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Effects of Alcohol on Subjective Ratings of Prospective and Everyday Memory Deficits

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## Abstract

**Background:** Research has shown that heavy alcohol use has a detrimental effect on retrospective memory. Less is known about the effect of alcohol on everyday memory.

**Method:** The present study examined self-ratings of two aspects of memory performance: prospective memory, for example, forgetting to pass on a message and everyday memory, measured by cognitive failures, such as telling someone a joke that you have told them before. To ensure anonymity and expand on the numbers of participants used in previous studies, data was collected using the Internet. Data from 763 participants remained after data screening.

**Results:** After controlling for other drug and strategy use, there was clear evidence that differential use of alcohol was associated with impairments in the long-term aspect of prospective memory and in an increased number of cognitive failures.

**Conclusions:** These results support and extend the findings of previous research: our findings are consistent with the idea that heavy use of alcohol does have a significant and negative impact on everyday cognitive performance. Possible causes of these impairments are discussed.

**Key words:** alcohol, prospective memory, PMQ, everyday memory, cognitive impairment

## Introduction

Several researchers have observed the presence of cognitive and neuropsychological deficits in heavy users of alcohol. These impairments include difficulties with problem solving and decision-making (Leckliter & Matarazzo, 1989; Selby & Azrin, 1998), and in a range of memory functions. For example, chronic heavy alcohol users and alcohol-dependent individuals show impaired performance on tasks such as learning word lists (Grant, 1987; Bachara et al., 2001), short- and long- term logical memory (Selby & Azrin, 1998), general working memory (Ambrose et al., 2001) and executive function (Wendt & Risberg, 2001). However, such research into memory dysfunction has tended to focus on laboratory and/or field tests of retrospective memory in which the learning, retention and retrieval of previously presented target material is examined. Although research on laboratory-based cognitive tasks can be very informative, it is also important to establish how memory function is affected in an everyday context.

Two important aspects of day-to-day memory function are prospective memory and cognitive failures. Prospective memory (PM) is the process of remembering to do things at some future point in time (Brandimonte et al., 1996). Examples of prospective memory include remembering to attend a particular function such as a party, or to carry out a particular task like remembering to pay a bill on time. PM has only recently been subjected to systematic empirical research ranging from laboratory studies to self-rated assessments (e.g. Brandimonte et al.; Ellis, et al., 1999). The Prospective Memory Questionnaire (PMQ), developed by Hannon et al. (1995) is a self-rating scale that requires participants to record the number of times their prospective memory has failed

them within a period of time. The PMQ contains a number of subscales which measure various aspects of memory. The PMQ has proved to be a useful tool in estimating the effectiveness of PM in a number of settings. These include assessing the impact of personality differences (Heffernan & Ling, 2001), as a neuropsychological instrument in the study of brain damaged patients (Hannon et al., 1995), and in self-rated prospective memory impairments in regular ecstasy users (Heffernan et al., 2001). In addition, the PMQ correlates well with objective measures of prospective memory (Hannon et al., 1995). The Everyday Memory Questionnaire (EMQ) was developed by Sunderland et al. (1983) and focuses on common memory lapses in everyday activities such as telling someone a story or joke that you have already told them, or having to go back and check whether you have done something that you meant to do.

There is some evidence to suggest that chronic heavy alcohol users show detriments in remembering within an everyday context (Knight & Godfrey, 1985). Given this and the evidence that retrospective memory is impaired in this group, one might expect that they would report more impairments in prospective memory when compared to a sample of low-dose/non-alcohol users. In one of the few studies to examine the effect of heavy alcohol use on everyday cognitive performance, Heffernan et al. (2002) investigated the prospective memory of heavy alcohol users (those who had consumed more than the recommended weekly number of units over a period 5 years or more) and found global impairments in comparison to a control group of low- or non-users. However in their study the sample was relatively small (30 in each condition) and participants were only compared across two groups, of high and low users. In addition, previous research has demonstrated that use of drugs can have an impact on cognitive

performance (e.g. Rodgers et al., 2001), and this use may covary with alcohol use. The present study therefore employed a web-based methodology (for further details see Rodgers et al. and below) in order to access a greater number of participants as well as obtain data related to concomitant drug use. A web-based design allows the effect of self-reported alcohol use on cognitive performance to be assessed while controlling for use of other substances at the same time as obtaining a degree of statistical power not possible in previous research.

