Physiological and psychological effects of a high dose of alcohol in young men and women

Efectos fisiológicos y psicológicos de una alta dosis de alcohol en hombres y mujeres jóvenes

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Resumen

El objetivo de este estudio fue evaluar los efectos de una dosis alta de alcohol sobre parámetros fisiológicos y psicológicos en hombres y mujeres jóvenes con historia previa de consumo de alcohol. La presión sanguínea sistólica y diastólica, la frecuencia cardiaca, la ansiedad estado, el procesamiento atencional, la estimación temporal y la destreza manual fueron registradas antes (fase 1) y después (fase 2) de la ingesta de alcohol (38,4 g) o de una bebida no alcohólica. La ansiedad rasgo fue registrada solamente en la fase 2. Los resultados mostraron que el consumo agudo de una dosis alta de alcohol: i) en hombres, mejora el procesamiento atencional (aunque la ejecución de los consumidores no fue mejor que la de los no consumidores); ii) en mujeres, bloquea el fenómeno de habituación observado en la presión sanguínea sistólica de los sujetos controles; iii) en ambos sexos, bloquea la mejoría en la ejecución en destreza manual (asociada a la experiencia en los no consumidores). Por otro lado, los hombres consumidores de alcohol mostraron una frecuencia cardiaca menor que los no consumidores, independientemente de la fase en la que se encuentren; mientras que en las mujeres se observó una mayor ansiedad estado y una peor ejecución en procesamiento atencional entre las consumidoras de alcohol, independientemente de la fase. Estos resultados ayudan a comprender la magnitud del deterioro en diversas medidas producido por el alcohol, tras un consumo de riesgo, en hombres y mujeres jóvenes.

Palabras clave: alcohol, hombres, mujeres, medidas fisiológicas, medidas psicológicas

Abstract

The objective of this study was to evaluate the effects of a high dose of alcohol on physiological and psychological parameters in young men and women with a previous history of alcohol consumption. Systolic and diastolic blood pressure, heart rate, state anxiety, attention, time estimation and manual dexterity were registered before (phase 1) and after (phase 2) intake of alcohol (38.4 g) or a non-alcoholic beverage. Trait anxiety was registered in phase 2 only. The results showed that acute consumption of a high dose of alcohol: i) improves attention in men (although the performance of alcohol consumers was not better than that of non-consumers); ii) blocks the systolic blood pressure habituation phenomenon (observed in controls) in women; and iii) blocks the improvement in manual dexterity (associated with experience in non-consumers) in both sexes. On the other hand, male consumers had a lower heart rate than non-consumers, independently of the phase, while female consumers had a higher state anxiety and performed worse in attention than controls, also independently of the phase. These results help to understand the extent of performance impairment of different tasks produced by risk alcohol consumption in young men and women.

Keywords: alcohol, men, women, physiological measures, psychological measures

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Alcohol is one of the most widely consumed psychoactive substances in the world, especially among young people and adolescents, among whom heavy drinking is becoming increasingly frequent, particularly in the case of 15- to 24-year-olds, whose alcohol consumption in the past 12 months is high (78.5%) (OEDT, 2012). In general, men show a higher prevalence of alcohol consumption than women, but these differences are less marked among 15- to 24-year-olds, due to the rising numbers of girls that drink in many countries. In Spain, alcohol consumption in adolescence is more frequent among women than among men (14-18 year-olds) (Observatorio Español sobre Drogas, 2013). As a consequence, the level of heavy episodic drinking among European adolescents has grown slowly but continuously over recent years (Chavez, Nelson, Naimi, & Brewer, 2011; Hibell, Guttormsson, Ahlström, Balakireva, Bjarnason, Kokkevi, & Kraus, 2007; Sánchez Pardo, 2002).

The World Health Organization and the Spanish Ministry of Health define risk alcohol consumption as upwards of 2.5 standard drink units (25 g of alcohol) for women and upwards of 4 standard drink units (40 g of alcohol) for men (Ministerio de Sanidad y Consumo, 2008). Consumption of the same amount of alcohol in men and women produces a significantly lower blood alcohol concentration (BAC) in the former sex, due to the lower metabolism rate of women and their higher sensitivity to this drug (Courtney & Polich, 2009). Similarly, animal studies show that females are more vulnerable than males to the neurotoxic/neuroinflammatory effects of ethanol, supporting the view that women are more susceptible than men to the medical consequences of alcohol abuse (Alfonso-Loeches, Pascual, & Guerri, 2013). This fact, together with a lack of studies of adolescent female social drinkers, make this latter group a risk population in whom the effects of alcohol need to be studied in a more exhaustive manner according to pattern of consumption (acute intake of a high dose and a long-term consumption history).

