The Effects of a Modest Dose of Alcohol on Executive Functioning and Prospective memory.

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Abstract

Rationale: Acute alcohol intoxication selectively impairs executive functioning and prospective memory. Much previous research in this area has used laboratory based tasks which may not mimic functions that individuals with dysexecutive syndrome have problems with in everyday life. The present study aimed to assess the effects of a modest dose of alcohol on executive functioning and Prospective Memory (PM) using a virtual reality task, and investigate the role of executive planning in PM performance. *Methods:* Forty healthy participants were administered 0.4g/kg alcohol or matched placebo in a double-blind design. Executive function and Prospective Memory were assessed using the Jansari, Agnew, Akesson, & Murphy (JAAM) task, requiring participants to play the role of an office worker. *Results:* Alcohol intoxication selectively impaired executive function and prospective memory. Participants in the alcohol condition performed worse on the planning, prioritisation, creativity and adaptability executive subscales and also on the time based and event based PM tasks. However, alcohol did not impair the selection executive function task or the action based PM task. *Conclusions:* The results provide further support for the effects of alcohol on executive functioning and prospective memory. In addition, the results suggest that such deficits may be present at relatively modest doses of alcohol, and in the absence of a subjective feeling of intoxication.

Introduction

Alcohol is one of the western world's most popular drugs (Babor et al. 2003), such that the subjective effects of alcohol are well known. Memory impairments while intoxicated (e.g. Poltavski et al. 2010), and memory impairments following chronic use of alcohol (i.e. alcoholism) are well documented (Oscar-Berman, 1980). However, much of the previous research in this area is reliant on laboratory based tasks which may not reflect processes that intoxicated individuals typically have problems with in day-to-day life.

Previous research using laboratory based tasks of executive functioning have shown that acute alcohol intoxication will adversely affect planning at higher doses, although not at moderate doses. For example, a dose of 0.8g/kg impaired planning time and number of trials completed in the minimum number of moves on the Tower of London (TOL) task (Weissenborn & Duka, 2003). However, 0.6g/kg alcohol does not appear to affect any aspect of TOL performance (Leitz et al. 2009), and may even facilitate performance (Paraskevaides et al. 2010). Alcohol intoxication also adversely affects performance on the Wisconsin Card Sorting Task (Lyvers & Malzman, 1991), with increased perseverative errors indicating set-switching deficits. Finn et al. (1999) similarly found an increase in set switching deficits while intoxicated. Decision making is also subject to the effects of alcohol intoxication, with 0.6g/kg increasing risky decision making in a gambling task (George et al. 2005). In comparison, inhibitory control, as measured by stop-signal and Go/No-Go tasks appears to be impaired at 0.4g/kg (e.g. Marczinski et al. 2005; de Wit et al. 2000). Alcohol has been shown to decrease glucose metabolism in the rat brain at high doses (1g/kg), although at low doses (0.25g/kg), actually increases glucose metabolism (Williams-Hemby & Porrino, 1994). However in humans, neuroimaging studies of low (0.25g/kg) vs. High (1g/kg) doses of alcohol show that glucose metabolism is impaired in a dose dependent fashion. However, participants showed no change in their Stroop, Digit-symbol substitution or word association scores between the alcohol and placebo sessions (Volkow et al. 2006), suggesting that such changes in metabolism due to alcohol may not impair these processes.

Among non-executive cognitive functions, acute alcohol intoxication also causes deficits in visuospatial attention (Post et al. 1996), spatial and verbal learning capacity (Mungas et al. 1994), memory and attention (Tiplady et al. 1998), episodic memory (Curran & Hildebrandt, 1999; Soderlund et al. 2007) and memory scanning (Grattan-Miscio & Vogel-Sprott, 2005). For a review of the effects of alcohol on cognition see Fillmore (2007).

