The effects of attentional lapses after alcohol consumption on performance; a pilot study

Frances Finnigan[1*], Jonathan Smallwood[2*] and Daniela Schulze[1]

[1] Department of Psychology
Glasgow Caledonian University
Glasgow G4 0BA

[2] Department of Psychology
University of British Columbia
Vancouver BC V6T 1Z4

[*]Joint Authors

This report shows the results of the influence of acute alcohol on attentional lapses whilst performing a sustained attention task. The sample consisted of 17 male and 7 female volunteers and the report is based on this data.

Although the sample size is small, the study did enable us to get an insight into the detrimental effects of acute alcohol ingestion on task disengagement. It is anticipated by the authors that, through the use of awareness probes in the context of the SART and a larger sample size we hope to shed further light on this phenomenon.

Introduction

During a cognitive task ones' attention often cycles between task relevant information available in the external environment and information that is derived from internal sources, such as when one is experiencing a day dream. During periods of rest whilst performing a cognitive task, which, it could be argued, is when attention is directed away from task relevant information, fMRI evidence suggests that it is likely that the individual is processing information derived from internal sources of information such as memories (Christoff, Ream & Gabrieli, 2004). In the literature, these spontaneous shifts in awareness have been variously described as stimulus independent thought (SI, Antrobus, 1968; Teasdale et al.,1995), task unrelated thought (TUT, Giambra, 1989, 1995; Smallwood, Obonsawin & Heim, 2003a; Smallwood, Baraciaia, Lowe & Obonsawin, 2003b; Smallwood, Obonsawin & Reid, 2003c; Smallwood, O'Connor, Sudberry & Ballantyre, 2004a;) zone outs (Schooler, Reichle, & Halpern in press; Schooler, 2002). Despite variations in terminology, these labels emphasise that periodically during a cognitive task ones' attention becomes "decoupled from the current environment and instead becomes directed to the processing of internally generated information" (Smallwood et al., 2003b, page 253). The interest of the present study is to determine whether task disengagement during a sustained vigilance task is influenced by acute alcohol ingestion. The importance of such a finding would be an important step in understanding the consequences of alcohol on safety conscious industries such as train or automobile driving.

The influence of alcohol on performance

Whilst it is well known that elevated blood alcohol level (BAL) impairs psychomotor performance on a range of tasks (e.g. Verster, van Duin, Volkerts, Schreuder & Verbaten2003; Moskowitz & Fiorentina, 2000; Koelega, 1995; Holloway, 1995; Finnigan & Hammersley, 1992), it is often the case that these effects are subtle and that even small amounts of alcohol impair performance on many common tasks, even when blood alcohol levels are at or below the legal limit for driving (e.g. West, Wilding, French, Kemp & Irving, 1993). Moreover, performance impairment can persist for at least two hours after drinking (Millar, Hammersley & Finnigan, 1992; Finnigan, Hammersley & Millar, 1995; Maylor, Rabbitt, James & Kerr, 1990; Rohrbaughet al., 1988) and perhaps much longer. Despite alcohol impairing performance on a range of tasks, there is a lack of consistent evidence that the acute administration of alcohol can impair reaction time to a target during a test of sustained vigilance (Hieshman, Araseth & Stitzer, 1997). For example, whilst both a Digit Symbol Task and word recall were impaired following the acute administration of alcohol, no difference was observed in a vigilance task (Heishman, Arasteh & Stitzer, 1997). Moreover, wide individual differences have been seen in the effects of alcohol on reaction time with some individuals showing faster and some individuals showing reaction times which did not vary from baseline (Hammersley, Finnigan & Millar 1994). This lack of consistent findings of the effects of alcohol on a simple reaction time task, particularly given the notion that alcohol is often described as the most likely cause of impaired driving, suggests that perhaps alcohol has more subtle effects which traditional tasks fail to detect (Borkenstein, Crowther, Shumate, Ziel & Zylman, 1974; Borkenstein, 1985; Moskovitch, Daily & Henderson, 1974).

Predicting alcohol impairment.

It has also been shown that performance at a given time is very poorly correlated with blood alcohol when both performance and BAL were recorded over time. Studies which have charted performance across the ascending and descending limbs of the blood-alcohol curve tend to show characteristic patterns whereby following ingestion of alcohol, the blood-alcohol level increases to a peak which is generally associated with maximal impairment of performance. Although BAL then declines on the descending limb of the curve, there is generally not a parallel reduction in the degree of performance impairment. For example, Millar et al. (1992) showed that reaction time was slowed to about 112% of baseline after a dose of about 40mg% BAL, but this impairment did not improve as BAL reduced over time. By 120 minutes after drinking, performance was still at 115% baseline, whereas BAL had reduced to below 10%mg% from peak. Furthermore, performance could be better predicted from initial alcohol dose than from current BAL. These issues make it difficult to determine the extent to which BAL can be indicative of current levels of impairments.