Ethanol produces a wide variety of behavioral and physiological effects in the body, but exactly how it acts to produce these effects is still poorly understood (Harris, Trudell, & Mihic, 2008). Alcohol impairs the functioning of a variety of domains throughout the life cycle (Espert & Gadea, 2012), including brain development (Guerri & Pascual, 2010), attentional processing (Marinkovic, Rickenbacher, Azma, & Artsy, 2012), memory (Squeglia, Schweinsburg, Pulido, & Tapert, 2011), academic performance (Inglés, Torregrosa, Rodríguez-Marín, García del Castillo, Gázquez, García-Fernández & Delgado, 2013), and motor performance (Marczinski, Fillmore, Henges, Ramsey, & Young, 2012; Modig, Fransson, Magnusson, & Patel, 2012), and it alters physiological parameters, as well as anxiety (Vinader-Caerols, Monleón, Carrasco, & Parra, 2012).

In a previous study in our laboratory, a low dose of alcohol (15.8 g in women and 18.7g in men) on physiological parameters and anxiety in a young population (mean age: 20.34 ± 2.34 years) produced a decrease in diastolic but not systolic blood pressure, and no alteration of the heart rate (Vinader-Caerols et al., 2012). These findings challenged previously published data suggesting that alcohol consumption increases blood pressure (Taylor, Irving, Baliunas, Roerecke, Patra, Mohapatra, & Rehm, 2009; Xin, He, Frontini, Ogden, Motsamai, & Whelton, 2001). In addition, we observed higher levels of state anxiety in alcohol consumers than in control subjects. However, no differences in state anxiety were detected in the former group when levels were compared before and after the acute intake of alcohol (Vinader-Caerols et al., 2012).

The aim of the present study was to evaluate the effects of a high dose of alcohol on core physiological and psychological parameters in young male and female social consumers. The physiological measures were systolic and diastolic blood pressure (SBP and DBP) and heart rate (HR), and the psychological measures were state anxiety (SA), trait anxiety (TA), attention (ATT), time estimation (TE) and manual dexterity (MD). The first two psychological parameters are measures of anxiety, the following two measure attentional processing, and the last measures motor behaviour. The novelty of the present study lies in that it combines the population sample (late adolescents with a history of risk alcohol consumption during the previous year), the consumption of a high dose of alcohol (38.4 g) in a short period of time (15-20 min), and the reproduction of the conditions under which alcohol is normally consumed. Following the rationale used by other researchers (Hindmarch, Rigney, Stanley, Quinlan, Rycroft, & Lane, 2000), we believe that administering alcohol to experimental subjects as it is usually ingested in "real life" is a more appropriate method of evaluating its effects in a risk population.

Method

Subjects

Twenty-two healthy male and 24 healthy female undergraduate students at the University of Valencia, Spain participated in the study (mean age: 19.36 ± 0.21 years old and 19.5± 0.48 years old, respectively). They were recruited as experimental subjects according to their consumption habits and general health status, which were determined by a self-report in which the following controlled variables were measured: consumption of drugs, frequency and level of consumption, hours and quality of sleep, physical health (e.g. normotensive subjects) and psychological health (e.g. no previous history of episodes of anxiety). Participants were classified as abstemious subjects or social consumers of alcohol (≥ 3 standard drink units for women and ≥ 4 standard drink units for men, consumed in a short period of time –over a weekend– on a regular basis during the previous year) whose alcohol consumption had begun at an early age (mean age: 15.00 ± 0.39 years old). A telephone

interview was then conducted with each selected subject in order to confirm the information provided in the self-report and to fix the date and time of the test.

Informed consent was obtained from all participants the test day and the study was conducted in accordance with the guidelines for human experimentation of the Ethics Committee of the University of Valencia and with those of the Helsinki Declaration. The following inclusion criteria were determined: 18 years old or older; and body mass index of 18-28 and good health, according to the data obtained through the self-report and subsequently checked in the interview. The exclusion criteria were as follows: being on medication; a history of mental disorders; an irregular sleep pattern; or a history of substance abuse, including caffeine and tobacco. Subjects (the consumers) were told to abstain from drinking alcohol and performing heavy physical exercise during the evening/night prior to the experiment, and all subjects were instructed to follow their normal sleep patterns. All the participants were right-handed.