Recently, the use of such tasks to infer impaired function in real-world settings has been criticised as such tasks typically require performance on a range of tasks, which participants might use infrequently in an everyday setting concepts (e.g. recalling sequences of spatial locations in a particular order). While some studies report moderate correlations between laboratory-based assessments and everyday situations (Chaytor & Schmitter-Edgecombe, 2003), in general there is little support for this (Amieva et al. 2003; Wilson, 1993). Recently researchers have used Virtual Reality (VR) environments to address this discrepancy (Rizzo & Buckwalter, 1997). While VR environments have not yet been used to assess the effects of acute alcohol intoxication on executive functions, research does suggest that Prospective Memory may be globally impaired using such tasks. Leitz et al. (2009) and Paraskevaides et al. (2010) have used the “Virtual Week” task to assess the effects of alcohol on PM and the moderating effects of executive function and future event simulation. The virtual week task (Rendell & Craik, 2000) is a computer-based board game requiring participants to make decisions and remember to carry out specified tasks at specific times, therefore simulating prospective remembering in the real world. While it was found that 0.6g/kg impaired time-based and event-based PM, simulating the event to-be-remembered at the encoding stage eliminated the significant between group differences. In addition, self-report studies looking at the effects of chronic alcohol use on PM have shown that heavy alcohol drinkers may report a greater incidence of PM slips in the real-world (e.g. Heffernan & Bartholemew 2006). In summary, while there is some evidence to suggest that VR assessments of PM are subject to the effects of acute alcohol intoxication, the effects of acute alcohol intoxication on executive functions using VR tasks is sparse.

The present study utilised the JAAM (Jansari et al. 2004). The JAAM was originally developed to assess dysexecutive syndrome in individuals with frontal lobe damage. Such individuals may perform normatively on laboratory-based executive measures, but have obvious problems with day-to-day functioning (e.g. McGeorge et al. 2001). The JAAM follows the Multiple Errands model as the components are designed to recreate realistic tasks as opposed to the more traditional functional tasks. The subscales that comprise the JAAM are based on 5 executive-type constructs, and are outlined in the method section.

It can be seen from previous research that acute alcohol intoxication can affect executive functioning and prospective memory, while some functions may be preserved especially at lower doses. The present study looks to further this research by looking at the effects of acute alcohol intoxication on a real-world executive function and prospective memory paradigm. Previous research has suggested that successful planning is required for prospective remembering (Kliegel et al. 2003). However, using the TOL as a measure of planning, Leitz et al. (2009) found no between groups differences, and the relationship between planning as measured by the TOL and PM performance was unclear. Therefore the present study aimed to investigate the link between executive planning and PM performance to further elucidate this relationship. While previous research shows that the majority of cognitive functions will be impaired at high doses of alcohol, functions that are more complex will likely be impaired at lower doses (e.g. Moskowitz & Fiorentino, 2000 showed impairments in driving ability at very low Breath Alcohol Concentration (BAC) readings). Taking into account the multitasking requirements of the JAAM assessment, it was perceived to be relatively complex and therefore a lower dose of 0.4g/kg was selected. In summary it was predicted that acute alcohol intoxication would adversely affect executive function and prospective memory, and that impairments would be especially pronounced on the more complex functions, namely planning, creative thinking and adaptive thinking. It was also predicted that alcohol would cause global impairments across the 3 PM subscales and that executive planning would contribute to performance on all 3 PM scales.

Method

Design

A double-blind between groups design was implemented with condition (alcohol versus placebo) as the between groups variable and the scores on the JAAM task as the dependent variables.

Participants

Forty participants were randomly allocated to the alcohol or placebo conditions[1]. Participants in the alcohol condition (6 male; mean age 20.15) and participants in the placebo condition (7 male; mean age 19.40) were of comparable age and gender composition. Participants were recruited via the online research participation scheme (SONA Experiment Management System) at Liverpool John Moores University (LJMU). All participants were of students of white British origin and were right handed. Participants were eligible to participate if they were aged between 18 and 25, had consumed at least 10 UK units[2] of alcohol in the last week, had consumed 4 UK units in one session in the last month, and weighed at least 50kg (females) and 60kg (males). Participants were not eligible to take part if they were pregnant or breastfeeding, if they had ever been advised by a medic to cut down on their alcohol use, or if they had ever been diagnosed with an alcohol or substance use disorder. In addition, participants were excluded if they had a neurological disorder (e.g. migraine, epilepsy, dyslexia), were currently taking medication that may affect Central Nervous System Functioning (e.g. antipsychotics, antidepressants) or had a history of illicit drug use.

Materials

The UWIST Mood Adjective Checklist (UMACL- Matthews et al. 1990)

[1] n = 20 in each group is sufficient for detecting a difference of 1 SD at alpha=.05 and beta = .20 (Hinkle et al. 1994).
[2] A UK unit of alcohol is 10ml by volume or 8g by weight of pure alcohol.

