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Cognitive repercussions of alcohol consumption on academic performance at university: a preliminary study

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Abstract

Introduction. Excessive alcohol consumption is the most widespread toxic habit in the world, and a particular problem among young people for whom alcohol is part of their recreational habits. The start of university studies coincides with adulthood when alcohol becomes easily available and used as a tool to deal with new stressors. It has been found that alcohol can alter the neuronal structure and physiology of the brain, affecting the prefrontal cortex and other areas associated with cognitive impairment, specifically of executive functions. The aim of this study is to examine the prevalence of excessive alcohol consumption among 100 first-year university students and to explore the relationship between academic performance and profiles of alcohol consumption ("risk free", "at risk consumption", "probable alcohol dependence syndrome or ADS").

Method. The sample consisted of 100 students (24% men and 76% women) between the ages of 17 and 25. All were first-year undergraduates studying a Degree in Psychology at the Francisco de Vitoria University (UFV), Spain. All participants were administered the AUDIT, a test used to assess alcohol consumption, four tests to assess executive functions. The average marks from the first semester of the first year of the Psychology degree was used as a measure of academic performance. Descriptive statistics and inferential analysis were used.

Results. The results show that more than half of the students have consumption habits that can be categorised as "at risk" or "probable alcohol dependency syndrome". The Kruskal-Wallis test suggests that there is a direct link between the consumption profile ("risk free", "at risk consumption", "probable alcohol dependency syndrome"), and academic performance (p=.011) and between the consumption profile and executive functions, specifically cognitive flexibility (p=.005), phonological verbal fluency (p=.001), working memory (p=.017) and processing speed (p=.001). No differences were detected for inhibitory control.

Discussion and Conclusion. These findings confirmed the negative cognitive impact of alcohol abuse during this period and the need for prevention campaigns in the university environment.

Keywords: alcohol consumption, executive functions, academic achievement, higher education

Resumen

Introducción. El consumo elevado de alcohol constituye el hábito tóxico más extendido en el mundo, y es un problema especialmente entre los jóvenes, ya que forma parte de su cultura de ocio. El inicio de la etapa universitaria coincide con la mayoría de edad, que da acceso libre a esta sustancia, utilizada además como herramienta para hacer frente a los nuevos estresores. Se ha comprobado que la ingesta de alcohol puede alterar la estructura y fisiología neuronal, afectando entre otras regiones a la corteza prefrontal, con el consiguiente deterioro cognitivo, concretamente de las funciones ejecutivas. Este estudio tiene como objetivo estudiar la prevalencia del consumo de alcohol en una muestra de 100 estudiantes universitarios, y comprobar la existencia de diferencias en su rendimiento académico y funciones ejecutivas en relación con el perfil de consumo ("sin riesgo", "de riesgo", "probable síndrome de dependencia alcohólica o SDA").

Método. La muestra estuvo conformada por 100 estudiantes universitarios del Grado en Psicología de la Universidad Francisco de Vitoria (UFV) (24% chicos y 76% chicas) con edades comprendidas entre 17 y 25 años. A todos los participantes se les administró el test AUDIT para evaluar el consumo de alcohol y cuatro pruebas (Stroop, Cambios, Fluidez verbal y Letras y Números) para valorar funciones ejecutivas, y se registró su nota media del primer cuatrimestre del primer curso del grado de Psicología como medida del rendimiento académico. Se emplearon estadísticos descriptivos y análisis inferencial.

Resultados. Los resultados obtenidos evidencian que más de la mitad de los participantes describe un consumo de riesgo o un consumo que indica probable SDA. La prueba de Kruskal Wallis sugiere una relación directa entre el perfil de consumo ("con riesgo", "sin riesgo" y "probable SDA", y las calificaciones obtenidas (p=.011), y entre el consumo de alcohol y las funciones ejecutivas, en particular la flexibilidad cognitiva (p=.005), la fluidez verbal fonológica (p=.001), la memoria de trabajo (p=.017) y la velocidad de procesamiento (p=.001). No se encontraron diferencias en el control inhibitorio relación al perfil de consumo.

Discusión y conclusiones. Estos hallazgos confirman las repercusiones a nivel cognitivo asociadas al consumo de alcohol en esta etapa y la necesidad de poner en marcha campañas de prevención en el entorno universitario.

