of faster learning and better concentration?\***

Yes /Skip to question 21. /

No /Skip to question 21. /

**Page break**

**16. Which of following substance(s) do you use (or you have tried ) for the purpose of faster learning and better concentration?\***

Multiple boxes may be checked.

Concerta – Methylphenidate

Oikamid – Piracetam

Cavinton forte, Cavinton – Vinpocetin

Landex, Tregona, Palidix, Yasnal , Donecept , Aricept - Donepezil

Exelon – Rivastigmin

Reminyl - Galantamin

Modavigil , Modaler , Provigril – Modafinil

Other:

**17. How many times have you used the checked substances so far (up to now)?\***

Multiple boxes may be checked.

Once

1 - 5 times

More than 5 times

**18. When do you most often use(d) the checked the substance(s)?\***

Multiple boxes may be checked.

- Throughout the year - regardless of learning needs
- Throughout the year - in relation with learning needs
- In exam period
- On the day of exam(s)
- Other:

**19 At whose proposal have you decided to try the checked substance(s)? \***

Multiple boxes may be checked.

- Health professionals (doctor, nurse, pharmacist ..)
- Friend – colleague
- Friend - not colleague
- Internet and media
- Own initiative
- Other:

**20. Impression on the effects of the substance(s) used: \***

Multiple boxes may be checked.

- It worked better than expected
- It worked as expected
- I don't know
- It didn't work as expected
- It had an unpleasant effect on me
- Other:



**Page break.**

**21. Have you ever tried / Do you use any supplements to improve your studying capacity?**

\*

Below you can find some examples of supplements

(not complete list)

Yes /Skip to question 22. /

No / Skip to question 27. /

**Page break.**

**22. Please specify which of the following supplements do you use (or you have tried) for faster learning and better concentration:\***

Multiple boxes may be checked.

Ginkbilobil

Ginko sandoz

Memoryn

AcetilLkarnitin

Ginko max + lecitin

Ginko forte

Žen šen

Omega 3 fish oil

Bilobil intense

Memoaktiv

<b>Ginkbilobil</b>
<b>Ginko max + lecitin</b>
<b>Bilobil intense</b>
<b>Ginko sandoz</b>
<b>Ginko forte</b>
<b>Memoaktiv</b>
<b>Memoryn</b>
<b>Žen šen</b>
<b>Akutil fosfor</b>
<b>Acetil-L-karnitin</b>
<b>Omega 3 kiseline</b>
<b>Vitamini</b>

Akutil fosfor

Vitamins

Other:

**23. For how long have you used the checked supplement(s) so far (up to now) for study purposes?\***

Multiple boxes may be checked.

Less than 6 months

6 months to 1 year

More than 1 year

Once

Other:

**24. When do you most often use(d) the checked the supplement(s)?**

Multiple boxes may be checked.

Throughout the year - regardless of learning needs

Throughout the year - in relation with learning needs

In exam period

On the day of exam(s)

Other:

**25. At whose proposal have you decided to try the checked supplement(s)?\***

Multiple boxes may be checked.

Health professionals (doctor, nurse, pharmacist ..)

Friend – colleague

- Friend - not colleague
- Internet and media
- Own initiative
- Other:

**26. Impression on the effects of the substance(s) used:\***

Multiple boxes may be checked.

- It worked better than expected
- It worked as expected
- I don't know
- It didn't work as expected
- It had an unpleasant effect on me
- Other:

**Page break.**

**27. Have you ever given a thought to try a supplement for the purpose of faster learning and better concentration ?\***

- Yes
- No

**28. Have you ever been offered a supplement to try for the purpose of faster learning and better concentration?\***

- Yes / Skip to question 29. /
- No / Skip to question 29. /

<b>Amfetamini</b>
<b>Ekstazi</b>
<b>Kokain</b>
<b>Metadon</b>
<b>Heroin</b>
<b>LSD</b>
<b>Spid</b>
<b>Kanabis</b>
<b>Hašiš</b>

**29. Have you ever consumed illicit substances ('drugs') including marijuana, for the purpose of faster learning and better concentration? \***

Below you can find some examples of illicit substances (not complete list)

- Yes /Skip to question 30. /
- No /Skip to question 35. /

**Page break.**

**30. Which of following illicit substances have you tried for the purpose of faster learning and better concentration?\***

Multiple boxes may be checked.