The present investigation therefore partially replicates the Heffernan et al. (2002) study using a significantly larger data set. This will allow a more detailed investigation of the possible contribution of a number of psychoactive substances to the presence of self-reported neuropsychological difficulties and allows a detailed exploration of the magnitude of any reported impairment on day to day living.

This study also aims to extend our knowledge of potential memory deficits resulting from heavy alcohol use, focusing here on self-rated errors of prospective memory, using both the EMQ and PMQ. If chronic heavy alcohol consumption does have an adverse effect on prospective memory, then one would expect this group to report significantly greater errors in their prospective memory functioning when compared to a low dose/alcohol-free group.

## Method

### Participants

Data from 763 participants remained after data screening was conducted (see below). Of these, 465 (60.9%) were female. The modal age group was 21-25 (32%). The

majority of respondents came from Europe (71%). Many were well educated having some University or college education (31%). The majority of participants (n = 606; 79.4%) stated that they drank at least some alcohol during a typical week. One hundred and fifty-seven participants (20.6%) drank no alcohol, 318 (41.7%) drank 1-9 units each week, 227 (29.8%) drank between 10 and 25 units every week, and 61 (8%) drank above 25 units.

### Materials

A website was created for the purposes of data acquisition. It was hosted on the University of Westminster web server, and could be accessed via a number of different addresses (e.g. [www.drugresearch.org.uk](http://www.drugresearch.org.uk)).

Memory was assessed using two self-report questionnaires. The first was the Everyday Memory Questionnaire (EMQ). This is a valid and reliable self-report measure of common memory lapses in everyday activities (Sunderland et al., 1983) comprising of 27 statements. Participants respond on a nine-point scale ranging from 'Not at all in the last six months' to 'More than once a day'. There are no sub-scales within this questionnaire. The higher the score the more forgetting is evident. Statements include "telling someone a story or joke that you have told them once already" and "forgetting where things are normally kept or looking in the wrong place for them".

Prospective memory was assessed using the Prospective Memory Questionnaire (PMQ), which is a valid and reliable self-report measure (Hannon et al., 1995). The PMQ provides measures of three aspects of PM on a series of nine-point scales. Fourteen questions measure short-term habitual PM (e.g. "I forgot to turn my alarm clock off when I got up this morning"). Fourteen items measure long-term episodic PM (e.g. "I forgot to pass on a message to someone"). Ten questions measure internally-cued PM (e.g. "I



forgot what I wanted to say in the middle of a sentence”). The PMQ provides a measure of self-reported errors in the previous week, or month or year, depending upon the specific questionnaire item. These scales range from 1 to 9, with greater scores indicating the more faulty one’s prospective memory. In addition, 14 further questions make up the ‘techniques to remember’ scale which gives a measure of the number of strategies used to aid recall. Scores on this scale also range from 1 to 9; higher scores indicated greater use of memory aids. The strategy scale was included since differences in PM are associated with differences in strategy use (Hannon et al., 1995).

Alcohol and other drug use were assessed with a version of the UEL Recreational Drug Use Questionnaire (Parrott, 2000). Respondents estimated their level of use of alcohol as well as other drugs (tobacco ecstasy, amphetamines, cocaine, LSD, barbiturates, opiates, magic mushrooms, anabolic steroids, solvents and cannabis). This was slightly modified for use on the Web with some drug descriptions amended to make it more suitable for an international sample. Participants were required to select a typical frequency from a drop-down menu. For all questions regarding drugs, a ‘prefer not to answer’ option was also included. The alcohol question read “Alcohol: roughly how many units of alcohol do you drink in a typical week? (One unit = half-a-pint of beer, glass of wine, or measure of spirits)”. In response, participants could select ‘0 units per week’, ‘1-9 units per week’, ‘10-25 units per week’, ‘More than 25 units per week’, or ‘Prefer not to answer’.