The UMACL is an 18 item checklist yielding scores for state anxiety, arousal and depressed mood. Participants indicate how they are feeling at the time of testing on a 5–point Likert scale ranging from “not at all” to “extremely” for each of the 18 adjectives. Total scores for anxiety, arousal and depressed mood are calculated by summing the component responses, taking account of reverse scored items. High scores (above the midpoint of 18) are indicative of higher levels of anxiety, arousal and depressed mood.

Subjective Intoxication- Addiction Research Centre Inventory (ARCI-Haertzen 1974)

The 15 items in the ARCI questionnaire are based on experienced substance users’ descriptions of intoxication, and all relate to some aspect of alcohol intoxication (e.g. “My Speech is Slurred”) that are answered in a True/False format. A total subjective intoxication score is calculated by summing the responses to all 15 items. Higher scores indicate higher perceived subjective intoxication.

Alcohol Use Disorders Identification Test (AUDIT: Saunders et al. 1993)

The AUDIT is used to identify hazardous drinking. It is comprised of 10 Likert scaled items pertaining to the frequency and intensity of recent alcohol use. A score of more than 8 indicates a strong likelihood of hazardous or harmful alcohol consumption.

Raven’s Progressive Matrices- RPM (Raven et al. 1998)

RPM is a measure of fluid intelligence consisting of 60 visual abstract reasoning problems. Participants have to choose the missing part of a sequence from multiple choice answers. The total score is the total number of correct responses.

The Epworth Sleepiness Scale- ESS (Johns & Hocking 1997)

The ESS represents the likelihood of dozing off during the day in various situations. Participants have to respond to the 8 items on a scale of 0 (would never doze off in this situation) to 3 (high chance of dozing off in this situation). The total score is calculated by summing the responses to all items, with higher scores indicating greater daytime sleepiness.

JAAM (Jansari et al. 2004)

The JAAM is a virtual reality assessment which involves the participant playing the role of someone working for a day in an office environment, helping to set up a meeting. The JAAM was created to assess aspects of day to day life that individuals with dysexecutive syndrome typically report having problems with. The task has been used extensively in a clinical setting and has previously documented executive function deficits in individuals with damage to the frontal lobes relative to "normal" individuals (e.g. Jansari et al. 2004; 2007; 2008). More recently it has been used in the area of Psychopharmacology to assess the effects of nicotine on executive functioning (Edginton et al. 2008), and ecstasy-related deficits in executive functioning (Montgomery et al. 2010a).

At the beginning of the task, participants read the scenario, which describes their virtual environment and their role as an office worker. They are then shown how to navigate around the virtual environment. Participants are given a list of tasks that need to be completed for the office manager. This includes arranging for items of post to be collected, setting up tables and chairs for a meeting and remembering to turn on the coffee machine when the first person arrives for the meeting. In addition to tasks that the participant is aware of at the beginning of the task, they are also handed a number of memos (virtual and hard copy) during the task which require them to perform additional tasks or amend current tasks/goals.

The JAAM task has 8 subscales. These are summarised in Table 1 below.

<<Insert Table 1 About Here>>

The JAAM takes around 40 minutes to complete. Participants receive a score of 0 (no attempt made), 1 (satisfactory performance) or 2 (perfect performance) for each sub-task of each subscale. The scores for subtasks of each subscale are then summed and standardised by calculating a total percentage score for each subscale. A total performance percentage score is calculated for the JAAM by summing raw scores for each subscale, dividing by the total possible score and multiplying by 100.

Procedure

Testing took place in the psychology laboratories at LJMU between 12 and 6pm. Participants were asked to abstain from tea and coffee on the morning of testing and eat a light meal 1-hour before participation. Participants gave informed consent, were weighed and breathalysed (all participants recorded a Breath Alcohol Concentration (BAC) of zero at the beginning of the experiment). Participants then completed the questionnaire measures: the AUDIT, UMACL, RPM and ESS. Participants then ingested either an alcoholic or placebo drink. The alcohol drink contained 0.4g/kg alcohol as a vodka and tonic water mixture (with a maximum of 100ml vodka). The drink was made up of one part vodka, 3 parts tonic water and several drops of Tabasco sauce (see Schoenmakers et al. 2008). The placebo drink contained the same volume of tonic water and Tabasco. Participants were asked to consume their beverage within 5 minutes in the lab. After 10 minutes, participants completed the ARCI for subjective intoxication, and were again breathalysed. Participants then completed the JAAM task. Following this they were breathalysed again. Participants were required to stay in the laboratory until they were below the UK legal drink drive limit (35µg/ml), and were requested to refrain from driving or riding a bicycle for the remainder of the day. The study was approved by Liverpool John Moores University Research Ethics Committee.