- Amphetamines
- Ecstasy
- Cocaine
- LSD
- Speed
- Cannabis, Marihuanna
- Heroine
- Methadone
- Hasish
- Other:

**31. How many times have you used the checked substance(s) so far (up to now) for study purposes?\***

Multiple boxes may be checked.

- Once
- 1 to 5 times
- More than 5 times

**32. When do you most often use(d) the checked the substance(s)?**

Multiple boxes may be checked.

- Throughout the year - regardless of learning needs
- Throughout the year - in relation with learning needs
- In exam period
- On the day of exam(s)
- Other:

**33. At whose proposal have you decided to try the checked substances?\***

Multiple boxes may be checked.

- Health professionals (doctor, nurse, pharmacist ..)
- Friend – colleague
- Friend - not colleague
- Internet and media
- Own initiative
- Other:

**34. Impression on the effects of the substance(s) used: \***

Multiple boxes may be checked.

- It worked better than expected

- It worked as expected
- I don't know
- It didn't work as expected
- It had an unpleasant effect on me
- Other:

**Page break.**

**35. Have you ever given a thought to try an illicit drug for the purpose of faster learning and better concentration?\***

- Yes
- No

**36. Have you ever been offered an illicit drug to try for the purpose of faster learning and better concentration?\***

- Yes /Skip to question 37. /
- No /Skip to question 37. /

**Page break.**

**37. Have you ever consumed energy drinks for faster learning and to increase studying capacity?\***

- Yes /Skip to question 38. /
- No /Skip to question 40. /

**Page break.**

**38. When did you most frequently consume energy drinks? \***

Multiple boxes may be checked.

- Throughout the year - regardless of learning needs
- Throughout the year - in relation with learning needs
- In exam period
- On the day of exam(s)
- Other:

**39. Impression on the effects of the energy drinks that you used: \***

Multiple boxes may be checked.

- It worked better than expected
- It worked as expected
- I don't know
- It didn't work as expected
- It had an unpleasant effect on me
- Other:

**Page break.**

**40. Have you ever used alcohol for faster learning and to increase studying capacity? \***

- Yes /Skip to question 41. /
- No /Skip to question 43. /

**Page break.**

**41. Most frequently you consumed alcohol: \***

Multiple boxes may be checked.

- Throughout the year - regardless of learning needs
- Throughout the year - in relation with learning needs
- In exam period
- On the day of exam(s)
- Other:

**42. Impression on the effects of the alcohol that you consumed:\***

Multiple boxes may be checked.

- It worked better than expected
- It worked as expected
- I don't know
- It didn't work as expected
- It had an unpleasant effect on me
- Other:

**Page break**

**43. Please label below WHY you use/have tried the substances (including the category of energy drinks and alcohol) previously checked: \***

Below you can find some summary of the previously listed substances. Multiple boxes may be checked.

- To improve concentration
- To clear mind
- To improve memory



- To cope with competitive pressure
- To learn faster and more effectively
- To reduce my appetite
- For better motivation
- To experiment, satisfy curiosity
- For better sleep
- To improve sexual life
- For fun
- To increase self esteem
- To reduce palpitation
- I have not checked any substances mentioned in the survey

<b>Concerta (Metilfenidat)</b>	<b>Ginkbilobil</b>	<b>Amfetamini</b>
<b>Oikamid (Piracetam)</b>	<b>Ginko max + lecitin</b>	<b>Ekstazi</b>
<b>Cavinton forte, Cavinton (Vinpocetin)</b>	<b>Bilobil intense</b>	<b>Kokain</b>
<b>Landex, Tregona, Palidix, Yasnal, Donecept , Aricept (Donepezil)</b>	<b>Ginko sandoz</b>	<b>Metadon</b>
<b>Exelon (Rivastigmin)</b>	<b>Ginko forte</b>	<b>Heroin</b>
<b>Reminyl (Galantamin)</b>	<b>Memoaktiv</b>	<b>LSD</b>
<b>Modavigil ,Modaler ,Provigril (Modafinil)</b>	<b>Memoryn</b>	<b>Spid</b>
	<b>Žen šen</b>	<b>Kanabis</b>
	<b>Akutil fosfor</b>	<b>Hašiš</b>
	<b>Acetil-L-karnitin</b>	
	<b>Omega 3 kiseline</b>	
	<b>Vitamini</b>	

**Thank You for completing the survey, your response has been recorded.  
We appreciate your contribution a lot!**

Sincerely, Vanja Dudas and Emoke Csernus

**'Submit'**