**Table 1 about here**

Participants also answered a number of demographic questions (age, sex, location, occupation and education) and questions relating to their participation (how they found out about the study, whether they were currently under the influence of any substance, and whether there was any reason their data should not be used in analyses). All of these instruments were presented as interactive forms on a single Web page. The final variable measured was mistakes made when completing the questionnaire. If participants submitted an incomplete form (i.e. left one or more questions blank) they were automatically informed of this and requested to supply the missing data then resubmit the form. The number of times each participant made such a mistake was recorded.

Ethical approval for the study came via University of Westminster. There was a brief introduction to the study that also explained that participants' responses were both voluntary and confidential. Each participant clicked an informed consent button on the web site reading "I understand the nature of the study and wish to continue".

#### Procedure

Participants were recruited using a variety of methods. These included messages posted to relevant Internet discussion groups, links from other online experiments, notices on WWW pages and announcements in our home institutions. Participants first saw an informed consent page. Via this page participants were informed that the study was designed to investigate everyday behaviour and recreational drug use. They were informed that the study aimed to look at the potential effects of using various drugs (such as alcohol, tobacco, cannabis, and so on) and that the study focused on those who use various drugs and those who do not use any of these such drugs. There was also a link to a statement on anonymity and confidentiality. This assured participants that individual

respondents would be unidentifiable and that they could select “prefer not to answer” options where appropriate.

To continue, participants clicked on a button labelled “I understand the nature of the study and wish to continue”. Having clicked on this, participants then saw a page bearing brief instructions, demographic items, the EMQ, PMQ and drug use questionnaires, and questions about their participation. Having completed all the items, they then clicked on a button labelled “Finished” at the bottom of the page.

Participants who had not answered all the questions then saw a page indicating this, and asking them to return to the form and fill it out completely prior to resubmission. Those who had answered all the items saw a debriefing page. This thanked them, outlined the purpose of the study, provided links to several Web sites with information about drugs, and also a link to a page where a summary of results would be posted on conclusion of the study. An email contact address was also provided for respondents who wished to submit feedback or ask questions.

#### Data screening and processing

Multiple submissions were detected by logging the respondent's IP address (the unique Internet address of their computer) and deleting multiple responses from the same IP (for ethical reasons IP addresses were not stored in the same file as information about drug use). Also flagged were instances where participants indicated they were under the influence of some substance or that there was some reason their data should not be used. Application of these criteria led to the exclusion of 435 of the initial 1199 submissions.

Fraudulent or mischievous data entry was controlled for, as much as possible, by using demographic information to screen out clearly implausible responses (e.g. very young respondents claiming to have doctoral degrees). One response (a person in the 16-20 age group claiming to have postgraduate education) was excluded on these grounds.

## Results

Prior to analysis, the psychometric properties of the EMQ and the subscales of the PMQ were examined. According to Hannon et al. (1995), the model underlying the PMQ has four factors, corresponding to the subscales described above. However, when we performed an exploratory factor analysis with extraction of four principal components followed by Varimax rotation, the picture that emerged was somewhat different. The items comprising the long-term and techniques to remember scales clearly loaded together on discrete factors in the expected way. However, the items comprising the short-term and internally-cued subscales had their highest loadings scattered across three different factors, and did not cluster together in the way one would expect if they loaded on discrete latent constructs. Therefore, in the current dataset there are no grounds for saying that these subscales measure anything, let alone the constructs delineated by Hannon et al. These findings are discussed at greater length elsewhere (Buchanan et al, 2002, 2003). For current purposes we may conclude that the PMQ short-term and internally cued scales are not psychometrically satisfactory with the current sample. These scales were therefore not included in the analysis: any conclusions based on data derived from them would be unsound. The other measures were more satisfactory: Cronbach's

alpha values were high, demonstrating good reliability, for PMQ long-term (alpha = .85) and techniques to remember scales (alpha = .89), and the EMQ (alpha = .94).