Statistical Analysis

All data analysis was conducted using PASW Version 17.0. A between groups MANOVA with the between participants factor of condition (alcohol vs. placebo) and dependent variables of scores on the JAAM was implemented. Linear regression analysis was used to assess the moderating effects of planning on PM performance.

Results

Scores for background variables are displayed in Table 2. A series of t-tests was performed to assess group differences in the background variables. There were no significant differences between the groups in any of the background variables, p>.05 in all cases, age: t(38) = 0.67, p>.05; RPM: t(38) = 0.20, p>.05; arousal: t(38) = 0.13, p>.05; anxiety: t(38) = 0.38, p>.05; depressed mood: t(38) = 0.56, p>.05 or ESS scores: t(38) = 1.00, p>.05. In terms of alcohol use, there were no significant group differences in units consumed in the week prior to testing: t(38) = .69, p>.05 or AUDIT scores: t(38) = 0.08, p>.05. As there were no significant differences between the alcohol and placebo groups on any of the background variables (p>.05 in all cases) these are not discussed further.

<Insert Table 2 about here>

Scores for subjective intoxication and breathalyzer readings at time 2 and 3 are displayed in Table 3. There were significant group differences in BAC at Time 2: t(19) = -11.96, p<.001 and BAC at time 3: t(19) = -5.25, p<.001 indicating that the alcohol group were intoxicated (as Levene’s test was significant, degrees of freedom have been adjusted accordingly). However, group differences on the ARCI (subjective intoxication) were non-significant: t(38) = -0.15, p>.05, indicating that drink type did not affect subjective intoxication.

<Insert Table 3 about here>

The JAAM performance percentage scores are displayed in Figure 1. There was a main effect of alcohol administration on JAAM performance F(8,31) = 8.92, p<.001. Participants in the alcohol condition performed worse on the planning subscale F(1,38) = 18.13, p<.001;

prioritisation subscale F(1,38) = 13.51, p<.001; creativity subscale F(1,38) = 19.27, p<.001; Adaptability subscale F(1,38) = 10.26, p<.01; event-based PM subscale F(1,38) = 12.12, p<.001 and time-based PM subscale F(1,38) = 15.55, p<.001. Group differences on the selection subscale and action-based prospective memory subscale were non-significant.

<Insert figure 1 about here>

Relationship between executive planning and PM.

To investigate the role of planning in the virtual environment in successful performance on the 3 PM subscales, a series of linear regression analyses were used. In each case, planning was the independent variable and each of the prospective memory subscales a dependent variable (i.e. 3 regression models in total). For action-based PM the regression model approached significance $R^2 = 0.15$, F(1,38) = 3.74, p = 0.06. For the Event-based PM scale the regression model was significant $R^2 = 0.11$, F(1,38) = 4.84, p<.05. For the time-based PM subscale $R^2 = 0.15$, F(1,38) = 6.60, <.05. Therefore in the present study, planning in the virtual environment contributes to event-based PM and Time-based PM performance, and despite non-significant effects of alcohol on action-based PM, there was a trend towards the moderating effects of planning.

Discussion

The present study aimed to assess the effects of 0.4g/kg alcohol on performance on a virtual reality task of executive functioning and prospective remembering. 0.4g/kg of alcohol differentially impaired executive constructs, which is noteworthy considering the dose compared to previous research. The results of the present research support previous laboratory based research into the effects of alcohol on prospective memory (e.g. Leitz et al. 2009; Paraskevaides et al. 2010) and the nature of alcohol-related prospective memory deficits (e.g. Leitz et al. 2009). However, the present study suggests that the impairments are present at a relatively modest dose of alcohol, and while participants BAC showed that they were intoxicated, they did not perceive themselves to be intoxicated.