Palabras Clave: consumo de alcohol, funciones ejecutivas, rendimiento académico, educación universitaria.

Introduction

Excessive alcohol consumption has been recognised as a social problem and is regarded as the most widespread toxic habit across the globe (Bolet & Socarrás, 2003) causing, according to the World Health Organisation (WHO), 5.9% of all deaths worldwide (3.3 million deaths annually). Among younger people (20 to 39 years of age), this percentage increases: the harmful intake of alcohol is involved in 25% of all deaths in this age range (WHO 2018) in addition to the public health impact this implies (Carvajal & Lerma-Cabrera, 2015). The 5th edition of the Diagnostic and Statistical Manual of Mental Illness (DSM-5), establishes the diagnosis for alcohol dependency syndrome, characterised by the intake of alcohol in large amounts or the persistent desire to do so (Diagnostic and Statistical Manual of Mental Illness [DSM-5], 2014). Alcohol consumption has traditionally been higher among men (Greenbaum, Del Boca, Wang & Goldman, 2005; Hartzler & Fromme, 2003), but this appears to be changing. Some countries are seeing an increasing propension among women to consume alcohol. Available studies appear to show that although women begin to consume alcohol at a later age than men their progression is faster from the onset of drinking to problematic use. This phenomenon demonstrates the greater vulnerability of women to the effects of alcohol (Míguez & Permuy, 2017).

In Spain, alcohol consumption among young people is alarming: the average age at drinking onset is 16; almost 80% of young people claim to have consumed alcohol in the last 12 months and approximately 60% during the last 30 days. According to the Spanish Household Survey on Alcohol and Drugs (EDADES, 2015-2016) of the European Monitoring Centre for Drugs and Addiction (EMCDDA, 2017), 35% of young people between the ages of 15 and 24 report having been intoxicated (drunk) in the last month, with the onset of alcohol consumption occurring earlier in women than in men. Various factors such as recreational or social use, ease of access, social changes or family circumstances may all be contributing factors in this high level of alcohol consumption.

The first year of university is a transition period in which the student establishes the foundation of their identity as an adult and in which they construct a new social network (Scheier & Botvin, 1997). Alcohol consumption is very common in this stage (Johnston, O'Malley & Bachman, 2003), since alcohol forms a part of the recreational culture of the great majority of young people. The start of university study also coincides with the age of majority,

meaning the free access and facility in acquiring alcohol. Furthermore, in the use of alcohol there are worrying episodes of intensive and compulsive drinking during a short period of time, known as *binge drinking* (National Institute on Alcohol Abuse and Alcoholism, 2004; Borsari, Murphy & Barnett, 2007; Parada el al., 2011), associated with high risk behaviour (Miller et al., 2007) such as aggression, reckless driving or unprotected sex (Castaño-Perez & Calderon-Vallejo, 2014). *Binge-drinking* (BD*),* defined by the World Health Organisation as heavy episodic drinking, is prevalent among adolescents and university students (World Health Organisation, 2014). This type of consumption has many short- and long-term effects on the individual, including physical and mental health problems, violent behaviour or difficulty adapting to school or family life (Carvajal & Lerma-Cabrera, 2015; Pascual, Pla, Miñarro, & Guerri, 2013). Although there is some dispute about the precise definition of binge drinking, it is generally considered that the consumption of 5 or more Standard Drinks (SD) in men and 4 SDs in women in a single drinking session (Wechsler et al., 1994). The Spanish Ministry of Health (2008) defines binge drinking as the intake of 6 or more alcoholic drinks (60g), 4 or more for women (40g) within a period of two hours.

Alcohol is also frequently used by young people in dealing with the stressors or negative emotions they may face during the first year of university (due to the perception of responsibility, greater freedom, study, work or the creation of new social networks) (Calvete & Estévez, 2009). But alcohol consumption is also driven by the search for new experiences and sensations, which tends to lead to *binge drinking* and the consumption of various psychotropic substances in addition to alcohol (Del Boca et al., 2004; White et al., 2006). University students can therefore be generally considered as a population at risk of problematic alcohol use.