Tests and Apparatus

A digital automatic blood pressure monitor (M10-IT, OMRON, Spain) was used to measure SBP (mmHg), DBP (mmHg) and HR in all the subjects.

The State-Trait Anxiety Inventory (STAI) (Spielberger, 1984) was used to measure anxiety. This is a questionnaire consisting of 20 items referring to self-reported SA and 20 items referring to TA. All subjects completed the standardized Spanish version of the STAI.

The Stroop task was used to measure attentional processing. This test measures the ability to focus attention on relevant stimuli while ignoring distracters and to suppress a prepotent response (i.e. word reading) in favour of an atypical one (i.e. colour naming) (Stroop, 1935). A standard printed version of this task consisting of three parts or sheets was employed. Sheet 1 (a page of words with the names of colours printed in black ink) and sheet 2 (a page printed with coloured 'Xs') are congruent conditions; in this case, the subject is instructed to read the words (sheet 1) or name the colours (sheet 2) as quickly as possible within a time limit of 45 s. Sheet 3 (a page of words from the first page printed in the colours appearing on from the second page) is the incongruent condition, as the colour and the word do not match (e.g. the word red is printed in blue ink); in this case the subject is told to name the ink colour rather than the word. Three scores (based on the number of items completed on each sheet) are provided, with the score for sheet 3 being the most relevant. An additional interference score known as the "Stroop effect" is also calculated [Stroop effect = score3 − (score1 * score2 / score1 + score2)]; the higher the Stroop effect value, the lower the interference effect. Taking into consideration the relevance of these measures, only sheet 3 and Stroop effect scores were analysed in the present study.

The time estimation task, an integrated computerized procedure used to provide time estimation trials and to record results, was also performed by the subjects. The programme and protocol were the same as those described in detail elsewhere (Somoza & Parra, 1995). Subjects were also asked to estimate a short time interval (10 s) without feedback in a prospective paradigm. In this time estimation task, subjects were asked to press a key when they believed that 10 s had elapsed following a "beep" sound. Ten experimental trials (per subject) were preceded by two practical trials in which the computer demonstrated a 10 s interval. No feedback on performance was offered. The intertrial interval was variable (mean = 5; range = 3-7 s).

A standard version of the Purdue Pegboard test was used to provide a global assessment of manual dexterity (Tiffin & Asher, 1948). The pegboard is equipped with pins, collars and washers placed in four cups at the top of the board. Four separate scores were obtained with this test: (1) right hand; (2) left hand; (3) both hands; and (4) assembly. For the first three measures, subjects were instructed to place as many round pegs (3 mm x 25 mm) as possible in the board within a short period of time (30 s), while for the last measure, they were told to assemble pins, collars, and washers using both hands simultaneously within a period of 1 min. The whole test lasted roughly 10 min.

An alcoholmeter (Alcoquant® 6020, Envitec, Germany) was employed to measure the concentration of alcohol in the air exhaled by the social consumers of alcohol before and after intake of a drink.

The Alcohol Use Disorders Identification Test (AUDIT) (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993) was also employed to measure alcohol dependency among the subjects. The AUDIT consists of 10 questions that evaluate the quantity and frequency of alcohol intake and alcohol-related behaviours and consequences. It uses a range of 0-40, in which a score of 8 or more indicates a problematic use of alcohol. A higher score is related to greater severity of alcohol dependence.

Procedure

The experimental procedure was approved by the Ethics Committee of the University of Valencia. The subjects were allocated by sex to two treatment groups according to their consumption habits: control group (C) and alcohol group (A). The C groups consisted of 11 male and 12 female abstemious individuals respectively, who received 100 ml of a lime- or orange-flavoured refreshment. The A groups consisted of 11 male and 12 female social consumers respectively, who were administered 38.4 g of alcohol in the form of vodka mixed with a refreshment (120 ml of vodka diluted in 100 ml of a lime- or orange-flavoured refreshment) that they were instructed to drink within a period of 15-20 min. The dose of alcohol was selected according to the consumption habits of the subjects. After finishing the drink, all subjects rinsed their mouths with water.