What is perhaps the greatest concern for our ability to prevent the detrimental effects of alcohol, however, is the dissociation between subjective ratings of alcohol intoxication and objective measures of both BALs and performance deficits. In general, subjects rate themselves most drunk within the first 15 minutes of drinking and progressively rate themselves less intoxicated despite their rising blood alcohol concentrations. (Hammersley et al., 1994). Despite this reduction in subjective impairment, Maylor and colleagues (Maylor & Rabbitt 1987; Maylor, Rabbitt & Connolly,1989) have shown that the detrimental effects of alcohol on the rate of processing are independent of practice or cognitive judgements. Similar to BAL, therefore, subjective intoxication does not provide a reliable index of acute alcohol impairment.

The evidence from the research and real life situations demonstrates the detrimental effect of alcohol is conclusive. While alcohol readily impairs performance, to date little evidence has supported impairment on tests of sustained attention. Moreover, it has too often been assumed that there is a simple correlation between dose, current BAL and impairment and also subjective and objective measures of BAL. However, it is clear from the findings discussed, this is not the case.

A recently developed task, the Sustained Attention to Response Task (SART) has been shown to be sensitive to the experience of everyday attentional lapses as measured by the Cognitive Failures Questionnaire (CFQ, Robertson, Manly, Andrade, Baddeley & Yeind, 1997). It has also been shown to be sensitive to the experience of task disengagement as measured by a thought sampling methodology (Smallwood et al., 2004b, Experiments 1 and 2) and retrospective self report (Experiment 3). During the SART task participants are presented with a random series of digits (0-9) on a VDU screen. The participant is asked to respond to a frequent non-target stimulus by pressing a button and inhibiting their responses whenever an infrequent target, such as the digit 3, appears on the screen. To perform this task correctly, the individual must remain "sufficiently attentive to their responses, such that at the appearance of a target they can substitute the directly antagonistic response" (Manly, Lewis, Robertson, Galloway & Hawkins, 1999, page 664). Recent research using thought sampling techniques has confirmed that periods in which transcribed verbal reports indicate attention has left the task are associated with errors on the SART (Smallwood et al., 2004B) and co-vary with physiological indices implicated in task disengagement, such as GSR (see also O'Keefe, Dockree & Robertson, 2004). In order to address the issue of the role played by attentional lapses during task performance after alcohol ingestion, the present study employed this task of sustained attention under alcohol and placebo condition

Method

Ethical Approval

The study was approved the university's Psychology Department Ethical Committee.

Participants

A total of 17 male and 7 female volunteers (see Table 1 for demographic details) were recruited by local advertising in and around the university. Females were specifically included in this study because data on alcohol and ingestion are seriously lacking in this area. Females were given a pregnancy test (Predictor Pregnancy, PredictorFrameset) to ensure that they were not unknowingly pregnant. All volunteers gave their informed consent to participate. Inclusion depended upon satisfactory completion of a health-check questionnaire, a history of moderate social drinking (a score of less than 3 on Short Michigan Alcoholism Screening Questionnaire [SMAST]: Selzer, Vinokur & Van Rooijen, 1975) and absence of current medication. Participants received a £15 disturbance allowance, £5:00 taxi fare and £5:00 food voucher (redeemable by the university refectory) on completion of the study. Participants were free to terminate the study without reason at any time.

Design

A between-group design was employed to avoid the asymmetrical transfer of treatment effects which often afflict within-subjects designs (Armitage & Hills, 1982; Cotton, 1989). Subjects were allocated at random to either to the alcohol (n=12) or control (n=12) condition.