Alcohol consumption can have a significant impact on general health, as it is associated with both physical medical problems and psychiatric disorders (Molina & Nelson, 2018). Poor academic performance of university students has been associated with excessive alcohol consumption (Davis et al., 2018), with some authors pointing more specifically pointing to compulsive or binge drinking (BD) (Patte, Quian & Leatherdale, 2017). Additionally, the continued use of alcohol among young university students is directly related to absenteeism and criminal behaviour (Flaherty, Sutphen & Ely, 2012). These effects will have an impact not only on students' learning and education but will also have consequences in later life in the form of lost opportunities and reduced employability, thus resulting in a greater social and economic burden.

To all of these factors must be added the cerebral and neuropsychological repercussions associated with high alcohol consumption. Alcohol can significantly alter both the structure and the neuronal physiology of the brain with severe neuropsychological effects (Jones, Lueras & Nagel, 2018; Squeglia et al., 2014). Neuroimaging studies in adolescents and young adults who consume alcohol show considerable cognitive deterioration and brain damage affecting the prefrontal cortex and other areas. Consequently, it has been shown that excessive alcohol consumption leads to deficits in the executive functions of the brain (Banich, 2009; Fjell et al., 2012; López-Caneda et al., 2014; Martínez & Manoiloff, 2010; Miyake & Friedman, 2012; Sanhueza, García-Moreno & Expósito, 2011), including skills related to planning, initiating and regulating behaviour, achieving goals, working memory, flexibility and problem solving. In addition to these cognitive deficits, the alcohol consumption is also related to problems maintaining interpersonal relationships (Maurage et al., 2016), the lack of emotional regulation (D'Hondt, Lepore & Maurage, 2014; Ram, George & Gowdappa, 2018), and very closely related to deficits in executive functions (Joormann & Siemer, 2011).

The impact of alcohol consumption on the brain can be particularly significant if consumption takes place during critical period of brain development (García-Moreno, Expósito, Sanhueza & Angulo, 2008), such as the final stages of neuromaturation when the brain is most vulnerable to external influences (Crews, He & Hodge, 2007). Between the ages of 18 and 22, precisely the age corresponding to the first years of university, there is a significant increase in white matter in associative areas, particularly in the prefrontal cortex (Gogtay et al., 2004). Changes have also been detected in the volume of grey matter in the first six months of the first year of university (Bennett & Baird, 2006). These modifications have been related to the end of maturation of the executive functions, taking place between the end of adolescence and early adulthood (Blakemore & Choudhury, 2006; Casey, Giedd & Thomas, 2000). This prolonged development stage explains the particular vulnerability of executive functions compared to other cognitive processes impacted by alcohol consumption.

There has been a great deal of research into the neurotoxic effects of alcohol on the neuro-physical level. Studies using animal models have found an alteration in the cortical thickness in frontal regions (midline cingulate and insular cortex) (Vetreno et al., 2016). Vetreno & Crews (2012), in their study of the impact of alcohol on adolescent rats, found that these effects (alteration in the prefrontal region medial & orbitofrontal) persist into adulthood.

In human adolescents it has been observed that the excessive alcohol consumption causes an alteration in the frontal pathways (fronto-limbic) of white matter (Bava et al., 2013; Jacobus et al., 2013). This decreased fronto-limbic connectivity appears to be manifested in fronto-striatal connectivity and in the connections between the prelimbic and infralimbic regions and between the infralimbic region and the orbitofrontal cortex (Broadwate et al., 2017). The deterioration of fronto-striatal connectivity appears to be related to reduced or impaired inhibitory control (Spear & Swartzwelder, 2014). A reduction in grey matter in the prefrontal regions has also been associated with high alcohol intake in university students (Meda et al., 2017). The loss of cholinergic and serotonergic neurons is associated with the intake of alcohol during adolescence persists into adulthood (Crews et al., 2016).

At a neuropsychological level, studies of adolescents and young people describe various alterations of executive functions. Tests on university students showed lower scores in inhibition, attention control, planning, sequencing, cognitive flexibility and self-monitoring (Salcedo, Ramírez & Acosta, 2015). Martínez-Mendoza (2018) suggests that university students who consume alcohol (both intensively and moderately) show a reduced capacity for emotion self-regulation in social situations and lowered inhibitory control. This diminished inhibitory control appears to affect the ability to cancel an ongoing response more than distraction inhibition (Paz, Rosselli & Conniff, 2018). Other work with adolescents and young people who frequently consume alcohol indicate the existence of deficits in the executive function (specifically in inhibitory control) and verbal memory. Contrarily, these studies found no effect on attention, processing speed, short term memory, planning and visuospatial construction (Carbia, López-Caneda, Corral & Cadaveira, 2018).