The effect of reported alcohol use on each of the remaining memory scores (EMQ, PMQ long term scale and techniques to remember) and the number of mistakes made completing the questionnaire were examined by means of multivariate analyses of covariance (MANCOVA). As previous research has indicated that the use of cannabis and Ecstasy is associated with deficits in cognitive performance and the PMQ and EMQ in particular (e.g. Rodgers et al., 2001), use of these drugs was employed as a covariate in the analyses. In addition, the 'techniques to remember scale' of the PMQ was also included as a covariate because use of memory strategies may affect memory performance. There was no correlation between age and level of reported alcohol intake,  $r = -.042$ ,  $p > 0.05$ , nor did age interact with any of the other variables therefore this factor was excluded from further analysis.

A MANCOVA examining the effect of alcohol use on submission errors, EMQ and PMQ-LT scores, with cannabis use, ecstasy use, and techniques to remember as covariates, indicated that level of reported alcohol use had a significant effect on the long-term scale of the PMQ,  $F(3, 753) = 6.47$ ,  $p < .001$ . Inspection of the means (see Table 1) showed that reported errors increased with increasing levels of alcohol use. Pairwise comparisons (with Bonferroni adjustment) indicated that the difference in the scores between those that consumed no alcohol and those that consumed more than 25 units per week was significant ( $p < .01$ ). Alcohol use also affected performance on the EMQ,  $F(3, 753) = 4.363$ ,  $p < .005$ , with greater use appearing to be associated with more reported cognitive failures. Participants who had no alcohol reported fewer problems than those

who had 10-25 units ( $p < .05$ ) and 25 + units per week ( $p < .05$ ). In addition, there was also a difference between low users (1-9 units) and high users (25 + units;  $p < .05$ ). There was no effect of alcohol on number of errors made when submitting responses,  $F(3, 753) = .548, p > .05$ .

**Table 2 about here**

A further investigation of the influence of reported alcohol use on PMQ-LT and EMQ helped to understand the contribution made by heavy use of alcohol to cognitive deficits (effect sizes are given in brackets). A typical heavy user of alcohol is likely to report 31.16% more problems with long term aspects of prospective memory than someone who does not drink ( $d = 0.62$ ) and to report 23.68% more problems than individuals who say they drink only small amounts of alcohol ( $d = 0.50$ ).

In their study, Heffernan et al. (2002) compared low or non-users with heavy users of alcohol. In order to make comparisons between the present dataset and their study, we conducted an additional analysis in which the data from no (0 units) or light (1-9 units) users was collapsed into one group and then compared to the performance of heavy users (more than 25 units of alcohol per week). This led to a total of 475 participants in the low-user group and 61 in the high-user group. As only the Long-Term scale of the PMQ was found to be psychometrically satisfactory in the present study, it was only possible to make a comparison with this element in a further MANCOVA, with cannabis and ecstasy use as covariates. This analysis confirmed the findings of Heffernan et al., PMQ Long-

Term ( $F(1, 528) = 13.18, p < .001$ ), with heavy users reporting more deficits than low users (2.745 and 2.245 respectively).

## Discussion

The findings from the present study support previous research that has observed differences between heavy and low or non-users of alcohol. Heffernan et al. (2002) found that compared to the low-dose/non-alcohol group, chronic heavy alcohol users report global impairments in prospective memory. In the present study, we also found that there was a significant difference between the performance of participants who consumed high levels of alcohol each week and those who used no alcohol. In addition we found that alcohol consumption had an effect on the number of reported cognitive failures (EMQ score), with the heaviest users having worse performance than those who did not drink. These findings were observed after other drug use and strategy use were incorporated into the statistical analysis as covariates, thus statistically controlling for these factors, a method used in previous research into drug use (Heffernan et al., 2001).