Alcohol

Alcohol was administered as vodka (37% v/v/ ethanol). Doses were calculated per litre of body water computed from height, weight and age, which as been advocated as a more accurate method than body weight alone (see Watson, Watson & Batt, 1981). The dose was chosen to achieve peak BAL of 80mg/100ml. The alcohol was mixed with an equal volume of water and diabetic orange juice (Robinsons Orange No Added Sugar). For placebo and alcohol mixtures, 4 ml of vodka was floated on the surface of the drink and the rim of the glass was swabbed with alcohol. In order to mask any taste of alcohol, the procedure of Fagan, Tiplady & Scott(1987) was followed whereby all participants first sucked a 5mg benzocaine 'Tyroset' lozenge and a menthol flavoured cough sweet 'Halls Mentholyptus extra strong' before ingesting the mixture. BALs were assessed using a Lion Alcometer,SD 400 series (Lion Laboratories, Cardiff, Wales) which was calibrated at weekly intervals.

Tasks

Participants performed the standard SART (Robertson et al., 1997), which consisted of single digit alpha numeric stimuli (X or Y) presented in the centre of a VDU against a black background. The target stimulus was the digit Y. All stimuli were non-masked and presented on the screen for 1000ms. The inter-stimulus interval (ISI) was 1000ms, during which time the screen was blank. The rate of stimuli presentation was comparable with that employed on standard SART tasks (see Robertson el al., 1997). In the present study, the duration of each test session on the task was ten minutes. There was a short practice session before the first task.

Questionnaires

Participants also completed the Thinking Content component of the Dundee Stress State Questionnaire (DSSQ; Matthews, Joyner, Gililand, Campbell, & Faulconner, 1999**)** which is a sixteen-item questionnaire that considers the content of thinking during a recently completed task. The instrument assesses (i) Task Appraisal (e.g. 'I thought about how I should work more carefully' or 'I thought about by level of ability' and (ii) Task Disengagement (e.g. 'I thought about my personal worries' or 'I thought about something than happened earlier today'). Each item contains eight factors which are measured on a five-point Likert scale ranging from 'Never' to 'Very Often'. Participants also completed a seven day retrospective drinking diary and a drinking history questionnaire. Subjective mood as assessed by an 11-item Subjective Feelings Questionnaire (Hammersley, Finnigan & Millar, 1994).

Procedure

Participants were required to abstain from alcohol, drugs and mediation for 24hours prior to test day. In order to control for stomach content, participants were instructed to refrain from eating or drinking anything except water for 4 hours prior to test. Smokers were requested to have their last cigarette one hour prior to test.

Upon arrival at the laboratory, participants gave informed consent to participate in the study. They were breathalysed, firstly, to ensure blood alcohol levels were zero and secondly, to familiarise them with the breathalysing procedure. Females were then asked to take a pregnancy test. Volunteers were then randomly assigned to an alcohol/placebo condition. Demographic details were obtained. They then completed a practice session on the SART, consisting of ten non-target and two target stimuli presented in a random order. Pilot studies had shown that such practice provided good performance stability. Following practice, baseline SART performance measures were obtained. Participants consumed the 'Tyrozet' and 'Hall' lozenges during baseline testing. They were then presented with their drink, which had to be consumed within 10 min. All drinks were prepared out-with the laboratory. Over the following 10 min participants completed the questionnaires and drinking diaries.

To ensure that our study measured the effects of alcohol over the ascending and descending limbs of the blood alcohol curve (BAC) and at peak, testing commenced and continued every 20 minutes over an 80 minute period (giving five data points for each participant) with BAL and subjective feelings measured before each testing session and the thinking component of the DSSQ assessed at the end of each test session. After the final breath test (2h after drinking), participants were debriefed, given tea/coffee and directed to the university refectory to offset the effects of fasting.

Results

Table 1 contains demographic information, physical characteristics and drinking history information. Independent sample t-test on these variables revealed no significant group differences ($p>0.01$ for all comparisons).