The aim of this study, further described below, is to provide empirical clarification of the relation between alcohol consumption and executive capacity (specifically cognitive flexibility, inhibitory control, verbal fluency and working memory) and academic performance of university students in Psychology.

The objectives are:

1) To study the prevalence of excessive alcohol consumption among a sample of 100 first year university students and differences in terms of gender.

2) To verify the existence of differences in academic performance in relation to the alcohol consumption.

3) To verify the existence of differences in certain executive functions (working memory, cognitive flexibility, verbal fluency and inhibitory control) in relation to the alcohol consumption.

For objectives 2) and 3) the following hypotheses are proposed:

H_1: academic performance is worse among university students with higher alcohol consumption.

H_2: higher alcohol consumption is related to the impairment of executive functions.

Method

Participants

The participants in this study were 100 students, 24% men and 76% women, between the ages of 17 and 25 (*M*=19.3; *DE*=1.84). All were first year undergraduates studying a Degree in Psychology at the Francisco de Vitoria University (UFV), Spain. Underage students were provided with an informed consent form to be completed and signed by the parents.

Participants were selected intentionally through using a non-probability sampling by accessibility. The criteria for inclusion were as follows: to be a first-year student in Psychology at the university, to provide informed consent in writing and have no history of neurological disorders, cerebral trauma or consumption of psychoactive drugs. Students participated voluntarily and were free to abandon the study at any time.

Instruments

The following evaluation instruments were used to collect information:

The *Alcohol Use Disorders Identification Test (AUDIT),* a standard questionnaire developed by the World Health Organisation (WHO 1992) used around the world and coherent with the definitions of the ICD-10 on alcohol dependence. The specific version of the test was

that validated for the Spanish population by Rubio, Bermejo, Caballero & Santo Domingo (1998). The test consists of 10 questions, the first three identify the risk consumption, the next three evaluate possible symptoms of dependence and the final four questions evaluate harmful consumption. The final result permits, depending on the cut-off score, the identification of at-risk consumption and possible alcohol dependency. The AUDIT is designed to identify persons with harmful or at-risk consumption by asking the participant about their consumption habits in different situations, recording the response on a scale of 0 to 4. The test for Spanish university students, recently validated by García Carretero, Novalbos Ruiz, Martínez Delgado & O'Ferrall González (2016), proposes the following optimum cut-offs to identify at risk consumption in men and women: 8 for men and 6 for women and a score of 13 for both men and women in order to identify probable ADS. The internal consistency (Cronbach Alpha) of the AUDIT for this study was .75, obtaining a value of .83 in the subscale for at risk consumption and .79 in the subscale for dependence.

The AUDIT was also used as a screening instrument to identify *Binge Drinking* (BD), or Episode of Intensive Alcohol Consumption, in university students (Hagman, 2016; Seguel, Santander & Alexandre, 2013). Specifically, question 2 (*How many drinks containing alcoholic do you have on a typical day when you are drinking?)* p provides information on the frequency of these episodes.

Test of cognitive flexibility (Seisdedos, 2004). This test evaluates cognitive flexibility using 27 items which the subject must determine if a sequence of geometric figures is correct according to certain parameters (size of the figure, number of sides of the polygon, intensity of the figure) in each element. Each correct answer scores a point and the total score is the final mark on the test. The reliability (Cronbach Alpha) of the test is .87.

Stroop Test (Golden, 1994). This test evaluates the inhibitory control consisting of three conditions: condition one, the person must read a series of words (three colours red, blue and green all written in black) in 45 seconds, registering the number of words read. Thus, it is a test of reading speed. Condition two, the person must name the colour of series of five X's (XXXXX) during the same time. This is a test of speed in identifying colour. Finally, in condition three, the interference, the person has to name the colour of the ink of the words from the first part also in 45 seconds. The word never corresponds to the colour of ink. The test requires the person to control the strong tendency to answer automatically. The so-called

interference index is calculated using the formula: PC – [(PxC)/ (P+C)], representing the difference between real and expected performance in condition 3 based on the results of conditions 1 and 2. The higher the score, the greater the interference control. The test re-test reliability is for P .89, for C .84 and for PC .73.