The body weight of C and A groups did not significantly differ for men (C group: 67.91 ± 1.06 kg; A group: 70.64 ± 1.55 kg) or women (C group: 58.25 ± 1.29 kg; A group: 57.33 ± 1.05 kg). Similarly, body mass index (BMI) did not significantly differ for men (C group: 20.8 ± 0.39; A group: 22.39 ± 0.43) or women (C group: 21.4 ± 0.55; A group: 20.85 ± 0.48). According to the body weight mean of A group, the mean alcohol intake was 0.55 g/kg in men and 0.66 g/kg in women, which is considered a medium-high dose of alcohol (Ogden, Wearden, Gallagher, & Montgomery, 2011). Body weight, BMI, drinking duration, and sex differences in metabolism were taken into account in this experimental procedure, as they are critical factors in the within-subject variability of blood alcohol concentration levels (Lange & Voas, 2001).

Each subject participated in two phases separated by a 35-min interval consisting of treatment (15-20 min) and wait (15 min). In the first phase, SBP, DBP, HR, SA, ATT, TE and MD were registered for all subjects. Alcohol concentration was measured in the social consumers using an alcoholmeter. Following the wait interval, a second phase took place in which, in addition to the aforementioned parameters, TA and alcoholic dependence were measured in social consumers of alcohol by the AUDIT test (mean score: 6,5 ± 1.12 in men and 6,64 ± 0.89 in women). The concentrations of alcohol in exhaled air were 0.00 mg/L for men and women before the alcoholic drink, and 0.22 ± 0.016 mg/L for men and 0.32 ± 0.021 mg/L for women after drinking. Subjects were told to follow their usual breakfast routine at least one hour before the experimental session. All the tests were performed between 10:30 a.m. and 12:30 p.m. and members of the A groups remained on the premises until their alcohol concentration dropped to legal limits for driving.

Statistical Analyses

After checking that data met the criteria for normality and homogeneity of variances, they were subjected to parametric analysis. Taking into account that alcohol concentration differed significantly in men and women, separate ANOVAs were performed for each sex. An ANOVA was performed for each measure (SBP, DBP, HR, SA, TA, ATT, TE and MD), with the between-subjects factor "Treatment" and the within-subjects factor "Phase" as independent variables. When their interaction was statistically significant, further analyses were carried out with Student's t-tests for dependent and independent samples. All analyses were performed using the "SPSS" Statistics software package, version 19.0 for Windows (IBM, 2010).

Results

A summary of significant ANOVA results for physiological (SBP, DBP and HR) and psychological (SA, TA, ATT, TE and MD) parameters is provided in table 1.

Table 1

Summary of significant ANOVAs for physiological (SBP, DBP and HR) and psychological (SA, ATT and MD) parameters.

MEASURE	Mean (±SEM) PHASE 1	Mean (±SEM) PHASE 2	PHASE	TREAT-MENT	PHASE X TREAT-MENT
SBP Men	C = 12.24 (±0.38) A = 12.28 (±0.26)	C = 11.89 (±0.40) A = 11.88 (±0.25)	n.s.	n.s.	n.s.
SBP Women	C = 11.32 (±0.23) A = 10.64 (±0.28)	C = 10.27 (±0.18) A = 10.27 (±0.17)	***	n.s.	*
DBP Men	C = 7.26 (±0.23) A = 7.44 (±0.37)	C = 6.91 (±0.30) A = 6.61 (±0.29)	**	n.s.	n.s.
DBP Women	C = 7.37 (±0.24) A = 6.94 (±0.21)	C = 6.94 (±0.22) A = 6.65 (±0.14)	***	n.s.	n.s.
HR Men	C = 77.00 (±4.53) A = 66.45 (±2.75)	C = 72.36 (±3.43) A = 64.18 (±2.21)	*	*	n.s.
HR Women	C = 83.58 (±1.93) A = 74.83 (±3.08)	C = 80.17 (±2.71) A = 76.92 (±1.72)	n.s.	n.s.	n.s.
SA Men	C = 22.32 (±4.21) A = 19.86 (±3.00)	C = 16.04 (±3.25) A = 18.23 (±4.76)	n.s.	n.s.	n.s.
SA Women	C = 13.58 (±3.54) A = 27.75 (±5.00)	C = 13.83 (±4.98) A = 42.83 (±7.12)	n.s.	**	n.s.
ATT (Sheet 3) Men	C = 58.45 (±2.49) A = 61.64 (±1.08)	C = 63.27 (±2.69) A = 66.27 (±1.13)	***	n.s.	n.s.
ATT (Sheet 3) Women	C = 60.25 (±1.59) A = 53.17 (±2.05)	C = 67.58 (±2.19) A = 56.42 (±2.41)	***	***	n.s.
ATT (Stroop Effect) Men	C = 59.18 (±1.70) A = 55.64 (±1.75)	C = 59.82 (±2.09) A = 63.00 (±1.94)	**	n.s.	*
ATT (Stroop Effect) Women	C = 58.33 (±1.81) A = 54.25 (±1.29)	C = 62.58 (±2.01) A = 58.25 (±1.42)	***	*	n.s.
MD (Right-hand) Men	C = 15.00 (±0.53) A = 14.91 (±0.54)	C = 15.14 (±0.59) A = 15.55 (±0.53)	n.s.	n.s.	n.s.
MD (Right-hand) Women	C = 15.44 (±0.38) A = 16.00 (±0.50)	C = 17.00 (±0.44) A = 15.92 (±0.43)	*	n.s.	*
MD (Left-hand) Men	C = 12.57 (±0.78) A = 13.91 (±0.45)	C = 14.00 (±0.49) A = 14.09 (±0.41)	n.s.	n.s.	n.s.
MD (Left-hand) Women	C = 14.78 (±0.32) A = 13.92 (±0.40)	C = 15.67 (±0.50) A = 14.92 (±0.48)	*	n.s.	n.s.
MD (Assembly) Men	C = 7.43 (±0.57) A = 8.18 (±0.50)	C = 8.43 (±0.48) A = 7.73 (±0.43)	n.s.	n.s.	**
MD (Assembly) Women	C = 8.00 (±0.29) A = 9.42 (±0.45)	C = 9.56 (±0.67) A = 8.83 (±0.47)	n.s.	n.s.	**