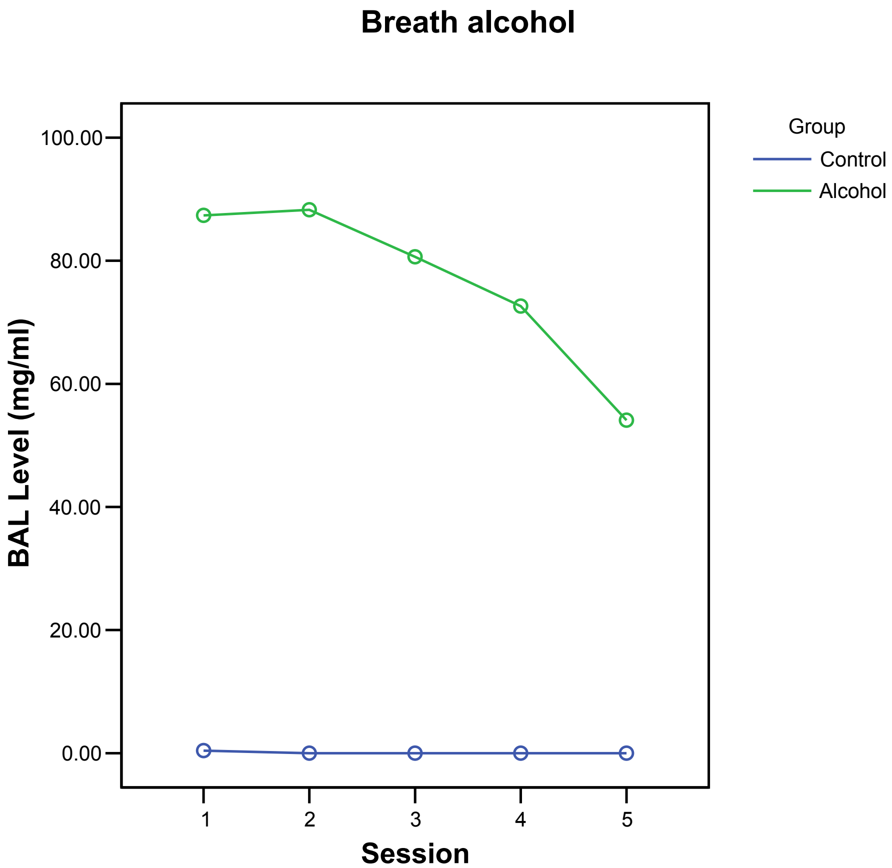
Effects of alcohol over the BAC.

Figure 1 shows BAL over the 80-minute observation period as a function of alcohol dose. As expected, there was no evidence of alcohol ingestion for those who had ingested placebo. It is relevant to note that, despite the use of an accurate computation to achieve a given BAL, some participates achieved a marginally higher BAL than targeted. It may be that Watson et al's. (1981) formula has yet to be established when breath, rather than blood, is sampled. A mixed ANOVA indicated that the difference between the two groups was reliable [$F(1,21)=520$, $p<0.0001$]. A test session by group interaction was significant, indicating that blood alcohol levels for those in the alcohol group decreased systematically over the course of the five test sessions [$F(4,87)=17.2$, $p<0.001$].

Table 1. Description of the individuals allocated to the Control and Alcohol conditions

	Group	Mean	Std.Dev
Age in years	Control	27.83	6.81
	Alcohol	29.92	7.86
SMAST	Control	0.50	0.80
	Alcohol	0.58	0.67
Weight in kg	Control	70.50	15.62
	Alcohol	71.08	13.29
Height in cm	Control	173.67	7.15
	Alcohol	171.75	5.53
Years in Education	Control	16.92	3.60
	Alcohol	18.42	3.65
Previous week's drinking: Quantity in units of alcohol	Control	20.83	19.79
	Alcohol	31.54	14.91
Previous week's drinking: Frequency in drinking sessions	Control	2.67	2.10
	Alcohol	3.83	1.34
Age first alcoholic drink in years	Control	13.17	2.92
	Alcohol	13.42	3.94
Age first drunk in years	Control	15.00	2.04
	Alcohol	14.92	3.82
Age started drinking at current levels in years	Control	18.33	1.72
	Alcohol	19.58	3.73
Self-reported Quantity consumed during an average drinking session in units	Control	10.33	10.36
	Alcohol	8.45	5.52
Self-reported Frequency of drinking in drinking sessions	Control	2.44	1.90
	Alcohol	3.21	1.67

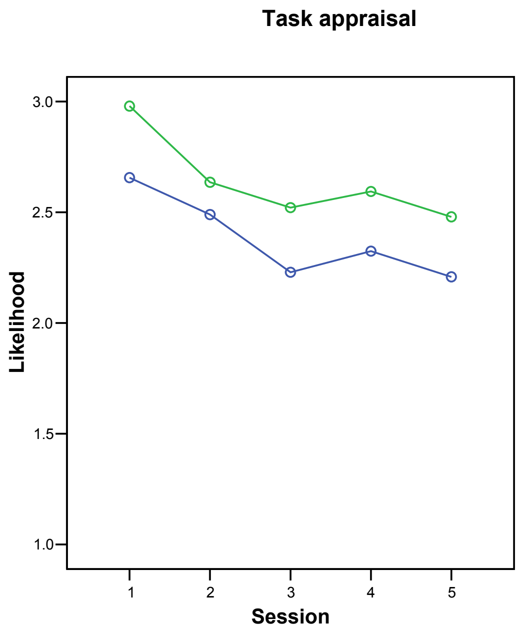
Figure 1. Blood alcohol levels assessed by breath analysis as a function of alcohol dose. Alcohol was administered to approximate blood alcohol level of 80 mg/100 ml (see text).