Letters and Numbers, a sub-test of the Wechsler Adult Intelligence Scale (WAIS IV; Wechsler, 2012) that evaluates working verbal memory. In this test the examiner reads out a series of numbers and letters to each participant who must repeat them in a specific sequence: first, the letters in alphabetical order and then the numbers from low to high (or vice versa). Each correct answer scores a point and the total score is the final mark on the test. The test is interrupted when a person makes three consecutive mistakes. The test has a reliability of .88 for this age group in a recently standardised WAIS scale for Spanish speakers (Rosas et al., 2014).

Verbal fluency test (Lezak, Howieson & Loring, 2004). In this test the person must produce the maximum number of words in specific phonological (starting with three letters: F, A, S) and semantic (animals, fruit, proper nouns) categories. Separate scores are kept for the phonological and semantic categories. Each correct word scores a point and the total score is the final mark on the test. The Cronbach Alpha for this test is .843 (Marino & Díaz-Fajreldines, 2011).

Academic performance: this is evaluated through the average mark obtained during the first semester of the first year of the Degree in Psychology. During the semester students take five courses, each with a final mark. The marking scale is the same for all subjects ranging from 0 to 10 with results under 5 considered as a failure, 5-6 satisfactory, 6-7 good, 7-8 very good, 9-10 excellent. For this study, marks are taken in a range from 0 to 100.

Procedure

After obtaining the approval of the corresponding University authority, the first-year students of Psychology were informed of the voluntary study. All participating students completed an informed consent form informing them of the nature and objectives of the study. Students participated voluntarily and were free to abandon the study at any time. Underage students were provided with an informed consent form to be completed and signed by the parents. Tests were conducted in a classroom reserved for this purpose, free from external

stimulation or interference. The order of the tests remained constant throughout in the following order: letters and numbers, cognitive flexibility, verbal fluency, Stroop and finally the AUDIT. The duration of the tests was approximately 45 minutes for each student, conducted individually by two researchers of the study. All instruments were administered during the first semester of the academic year.

Data analysis

The data was analysed using the SPSS statistical program, version 21.0 for Windows. In addition to a descriptive analysis, the non-parametric Kruskal-Wallis test was used to check for differences both in academic results and in the testing used to evaluate cognitive functions among the three consumption profiles ("risk free", "at risk" and "probable ADS"), according to the cut-offs for university populations set by García Carretero et al. (2016), described above. The Kruskal-Wallis test uses the significance level α=.05. A *post hoc*, comparative analysis of the groups was made using the Mann-Whitney U test, and the effect size was calculated.

Results

With regards to the first objective of the study, to determine the prevalence of excessive alcohol consumption by university students, Table 1 shows the frequency of consumption for each profile. Notably, more than half of participants have a consumption habit considered as at risk or show signs of probable ADS. The latter group (probable ADS) consists entirely of women. In contrast, there is also a higher percentage of women whose consumption is considered risk free.

Table 1. *Prevalence of alcohol consumption*

Prevalence	*Gender*		
	Men	Women	Total
Risk free consumption	6 (25%)	42 (55%)	48
At risk consumption	18 (75%)	25 (33%)	43
Probable ADS	0	9 (12%)	9
Total	24 (100%)	76 (100%)	100

Using these category definitions, the Mann-Whitney U test was used to identify differences in the consumption habits of men and women. No significant gender differences were discovered in the results of the AUDIT (z = -7.92, p = .428).

To determine if the consumption habits of students corresponds to the pattern of BD, a frequency analysis was conducted of items 1 and 2 of the AUDIT. Item 1 evaluates the frequency of alcohol consumption while Item 2 the number of alcoholic drinks consumed in each session. These two questions allow the identification of this type of consumption. The results are provided in Tables 2 and 3 below:

Table 2. *Frequency of alcohol consumption*

Frequency	*Gender*		
	Men	Women	Total
Never	1	0	1
1 time or less a month	0	14	14
2 to 4 times a month	6	46	52
2 to 3 times a week	17	15	32
4 or more times a week	0	1	1
Total	24	76	100

The majority of the women (60.5%) consume alcohol 2 to 4 times a month. However, among men the frequency of consumption is higher, with the majority (70.8%) consuming 2 to 3 times a week.