Note. SBP = systolic blood pressure, DBP = diastolic blood pressure, HR = heart rate, SA = state anxiety, ATT = attention (Stroop test), MD = manual dexterity (Purdue test). C = control group, A = alcohol group. * $p < .05$; ** $p < .01$; *** $p < .005$.

Blood pressure

The ANOVA for SBP in women revealed that the factor "Phase" was significant, with a decrease observed in the second phase, $F(1, 22) = 18.56$, $p < .0001$. The factor "Treatment" was not significant, while the interaction "Phase" x "Treatment" was statistically significant $F(1, 22) = 4.32$, $p < .05$. Comparison of dependent samples revealed a decrease of SBP in the C group $t(11) = 5.73$, $p < .0001$, but not in the A group (see Figure 1). Neither the main factors nor their interaction were significant in men.
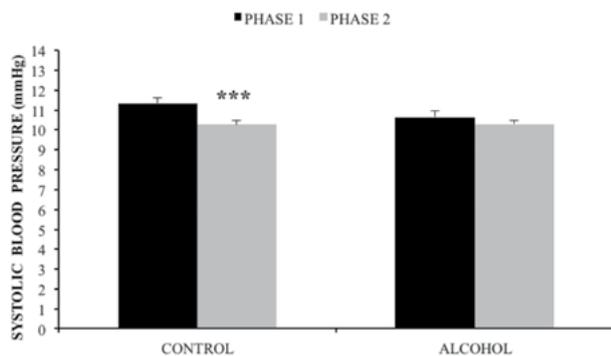
Figure 1. Mean (+SEM) systolic blood pressure (mmHg) in Control and Alcohol women. *** p < .005 versus phase 1.

In the case of DBP, the factor "Phase" was significant in men, $F(1, 20) = 7.6$, $p < .05$, and women, $F(1, 22) = 11.13$, $p < .005$. A decrease was observed in the second phase in both sexes. The factor "Treatment" and the interaction "Phase" x "Treatment" were not significant with respect to DBP in either men or women.

Heart rate

The ANOVA for HR in men revealed that the factor "Phase" was significant, with a decrease observed in the second phase, $F(1, 20) = 4.4$, $p < .05$. "Treatment" was also significant in men, $F(1, 20) = 4.45$, $p < .05$, with alcohol consumers showing a lower HR than control subjects. The interaction "Phase" x "Treatment" was not significant. Neither the main factors nor their interaction were significant in women.

State-Trait anxiety

The factor "Treatment" was significant for SA in women, $F(1, 22) = 11.42$, $p < .005$, with higher values recorded for alcohol consumers. Neither the factor "Phase" nor the interaction "Phase" x "Treatment" was significant with respect to SA in women. Neither the main factors nor their interaction were significant in men.

"Treatment" was not significant with respect to TA in either men or women.