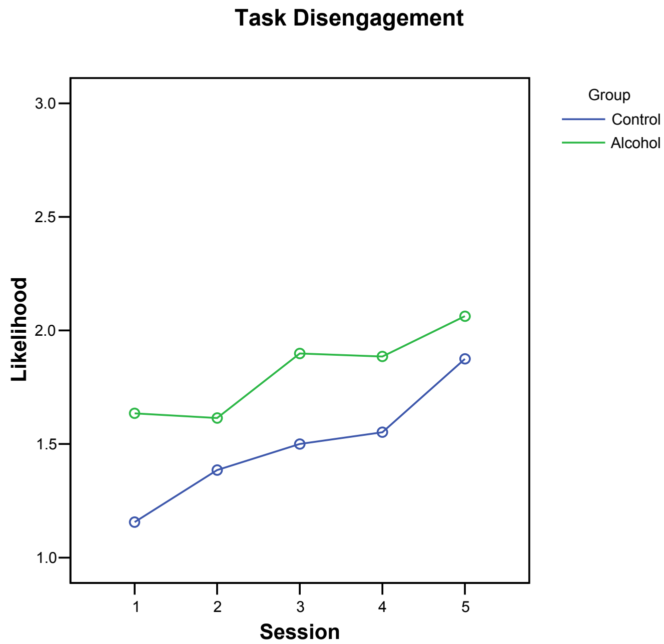


Verbal Reports as a Consequence of Group

The frequency with which each group reported 'task appraisal' and 'task disengagement' is presented in Figure 2 (A & B). Mixed ANOVA revealed no group differences in the frequency for 'task appraisal' although a general decrease in this measure was observed for both groups over the five test sessions [$F(4,88)=3.55$, $p<0.01$]. By contrast, the analysis of 'task disengagement' indicate an increase in this measure over the same test period [$F(4,88)=5.7$, $p<0.01$]. In addition, marginally higher levels of 'task disengagement' were reported for those participants in the alcohol condition [$F(1,22)=2.9$, $p=0.09$]. Individual ANOVA conducted for each test session of the task over the 80-minute test period of this group revealed that the self reported higher levels of 'task disengagement' was significant during the first test session only [$F(1,22)=4.38$, $p<0.05$).

Figure 2. The likelihood of verbal reports of task appraisal (Top) and task disengagement (Bottom) over the five sessions of the task.