Table 3. *Number of alcoholic drinks consumed per session*

Prevalence	*Gender*		
	Men	Women	Total
1 or 2	3	22	25
3 or 4	18	35	53
5 or 6	3	17	20
From 7 to 9	0	2	2
More than 10	0	0	0
Total	24	76	100

The majority of the participants have a profile of consumption that approaches or is characteristic of BD: 75% of men and 46% of women consume 3 to 4 alcoholic drinks per session, while 12.5% of men and 22.4% of women consume 5 to 6 alcoholic drinks per session. Only 2 women, 2.6% and no men, consume 7 to 9 alcoholic drinks per drinking session.

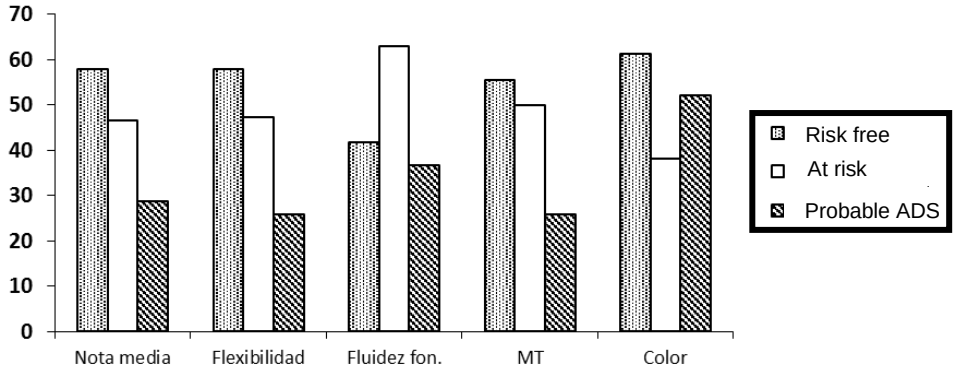
In relation to objectives 2 and 3 of the study, a non-parametric Kruskal-Wallis test with a significance level of α=.05 was conducted to determine differences in academic performance and executive functions according to alcohol consumption. The results, Table 4, show significant differences in both academic performance and in average cognitive flexibility, phonological fluency, working memory and the Stroop "colour" condition.

Table 4. *Descriptive statistics and the Krustal-Wallis test*

Variables	*M*	*DE*	χ^2	*Gl*	*p*
Average mark (out of 100)	59.1	12.4	9.06	2	.011*
Flexibility	15.77	4.41	10.45	2	.005*
Phonological fluency	37.98	5.36	14.39	2	.001*
Semantic fluency	54.82	5.37	3.99	2	.136
Working memory	12.01	2.16	8.15	2	.017*
Stroop word	106.05	14.33	.85	2	.654
Stroop colour	75.82	10.36	14.67	2	.001*
Stroop interference	6.85	7.22	.70	2	.704

**The correlation is significant at .05 (bilateral).*
M: average; DE: standard deviation; χ^2: statistic; gl: degree of freedom; p: signification

Graph 1 shows the results for each consumption profile. The highest scores are by those with risk-free consumption habits, followed by those showing with at risk consumption, and finally those with "probable ADS". This is also the case with cognitive flexibility: higher alcohol consumption corresponds to less flexibility, and similarly with working memory. In the rest of the evaluated areas, however, the relation does not appear as lineal.



Graph 1. Average test results in relation to alcohol consumption profile.

To understand these differences, a comparative analysis was made of each group using the Mann-Whitney U test. To estimate the impact of different consumption habits the statistical *r* value was calculated using the procedure by Tomczak & Tomcak, (2014). The differences between the most contrasting groups, "risk-free" and "probable ADS", were significant in the following measurements: average score (z = -2.2, p = .025; r = .22), flexibility (z = -2,5, p = .013; r = .25) and working memory (z = -1.9, p = ,05; r = .19).

The difference between the "risk free" and "at risk" was significant for the average score (z = -2.1, p = .038; r = .21), flexibility (z = -1.9, p = .05; r = .19), phonological fluency (z = -3,2, p = .001; r = .32) (curiously, in this case the highest score in phonological fluency was found in the "at risk" group) and for the colour condition (z = -3.9, p = .000; r = .39).

Significant differences were found between the "at risk" and "probable ADS" groups in the average score (z = -2.7, p = .007; r = .27), flexibility (z = -2.9, p = .003; r = .29) and phonetic fluency (z = -2.6, p = .008; r = .26).

The effect size was determined using Cohen's criteria (1988) and can be considered as medium or medium-low (r=0,10 (low) /r=0,30 (medium) /r=0,50 (large) /r=0,70 (very large).