Attention

In sheet 3 of the Stroop task (incongruent condition), the "Phase" factor was significant in men, $F(1, 20) = 18.9$, $p < .0001$, who showed an improvement in the second phase, while neither the factor "Treatment" nor the interaction "Phase" x "Treatment" was significant. In women, the factor "Phase" was significant, $F(1, 22) = 14.01$, $p < .001$, as an improvement was detected in the second phase. "Treatment" was also significant $F(1, 22) = 12.52$, $p < .005$, as the C group performed better than the treatment group. The interaction was not statistically significant.

The Stroop effect highlighted that there was less interference in the second phase than in the first phase in both men, $F(1, 20) = 8.62$, $p < .01$, and women $F(1, 22) = 11.23$, $p < .005$. The factor "Treatment" was not significant in men but was so in women, $F(1, 22) = 4.46$, $p < .05$, among whom control subjects exhibited less interference than their alcohol-consuming counterparts. The interaction "Phase" x "Treatment" was not statistically significant in women but was so in men $F(1, 20) = 6.09$, $p < .05$. The comparison of dependent samples revealed a minor interference in the second versus first phase in the A group $t(10) = 3.77$, $p < .005$, but not in C group (see Figure 2).
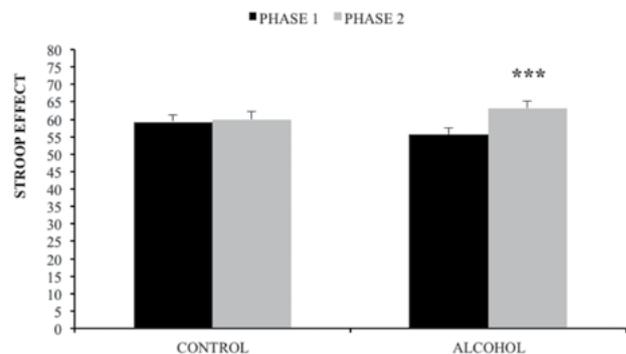

Figure 2. Mean (+SEM) score for Stroop effect in Control and Alcohol men. *** p < .005 versus phase 1.

Time estimation

Neither the main factors nor their interaction were significant in men or women.

Manual dexterity

The results obtained for each measure in the Purdue Pegboard test were as follows:

Right hand. In women, the factor "Phase" was significant, $F(1, 19) = 5.15$, $p < .05$, as subjects obtained a higher score in the second phase. The factor "Treatment" was not significant, while the interaction was, $F(1, 19) = 6.38$, $p < .05$. The comparison of dependent samples revealed an improvement in the C group, $t(8) = 3.5$, $p < .01$, that was not observed in the A group (see Figure 3). Neither the main factors nor their interaction were significant in men.
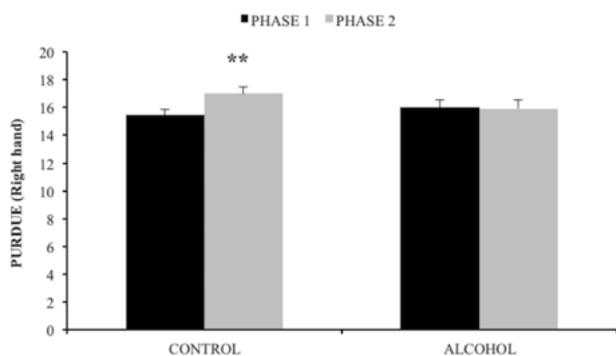
Figure 3. Mean (+SEM) score for right-hand Purdue task in Control and Alcohol women. ** p < .01 versus phase 1.

Left hand. The factor "Phase" was significant, with higher scores being obtained in the second phase by men, $F(1, 16)$ = 4.29, $p < .05$, and women, $F(1, 19)$ = 6.13, $p < .05$. Neither "Treatment" nor the interaction of the two factors was significant in either sex.

Both hands. Neither the main factors nor their interaction was statistically significant with respect to this measure in men or in women.

Assembly. The main factors "Phase" and "Treatment" were not significant in either sex, though their interaction was significant in both men, $F(1,16)$ = 7.73, $p < .01$, and women, $F(1,19)$ = 7.56, $p < .01$.

In men, comparison of dependent samples revealed an improvement among controls in the second versus first phase, $t(6)$ = 4.58, $p < .005$, a result that was not observed in the alcohol consumers (see Figure 4).
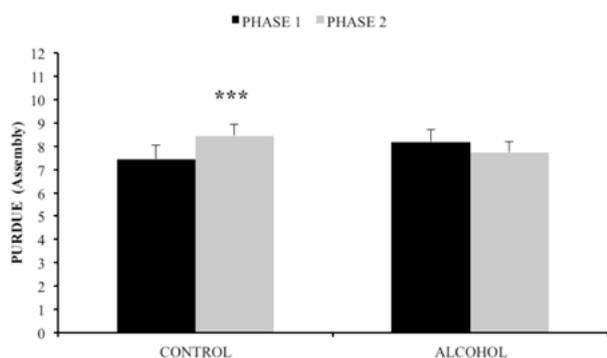

Figure 4. Mean (+SEM) score for assembly Purdue task in Control and Alcohol men. *** p < .005 versus phase 1.