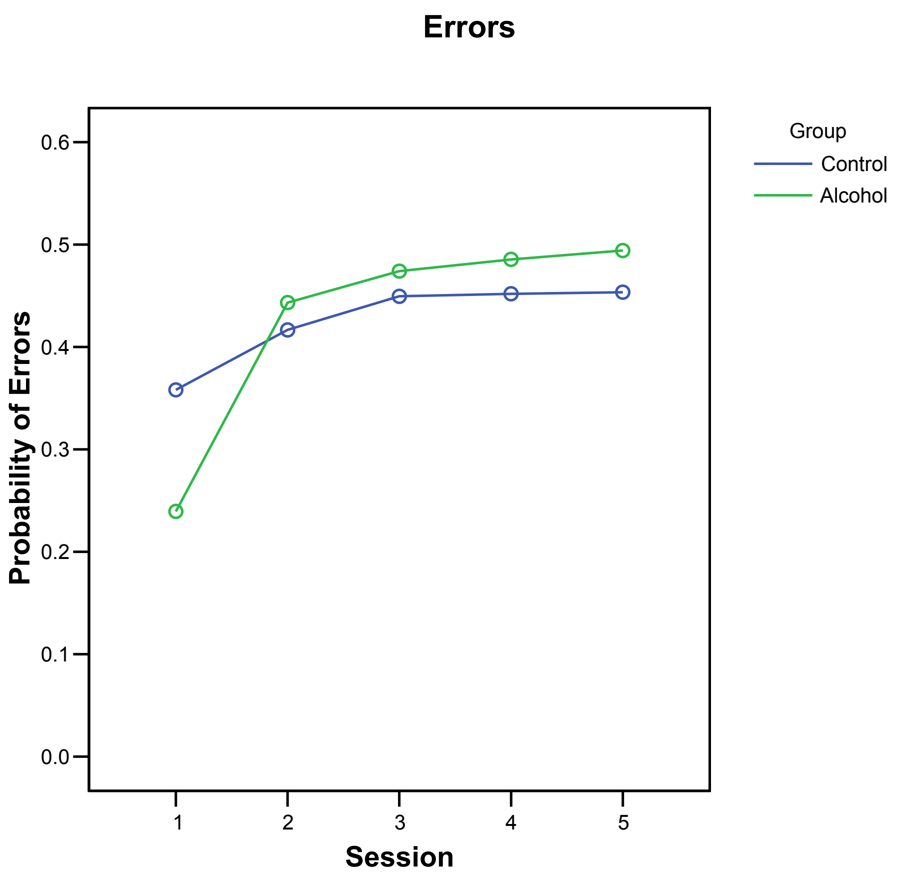




Behavioural Performance as a Consequence of Group.

The consequences of alcohol ingestion on the probability of making errors on the SART over time are presented in Figure 3. Mixed ANOVA revealed a significant interaction between the effects of alcohol and SART over time [$F(4,80)=3.6$, $p>0.05$). Separate ANOVAs for each group revealed a reliable increase in this probability over the five test sessions for the alcohol condition [$F(4,36)=16.9$, $p<0.01$]. This session effect was not revealed for the control group.

Figure 3. Probability of an error over the course of the experiment.



Discussion

The results of this pilot study clearly indicate that the SART is a sensitive measure to the sedative effects of acute alcohol ingestion. As can be observed from Figure 3, participants in the alcohol condition showed a statistically significant increase in errors across the five test session. Whilst an increase in errors was also observed for those in the control group, this effect was not significant. In addition, verbal reports (see Figure 2) indicated a higher level of subjective accounts of 'task disengagement' for those the in alcohol condition, however, this effect was significant for the initial testing session only. There were no significant group differences for 'task appraisal'. Although a significant effect was revealed for both verbal reports of 'task engagement' and probability of errors on the SART and both of these measures showed a linear increase over the five test sessions, the actual relationship between these two measures and the acute effects of alcohol were inconsistent. For example, the acute alcohol group showed a higher level of 'task disengagement' in the session directly after alcohol ingestion, whereas the frequency of errors on the SART showed an increase over time. One explanation for this may be that self reports of performance are based initially on the physiological effects of alcohol and this influences participants' awareness and subsequent verbal report which is compensated for across time, whereas, this might not be possible for actual performance. For example, as mentioned above, Hammersley et al. (1994) found that participants rated themselves most drunk within the first 15 minutes of drinking and progressively rated themselves less intoxicated across time despite their rising blood alcohol concentrations.

A second reason for this partial dissociation between the acute effects of alcohol between the two measures may reflect the nature of awareness. For example, Schooler (2002) suggests that, at various points during task performance, an individual may lack meta-awareness that their attention has left task-relevant processing. It is possible that the acute effects of alcohol on 'task disengagement' are such that they prevent the individual becoming aware that their attention has drifted from the task. Recent work by Sayette, Schooler & Reichle (in press) lends support to this explanation. These authors report findings which suggest that alcohol can dissociate an individual's attention away from a task without any change in likelihood that this phenomenon is reported by the individual in question.

It should be noted that the sample size employed in the present investigation is small, and thus, the explanatory power of the above explanations in relation to the current findings are, at present, tentative. However, the results add support to the theoretical perspective that acute alcohol ingestion leads to an increase in level of task disengagement whilst performing a task which requires sustained attention. This argument is consistent with the suggestion in the literature (Finnigan, Smallwood, Schulze & Helanders, submitted; Finnigan & Schulze, 2003) which proposes that one reason why it is difficult to detect the detrimental effects of acute alcohol ingestion is because the tasks employed are not sensitive to the drug's sedative effects. In the main, it is argued that certain tasks may encourage the individual to completely engage with the task. In certain tasks which are relatively undemanding and yet require the deployment of attentional resources over a prolonged period of time the detrimental consequences alcohol may arise from the individual's inability to maintain their attention on the current situation.

To conclude, although the sample size in the current study is small, it did enable us to get an insight into the effect of alcohol in situations where individuals remain sufficiently attentive to their own responses such that, at the appearance of a crucial target, they can substitute the antagonistic, but correct, response (Manly, et al., 1999; Manly, Lewis, Robertson, Watson & Datta, 2002). It is anticipated by the authors that, through the use of awareness probes in the context of the SART (Smallwood et al., 2004b) and a larger sample size, a fuller account of the detrimental effects of acute alcohol ingestion on 'task disengagement' will shed further light on this phenomenon.