The results of the inferential analysis show there are significant differences in academic performance and some executive functions among the three consumption profiles. Academic performance, cognitive flexibility, working memory is worse in students with "at risk" consumption or "probable ADS". In the case of phonological fluency, the high-risk group scored the highest compared to the risk-free and probable ADS groups.

Discussion and Conclusions

This empirical study aims to provide information about the cognitive impact of alcohol consumption among university students. Three objectives and two hypotheses were established at the outset to be contrasted in light of the statistical analysis of the results.

Regarding the first objective, the data shows that more than half of participating students have a problematic habits of alcohol consumption according to the established cut-offs (García

Carretero et al., 2016). Specifically, 43% of participants have a "at risk" consumption and 12% appears susceptible to ADS. These figures are truly alarming. These results coincide with the findings of previous studies, using similar samples, predominantly women, which show high alcohol consumption among university students (Cadaveira & Corral-Varela, 2005; Oei & Morawska, 2004). Although no significant general differences were discovered in consumption habits of men and women, the categories of consumption ("risk-free", "at risk" and "probable ADS") show that the majority of women (55%) have "risk-free" consumption habits compared to men, the majority of whom (75%) have "at risk" habits.

By contrast, the "probable ADS" group consists exclusively of women: 9 participants show this type of consumption habit. These figures confirm that alcohol consumption can no longer be largely ascribed to men as indicated by previous studies (Míguez & Permuy, 2017). This is in line with current trends observed in some countries about the significant increase in problematic alcohol consumption among women (Counter, 2016; Míguez & Permuy, 2017). Females appear to be more susceptible to the effects of alcohol that males: women absorb alcohol more rapidly and metabolise it more slowly, meaning that the same amount of alcohol results in higher blood alcohol concentration than in men (Montero, González & Molina, 2010), possibly leading to alcohol dependency. Additionally, it has been noted that although women tend to initiate alcohol consumption later than men their progression towards problematic consumption is more rapid (Míguez & Permuy, 2017). All of this suggests a greater vulnerability of women to the effects of alcohol.

On the other hand, these results may be conditioned by the gender distribution of the sample, with a large majority of women, and by socio-environmental factors. In addition, the age of the participants may influence the results given that at different ages habits of alcohol consumption may vary according to gender. Wilsnack, Wilsnack, Gnek & Kantor (2018), studying differences in consumption among men and women, differences in risk factors and health consequences, found that the culture of alcohol consumption and social circumstances play an important role in relation to age, gender and excessive alcohol consumption, particularly in BD patterns of consumption.

The descriptive analysis of the scores obtained in Items 1 (frequency of alcohol consumption) and 2 (number of drinks per session), suggest that BD or compulsive consumption is the most common form of consumption among young people. Many authors have shown that

is the most common form of consumption among university students (Motos-Sellés, Cortés-Tomás & Giménez-Costa, 2018). In addition to the long-term consequences, BD also tends to involve certain high-risk behaviour such as unprotected sex, drunk driving, fighting and aggression (Barnet et al., 2014).

Regarding the second objective and first hypothesis, significant differences in academic performance were found between the groups: university students with risk-free consumption habits have a higher performance, followed by those with "at risk" habits and finally the group with "probable alcohol dependence syndrome" showing the worst academic performance. These results point to the impact of alcohol consumption on student academic performance and coincide with the results of previous studies by Brook, Finch, Whiteman & Brook (2002), who found, in a study of 600 adolescents in the United States, a direct relation between alcohol consumption and poor academic performance. Other subsequent studies however, such as that by Andrade & Ramírez (2009) or Soliz, Mena & Lara (2017), both conducted on Ecuadorean university students, found no significant relation between alcohol consumption and average academic results. This disparity of results may indicate that alcohol consumption, also having an impact on academic results, is not the only determining factor in student performance. For example, the circumstances of the participants in the study, their first year of university, involving a new academic environment (greater autonomy, greater responsibility) may also account for falling performance. Another important variable is the history of consumption. The AUDIT only refers to alcohol consumption in the last year, a factor that it may be necessary to take into account and require longitudinal studies of this population in order to identify more precisely the effects of alcohol consumption on academic performance in the medium and long term. One important discovery related to these results is that alcohol consumption is not only associated with poor academic performance but also with a style or manner in dealing with academic activities, characterised by lateness and procrastination in completing academic assignments (Westgate, Wormington, Oleson & Lindgren, 2017).