The results of the present study showed that acute alcohol intoxication affects different aspects of executive function. Alcohol impairments were seen on the planning, prioritisation, creativity and adaptability subscales. The results of the present study support previous research in a number of ways. Firstly, previous research has shown that acute alcohol intoxication will impair performance on the TOL (e.g. Weissenborn & Duka, 2003), which has a large planning component, although this is not always the case (e.g. Leitz et al. 2009 found 0.6g/kg of alcohol did not impair performance on TOL, while Paraskevaides et al. 2010 found that alcohol administration actually decreased completion time). Secondly, previous research shows that cognitive flexibility is also subject to the effects of alcohol administration (e.g. Finn et al. 1999; Lyvers & Malzman 1991). Both the creative thinking and adaptive thinking subscales of the JAAM task would require cognitive flexibility, especially when re-assigning tasks during the JAAM when the changing demands require one to do so. The prioritisation subscale required participants to order events according to importance, for example they had to order agenda items for the meeting. Thirdly, previous research has also shown that alcohol intoxication will impair logical decision making and memory updating, which would be important for adequate performance on this aspect of the JAAM (e.g. George et al. 2005). However, alcohol did not impair the selection subscale of the task. This subscale is similar to a decision making task- for example participants have to decide which postal services are most appropriate for a range of mail items that need to be sent. There are a number of possible reasons for the absence of alcohol-related impairments. Firstly, it may be that in *real-world settings*, our ability to select simple appropriate responses when we have adequate information is not impaired as it is a relatively easy task. Secondly, it may also be possible that at a dose of 0.4g/kg, alcohol does not impair this aspect of executive functioning. Indeed many simpler cognitive functions may be relatively preserved at this dose (e.g. Fillmore, 2007), and it would be interesting for future research to investigate the effects of a higher dose of alcohol using this paradigm.

In terms of prospective remembering, the present study showed that a low dose of alcohol will impair time-based (TB) and event-based (EB) prospective memory, but action-based prospective memory (ABPM) appears to be relatively preserved at this dose. Similarly Curran and co-workers (Leitz et al. 2009; Paraskevaides et al. 2010) found that a higher dose of alcohol also impaired prospective memory. The tasks in these subscales typically involved recording events (e.g. recording the times of fire alarms- EBPM), turning on equipment 10 minutes prior to the start of the meeting (TBPM) or remembering to amend diaries (e.g. when new items of post need to be sent, update post diary- ABPM). While it is possible that successful PM performance is somewhat reliant on episodic “tagging” of context relative to intentions (Paraskevaides et al. 2010), the magnitude of alcohol’s effects on TBPM and EBPM was similar. Unlike EBPM, TBPM would supposedly be less reliant on retrospective memory (Rendell et al. 2007) and the similarity of deficits on the two aspects, suggests that in the present study they are governed by similar systems. Executive planning emerged as a significant predictor of event and time-based PM. Previous research using non-immersive VR technology to assess executive functioning has also found a link between planning and PM performance (Sweeney et al. 2010). Burgess and Shallice (1997) have argued that the *type* of planning and not just planning per se is important for PM performance. In the present study, the score for planning was based on both written prescriptive elements (e.g. participants had to write a plan of action based on the tasks that had been left for them by the manager), and also environment-based elements (e.g. participants had to arrange the chairs in the meeting room so that everyone could see the board). It is likely that the more prescriptive elements of planning, such as writing and indeed following the plan of action contributed to performance in the PM subscales in the current study.

While the most likely moderator of PM performance itself is not only the executive planning of the task but the maintenance of task demands and attention to a visible clock, it is possible that prospective memory is to some extent governed by an internal clock and the efficiency of this clock in tracking time. Studies on human prospective timing have also shown that alcohol may affect internal clock speed (Ogden et al. under review), with higher doses (0.6g/kg) yielding mixed results. For example a dose of 0.6g/kg resulted in overestimations of time in a verbal estimation task, although this dose appeared to facilitate performance on a short-duration (400ms) temporal generalization task It is therefore suggested that administration of 0.6g/kg alcohol results in an increase in internal clock speed. However, the same was not seen for a dose of 0.4g/kg, and in future studies it would be beneficial to investigate the role of human timing in prospective memory performance.

The results in terms of intoxication were worthy of note. Participants were administered 0.4g/kg of alcohol; depending on bodyweight, this meant participants consumed between 2.75 – 4 UK units of alcohol. The BAC levels indicated that participants who received the alcoholic beverage were intoxicated. However, the absence of a group difference on the ARCI suggests that individuals in the alcohol group did not perceive themselves to be significantly more intoxicated than those in the placebo group (although mean scores are in the right direction). One possible explanation is that participants may have presented some tolerance to the effects of alcohol, as a result of regular previous exposure (all participants were regular social drinkers). Such behavioural tolerance has been shown between experienced and novice alcohol users, after administration of an alcoholic beverage. Fillmore & Vogel-Sprott (1996) found that alcohol administration impaired the performance of novice drinkers in a rotor pursuit task, but not that of experienced users. Therefore it would be interesting for future research to investigate the effects acute intoxication on heavy versus light drinkers using this paradigm.