References

Antrobus. J. (1968). Information theory and stimulus independent thought. *British Journal of Psychology, 59,* 432-430.

Armitage, P. & Hills, M. (1982). The two-period crossover trial. *The Statistician,* 31, 119-131.

Borkenstein, R. F., Crowther, R. F., Shumate, R. P., Ziel, W. B. & Zylman, R. (1974). The role of the drinking driver in traffic accidents. *Blutalkohol, 11,* 1-132.

Borkenstein, R. F. (1985). Driver Characteristics and Impairment at Various BACs. Journal of Studies on Alcohol, *Suppl. 10,* 3-12.

Christoff, K., Ream, J.M. & Gabrieli, J.D.E. (2004) Cognitive and neural basis of spontaneous thought processes. *Cortex*, *40*, 623-630.

Cotton, J. W. (1989). Interpreting data from two-period crossover design. *Psychological Bulletin*, 106, 503-515.

Fagan, D., Tiplady, B. & Scott, D.B. (1987). Effects of ethanol on psychomotor *performance. British Journal of Anaesthesia, 59, 961-965.*

Finnigan, F. & Hammersley, R.H. (1992). Effects of alcohol on performance. *In:* Jones, D. M. & Smith, A. P.(Eds). Factors affecting human performance. London: Academic Press.

Finnigan, F., Hammersley, R. H. & Millar, K. (1995). The effects of expectancy and alcohol on cognitive-motor performances. *Addiction, 90,* 661-672.

Finnigan, F., Schulze, D., Smallwood, J. & Helanders, (2004). The effects of self-administered alcohol induced hangover attained in a naturalistic setting on psychomotor and cognitive performance and subjective state. (*Submitted to Addiction).*

Finnigan, F., & Schulze, D. (2003). An examination of the effects of self-administered alcohol induced hangover in a naturalistic setting. *Final Report Submitted the Alcohol Education and Research Council.*

Giambra, L. M. (1989). Task-unrelated-thought frequency as a function of age: A laboratory study. *Psychol. Aging, 4*(2), 136-143.

Giambra, L. M. (1995). A laboratory method for investigating influences on switching attention to task-unrelated imagery and thought. *Consciousness and Cognition, 4,* 1-21.

Hammersley, R.H., Finnigan, F. & Millar, K. (1994). Individual differences in the acute response to alcohol. *Personality and Individual Differences*, *17*, 497-510.

Heishman, S. J., Arasteh, K. & Stitzer, M. L. (1997). Comparative effects of alcohol and marijuana on mood, memory, and performance. *Pharmacology, Biochemistry & Behaviour, 58(1),* 93-101.

Holloway, F. A. (1995). Low–dose alcohol effects on human behaviour and performance. *Alcohol, Drugs Driving, 11*, 39-56.

Koelega, S. (1995). Alcohol and vigilance performance: A review. *Psychopharmacology, 118*, 233-249.

Manly, T., Robertson, I.H., Galloway, M., Hawkins, K (1999) *The absent mind: Further investigations of sustained attention to response.* Neuropsychologia, 37, 661-670.

Manly, T., Lewis, G.H., Robertson, I.H., Watson, P.C., Datta, A.K. (2002). *Coffee in the cornflakes: Time-of-day, routine response control and subjective sleepiness,* Neuropsychologia, *40*(1), 1-6

Matthews G, Joyner L, Gililand K., Campbell S.E. & Faulconner S. (1999). Validation of a comprehensive stress state questionnaire: Towards a state "Big three"? *In*: I. Mervielde, I.J. Deary, F. De Fruyt, & F. Ostendorf (Eds). *Handbook of Coping: Theory, research and applications. (pp 333-350). Tilburg Netherlands: Tilburg University Press.?*

Maylor, E. A., Rabbitt, P. M. A., James, G. H. & Kerr, S. A. (1990). Effects of alcohol and extended practice on divided-attention performance, *Perception and Psychophysics, 48*(5), 445-452.

Maylor, E.A., Rabbitt, P.M.A. & Connolly, S.A.V. (1989). Effects of alcohol and extended practice on divided-attention performance. *Perception and Psychophysics, 45,* 431-438.