In women, comparison of dependent samples revealed an improvement among controls in the second versus first phase, $t(8)$ = 2.8, $p < .005$, that was not observed among the alcohol consumers. Comparison of independent samples revealed a better performance among alcohol consumers than control subjects in the first phase, $t(19)$ = 2.44, $p < .05$ (see Figure 5).
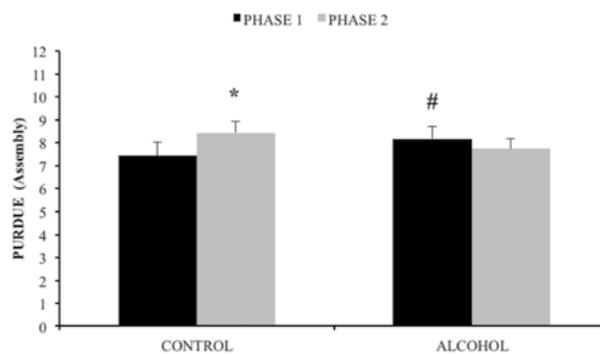

Figure 5. Mean (+SEM) score for assembly Purdue task in Control and Alcohol women. * p < .05 versus phase 1; # p < .05 versus Control in the same phase.

Discussion

Alcohol consumption is highly prevalent during adolescence and youth in many countries, and an increase in heavy episodic drinking has become apparent among young people, and especially women, over recent years (Chavez et al., 2011; Hibell et al., 2007; Observatorio Español sobre Drogas, 2013). With this context in mind, the present study set out to evaluate the effects of a high dose of alcohol on physiological and psychological parameters in young male and female social consumers with a previous history of alcohol consumption.

In terms of physiological parameters, no differences were observed in SBP among men in either of the groups. In the case of women, SBP was found to be lower in control subjects after drinking the non-alcoholic beverage, while it did not change in alcohol consumers. This reduction observed in the second phase is likely to be a result of habituation to the experimental situation, which was prevented by alcohol consumption. This habituation phenomenon was also observed with respect to SBP in women and with respect to DBP in both sexes, as a reduction of blood pressure was observed in the second phase, independently of the treatment received. Furthermore, DBP was not affected by a high dose of alcohol (38.4 g) in either men or women. Our findings challenge previously published data associating total habitual alcohol consumption, consumption of specific alcoholic drinks, and binge drinking with higher mean blood pressure in adults (Abramson Lewis, & Murrah, 2010; Briasoulis, Agarwal, & Messerli, 2012; Xin et al., 2001). A meta-analysis by Taylor et al. (2009) concluded that the risk of hypertension increases linearly with alcohol consumption. Nevertheless, the relation between alcohol consumption and hypertension is still unclear (Halanych, Safford, Kertesz, Pletcher, Kim, Person, Lewis, & Kiefe, 2010).

HR was lower in male alcohol consumers than in male controls, while HR was similar in female control subjects and alcohol consumers, in contrast to the findings of other studies reporting an increase in this respect (e.g. Spaak, Tom-

linson, McGowan, Soleas, Morris, Picton, Notarius & Floras, 2010). Besides the reduction of HR produced by alcohol in men, the habituation phenomenon was also observed with respect to this measure in the second phase (lower HR, independently of treatment). However, no such habituation was observed in women.

Higher SA was observed among in female alcohol consumers than their control counterparts, independently of the phase. Other authors have reported an association between symptoms of anxiety and an increased risk of alcohol use disorders in early adulthood (e.g. Liang & Chikritzhs, 2011; McKenzie, Jorm, Romaniuk, Olsson, & Patton, 2011). For example, Blumenthal, Leen-Feldner, Frala, Badour, and Ham (2010) found that socially anxious youths drink alcohol to manage their anxious arousal. As expected, control and alcohol consumers of both sexes exhibited similar TA in our study. In view of this finding, it is reasonable to believe that the differences observed in SA were due to a history of alcohol consumption rather than stable individual differences of personality (Vinader-Caerols et al, 2012).