There were however a number of limitations of the present study. Drinks were administered in a double-blind design, but we did not check the participants' and experimenter's beliefs on the content of the drink. Consequently it remains a possibility that the participants or the experimenter may have guessed which condition was being administered and acted accordingly. However, there were no group differences on the subjective intoxication scale. If participants in the alcohol condition had correctly guessed their beverage then one would expect that there would be significant group differences on this scale. In addition, previous research where the double-blind manipulation has been tested has shown that the participants and the experimenter may be able to correctly infer level of dosage, but are poorer at distinguishing alcohol from placebo (Bisby et al. 2010). A further limitation is that we cannot control for individual differences in the pharmacokinetic time course of alcohol, although many studies in this area follow a similar methodology (Leitz et al. 2009; Montgomery et al. 2010b; Paraskevaides et al. 2010; Schoenmakers et al. 2008). While we attempted to recruit non-illicit drug users, and all participants reported non-use of illicit drugs, it is possible that previous use of alcohol and/or drugs may have also affected the results.

In conclusion, the present study provides further support for the effect of alcohol intoxication on executive processes and prospective memory. The dose of alcohol used in the present study was modest suggesting that in real-world processes such as those in the virtual reality paradigm, impairments may be present at lower doses. Individuals who drink similarly modest amounts of alcohol outside the laboratory and attempt to perform routine duties (e.g. organising items in work, adapting to changing goals in their job, driving a car) may not realise that their performance will be impaired.

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None.

Conflicts of Interest

None

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Table 1

Subscales in the JAAM task

Scale	Description
Planning	Participants are required to order items in a logical manner and not due to their perceived importance. Therefore they have to decide which tasks would logically be carried out first, for example writing a plan of action based on the list of tasks left for them by their manager.
Prioritisation	Participants must order items according to their relative importance; for example they should order the items on the agenda so that the important ones will be discussed first.
Selection	Participants have to choose between two or more alternatives by drawing on previous knowledge. For example the participant has items of post which need to be sent to various destinations, and with differing urgency. Thus successful performance requires them to select the appropriate postal service based on the urgencies and type of mail.
Creative Thinking	Participants must look for solutions to problems using non-specified ways. For example, there is graffiti on the whiteboard. It is written in permanent ink and they must find a way to cover it.
Adaptive Thinking	Participants must achieve their goals in changing conditions of success. This requires them to propose suitable solutions to new problems as they arise.
Action-Based PM	Participants must remember to execute a task cued by a stimulus in the task they are already engaged with. For example, they receive a message about new items of post to be sent, and must update the post diary accordingly.
Event-Based PM	Participants must remember to perform a task cued by an event, for example noting the time of fire alarms on their notes for the manager.
Time-Based PM	Participants must remember to perform an action at a certain time point. For example participants must turn on the Overhead Projector 10 minutes before the start of the meeting.

Table 2

Scores for Alcohol and Placebo conditions on Background variables

	Alcohol		Placebo		p (sig.)
	Mean	S.D.	Mean	S.D.	
Age (years)	19.40	4.42	20.15	2.30	p>.05
Raven's Progressive Matrices (maximum 60)	46.87	6.13	51.51	4.45	p>.05
Epworth Sleep Scale (Maximum 24)	7.39	4.84	6.52	3.99	p>.05
Average Weekly Alcohol Use (Units)	4.30	1.66	4.44	1.60	p>.05
Depressed Mood	11.75	2.45	12.25	3.13	p>.05
Anxiety	12.30	3.80	12.75	3.67	p>.05
Arousal	20.60	3.35	20.75	3.91	p>.05
AUDIT	9.55	4.21	9.65	3.42	p>.05

Table 3: Indices of intoxication

	Alcohol		Placebo	
	Mean	SD	Mean	SD
ARCI (subjective Intoxication)	3.30	1.66	2.70	1.66
BAC 2	0.19	.07	0.00	0.00
BAC 3	0.20	0.17	0.00	0.00

Figure 1

JAAM Performance for the Alcohol and Placebo Conditions.