Maylor, E.A., & Rabbitt, P.M.A. (1987). Effects of practice and alcohol on performance of a perceptual-motor task. *Quarterly Journal of Experimental Psychology,* 39A, 777-795.

Millar, K., Hammersley, R.H., & Finnigan, F. (1992). Reduction of alcohol-induced performance impairment by prior ingestion of food. *British Journal of Psychology, 83,* 261-278.

Moskowitz, H. & Fiorentina, D. (2000). A review of the scientific literature regarding the effects of alcohol on driving-related behavior at blood alcohol concentrations of 80mg/dl and lower. *Report HS-809-028.* US Department of Transport, National Highway Traffic Safety Administration: Washington, DC.

Moskowitz, H., Daily, J. & Henderson, R. (1974). Acute tolerance to behavioral Impairment by Alcohol in Moderate and Heavy Drinkers. *Report HS-009-2-322.* Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration.

O'Keefe, F., Dockree, P. & Robertson, I. H. (2004). Awareness deficits in traumatic brain injury mediated by impaired error processing? Evidence from electrodermal activity. *Journal of Cognitive Neuroscience*, Supplement 31

McMurran, M., Parasuraman, R., Frowein, H. W., Adinoff, B., Varner, J.L., Zubovic, E.A., Lane, E.A., Eckardt, M.J., & Linnoila, M (1988). Alcohol intoxication reduces visual sustained attention. *Psychopharmacology*, *96*, 442-446.

Robertson, I.H., Manly, T., Andrade, J., Baddeley, B. T. & Yiend, J. (1997). Oops: Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. *Neurospsychologia*, 35, 6, 747-758.

Sayette. M., Schooler, J.W. & Reichle E.D. (in press). The effects of alcohol on self and probe caught episodes of zoning-out. Unpublished manuscript. University of Pittsburgh.

Schooler, J.W. (2002). Representing consciousness: Dissociations between consciousness and meta-consciousness. *Trends in Cognitive Science*, *6*, 339-344.

Schooler, J.W., Reichle, E. D. & Halpern, D. V. (in press). Zoning-out during reading: Evidence for dissociations between experience and meta-consciousness. Daniel Levin (Eds) *Visual Meta-Cognition: Thinking About Seeing*. Praeger.

Selzer, M. L., Vinocour, A. & Van Rooijen, L. (1975). A self-administered Short Michigan Alcohol Screening Test (SMAST). *Journal of Studies on Alcohol, 36*, 117-126.

Smallwood, J., Obonsawin, M.C. & Reid, H. (2003c). The effects of block duration & task demands on the experience of task unrelated thought. *Imagination, Cognition and Personality, 22, 13-31.*

Smallwood, J., Baraciaia, S.F., Lowe, M. & Obonsawin, M.C. (2003b). Task unrelated thought whilst encoding information. *Consciousness and Cognition, 12, 452-484*.

Smallwood, J., Obonsawin, M.C. & Heim, S.D. (2003a). Task Unrelated Thought: the role of distributed processing. *Consciousness and Cognition, 12, 169-189.*

Smallwood, J., O'Connor R. C., Sudberry, M. V. & Ballantyre, C. (2004a). The consequences of encoding information on the maintenance of internally generated images and thoughts: The role of meaning. *Consciousness and Cognition, 4*, 789-820.

Smallwood, J., Davies, J. B., Heim, D, Finnigan, F. Sudberry, M. V., O'Connor, R. C. & Obonsawain, Initial?.(2004b). Subjective experiences and the attentional lapse. Task engagement and disengagement during sustained attention. *Consciousness and Cognition, 4*, 789-820.

Teasdale, J.D., Dritschell, B.H., Taylor, M.J., Proctor, L., Lloyd, C.A., Nimmo-Smith, I. & Baddeley, A.D. (1995). Stimulus Independent Thought depends upon central executive resources. *Memory & Cognition.Issue?*

Verster, J.C., van Duin, D., Volkerts, E.R., Schreuder, A.H.C.M.L. & Verbaten M.N. (2003). Alcohol hangover effects on memory functioning and vigilance performance after an evening of binge drinking. *Neuropsychopharmacology, 28 (4) 740-746.*

Watson, P.E., Watson, I.D. & Batt, R.D. (1981). Prediction of blood alcohol in human subjects. *Journal of Studies on Alcohol, 42*, 547-556.

West. R., Wilding, J., French, D., Kemp, R. & Irving, A. (1993). Effects of low and moderate doses of alcohol on driving hazard perception latency and driving speed. *Addiction*, *88*, 527-532.