The effects on psychological parameters of a high dose of alcohol administered in conditions that simulate those under which alcohol is normally consumed by the population sample have not been well studied. The neural basis of alcohol's effects on cognitive control is also poorly understood, despite evidence of impaired ability to evaluate competing demands and to inhibit maladaptive responses (Marinkovic et al., 2012). The Stroop test is an appropriate task for evaluating this aspect. Our results show that the habituation phenomenon was advantageous to both men and women in the sheet 3 and Stroop effect, with both sexes performing better in the second phase than in the first (independently of the treatment received). On the other hand, female -but not male- alcohol consumers performed worse than control subjects in the sheet 3 test and displayed a higher interference effect in the attentional processing evaluated by this task. Furthermore, men with a history of alcohol consumption showed a lower interference effect (higher Stroop effect score) under the effects of alcohol (second phase). However, it is important to point out that the performance of alcohol consumers was not superior to that of non-consumers. Past research has indicated an impairment of attentional process under the effects of alcohol (e.g. Marinkovic et al., 2012), and we do not have a logical explanation to the apparent improvement in the male alcohol consumers' performance in our study.

In the case of TE, alcohol consumption did not significantly affect this measure in men or women. Published data regarding the effects of alcohol on TE are somewhat discrepant (Heishman, Arasteh, & Stitzer, 1997; Lapp, Collins, Zywiak, & Izzo, 1994; Tinklenberg, Roth, & Kopell, 1976). Tinklenberg et al. administered ethanol to subjects who were instructed to indicate when 30 s, 60 s and 120 s had passed and found that the estimations were longer than

the stipulated time intervals. The opposite was reported by Lapp et al., whose subjects' estimations were shorter than the stipulated time intervals of 5 s, 10 s and 30 s. Heishman et al. failed to detect an effect of alcohol on the estimations of intervals from 5 to 80 s, results that are in accordance with those of the present study.

In terms of manual dexterity, control men and women showed an improvement in the assembly measure of the Purdue task, whilst alcohol seemed to block this improvement. In the right-hand measure, the same pattern was observed in women, but not in men. Marczinski et al. have reported that alcohol impairs simple and complex motor coordination in the same task. The negative impact of alcohol in our study was obvious in an impairment of the adaptive response (improved performance in the second phase) normally observed in control subjects. The improvement in the right-hand (and not in the left-hand) component of the Purdue task cannot be due to the fact that all our participants were right-handed, as this effect was observed only in women.

Furthermore, our female subjects benefitted from the habituation phenomenon, as they performed better in the second phase (independently of the treatment received) in both right- and left-hand measures of the Purdue task.

BAC obtained in the present study was a significantly higher in women and the blood pressure and manual dexterity measures were affected by alcohol consumption in this sex. Despite the fact that men had a lower BAC after consuming the same quantity of alcohol, two measures - attention and manual dexterity- were affected in their case.

The results obtained in women in the present study and previous findings by our group (Vinader-Careols et al., 2012) are in line; namely: i) a decrease in SBP and DBP, independently of treatment, was observed in the second phase; ii) HR and TA was not affected by either treatment or phase; and iii) SA levels were higher among alcohol consumers. On the other hand, in contrast to the findings of our previous study, in the present work the decrease of SBP occurred specifically in control subjects but not in alcohol consumers, while no reduction of DBP was observed in the latter group.

In summary, taking into account that the present study is mainly descriptive and that the results have been obtained by mimicking the consumption habits of young people and reproducing the conditions under which they normally consume alcohol, it can be affirmed that:

i. In men, acute alcohol consumption improves ATT (although the performance of alcohol consumers was not better than that of non-consumers).

ii. In women, acute alcohol consumption blocks the habituation phenomenon with respect to SBP observed in controls.

iii. In both sexes, acute alcohol consumption blocks the improvement in MD performance associated with experience in non-consumers.

These results help to understand the extent of performance impairment produced by risk alcohol consumption in young men and women. They reinforce the idea that the adolescent brain is especially sensitive to the impact of ethanol exposure during this critical developmental period (Maldonado-Devincci, Badanich, & Kirstein, 2010). Moreover, they support the hypothesis that the phenomenon of habituation and the improvement in performance associated with experience can be blocked by alcohol.

Future research with larger samples of young men and women and alternative experimental designs is required to understand better the effects of alcohol on young people with consumption habits established in adolescence.

Funding

Acknowledgements

Conflict of interest

All authors have no conflicts of interest to declare.

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