With regards to the third objective and second hypothesis, the study confirms the significant differences between the three profiles in the evaluated executive functions, specifically cognitive flexibility, phonological fluency and working memory. Differences were also found in relation to alcohol consumption and the Stroop "colour" condition, a test used to evaluate the speed of mental processing (Arentsen & Goldberg, 2010). The results confirm that university students in the "probable ADS" group are cognitively more rigid than "at risk" group

and have less mental flexibility than the "risk-free" group. These findings point in the same direction as other studies (Ratti, Bo, Giardini & Soragna, 2002; Townshend & Duka, 2005). As for phonological fluency, previous studies show impaired communication skills and verbal fluency among adolescents with a history of severe prenatal exposure to alcohol (Doyle et al., 2018).

This study did not encounter any differences in semantic fluency among the different groups but did find them in the phonological fluency task. Among these differences, the "at risk" group unexpectedly scored higher than the "risk-free" and "probable ADS" groups, between which little significant difference was identified. This may be related to what has been suggested in previous studies, that is, there are other factors impacting verbal fluency, both phonological and semantic, such as age, the cognitive strategies (Coni & Vivas, 2014) or sociocultural level (Abreu et al., 2013) of the participants. Risk-free students score higher in working memory although there is no significant difference with the scores of the "at risk" group. The "probable ADS" group scored significantly lower than the other groups. This suggests that working memory performance is clearly affected by excessive alcohol consumption. These figures also coincide with the results of previous studies (Ambrose, Bowden & Whelan, 2001; Crego et al., 2009) which show increasingly poor working memory as alcohol consumption increases.

Finally, and contrary to expectations, no significant differences were found among the three groups in inhibitory control. This stands in contrast to the results of previous studies (Townshend & Duka, 2005; Hartley et al., 2004). However, in the Stroop "colour" condition, evaluating processing speed (Arentsen & Goldberg, 2010), the "high- risk" group showed the worst performance, while the results of the "probable ADS" group, while scoring lower than the risk-free group, did not differ greatly. Some authors have linked slower processing speeds to alcohol consumption (Courtney & Polich, 2009), as opposed to Carbia, López-Caneda, Corral & Cadaveira (2018) who found no alteration in this variable in relation to alcohol intake. Slower processing speed among subjects with high alcohol intake is consistent with alterations in white matter in the prefrontal cortex (Bava et al., 2013; Jacobus et al., 2013) and reduced connectivity in frontal-limbic and orbitofrontal cortex regions (Broadwate et al., 2017) found among heavy drinkers. However, it appears that other variables must also be taken into consideration and more study of this relation is no doubt required.

This preliminary research provides information about the relation between alcohol consumption, academic performance and the execution of executive functions among first-year university students of Psychology. The study find evidence that students with a higher alcohol intake have significantly lower academic performance and poorer results in their executive functions (cognitive flexibility, working memory, phonological fluency and processing speed) than those with no-risk consumption habits. This cognitive impact of alcohol consumption and its manifestation in academic performance determines, along with other factors, student learning given that neuronal connections in the brain are modulated by external and/or environmental factors. These findings are an interesting contribution to the integration of neuroscience and educational psychology, a line of research championed by various authors (Salas Silva, 2003) in recent decades. Teachers must be aware of these issues in designing their course curricula and evaluations to make the teaching/learning process more effective. The findings of the study call for direct engagement through the design, development and execution of prevention campaigns as a means to fight alcohol abuse, enhance neurological development, improve academic performance and help students prepare for their future professional life and avoid high risk behaviour within the university community.

As an exploratory study this work has certain limitations, principally the size of the sample and the gender homogeneity of the participants, and one should be cautious in generalising the obtain results. These shortcomings can be solved in future studies by expanding and harmonising the sample population, including students not only from Psychology but from other areas. It would also be interesting to design longitudinal studies to evaluate the maturation of neuropsychological processes and academic performance as consumption habits evolve.

To summarise, recreational alcohol consumption among university students can have severe cognitive effects that can cause significant harm to the maturation of the nervous system with consequences for students' personal and professional life. However, it should be noted that a number of personal, family and social factors and/or problems, both direct and indirect, can influence alcohol consumption among university students.

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