A further aim of this investigation was to determine what the impact of drug use would be on day to day experiences outside of a highly controlled laboratory based environment. The findings from the PMQ-LT indicate that heavy reported use of alcohol will result in a user experiencing (and reporting) more difficulties with memory than those who report that they are light drinkers (23.68% more problems reported). When compared to individuals who claimed never to drink, the heavy users of alcohol were more than 30% more likely to report compromised memory ability. Similar difficulties are also experienced with everyday memory for individuals reporting heavy use of

alcohol. The magnitude of the effect sizes are such that the cognitive problems experienced by heavy drinkers should be apparent to the casual observer in everyday life (Cohen, 1992).

The results of the present study suggest that both prospective memory and everyday memory errors be added to the growing list of cognitive and particularly, memory impairments associated with heavy use of alcohol (e.g. Ambrose et al., 2001; Bachara et al., 2001; Grant, 1987; Heffernan et al., 2002; Selby & Azrin, 1998; Wendt & Risberg, 2001). Possible causes of the alcohol-related impairments observed in these variables are discussed below.

The use of the web as a means of participant recruitment enabled access to a much larger population of substance users and non-users, increasing the power of our analyses and possibly the validity of our findings. The Internet is particularly useful when the topic is of a sensitive nature where participants might be ordinarily be unwilling to admit to their status as drug users, but are prepared to do so when submitting anonymised data to a web page (Buchanan, 2000). As previous research has found that use of particular drugs is associated with deficits in cognitive performance (Rodgers et al., 2001), it was essential that we were able to collect data on both the quantity and nature of drugs consumed. The large number of participants recruited via the web site thus appears to indicate that the use of a web-based methodology is a valuable one for research such as that reported in this paper. It is possible, though, that using this novel administration format could affect the way people respond (this might in part account for the failure to find the expected factor structure for the PMQ). While there is an increasing literature on the topic, possible effects of using the Internet as a research medium are not fully understood. The balance



of evidence, however, indicates that the same psychological phenomena are addressed by both laboratory and web-based experiments (Krantz & Dalal, 2000). If there is any effect of administering questionnaires via the Internet, it is likely to be a positive one, given research that suggests people tested via the Internet will disclose more and be less influenced by social desirability concerns (Joinson, 1999).

As has been suggested by Heffernan et al. (2002) there is, at present, no clear understanding of the mechanisms underlying the range of cognitive impairments associated with increased doses of alcohol. However, it is possible that hypotheses may include a range of potential causes, including physical damage to cortical and/or sub-cortical regions, as well as neurotransmitter impairments. Brain shrinkage is associated with alcohol ingestion, with some suggestion that such shrinkage may become permanent with persistent, high-doses of alcohol (Kril & Halliday, 1998). It is possible that there are underlying neurotransmitter deficits which may account for some/all of the deficits observed here. For example, the prospective memory and everyday memory deficits reported herein may be caused by depletion in the neurotransmitter substance serotonin, known to impact upon mnemonic processes (Spoont, 1992; Hunter, 2000). It is equally feasible that there is an interaction between physical brain damage and neurotransmitter depletion causing the types of memory deficits reported here and observed in other studies.

Clearly on the basis of the present data we cannot say whether those individuals who report drinking heavily were functioning within the normal range of memory ability prior to the onset of their drinking. Indeed, strictly speaking, it is not possible to conclude whether alcohol is responsible for the observed deficits: it is possible (though perhaps

unlikely) that individuals with cognitive deficits may be more likely to drink heavily. Only a longitudinal study would be able to address this issue. However the finding that the number of reported memory difficulties increases with the level of drinking cited by participants does suggest that there is a relationship between higher levels of alcohol use and lower levels of memory performance.

These findings have implications on the potentially harmful effects of heavy alcohol use. Given that the modal age of participants was 21-25, it could be argued that the participants in the present study may have displayed smaller impairments than would be found in older participants, particularly those that are 'problem drinkers' (Kril & Halliday, 1998). Future research should focus on the cognitive functioning of older, long-term problem drinkers, as it is likely that the impairments observed herein will be an underestimate of the negative cognitive effects of heavy alcohol use, particularly given the relatively youth of participants in the present study who may lack an extended history of heavy alcohol use. In addition, further research needs to clarify the relationship between chronic heavy alcohol use, impairments in prospective and everyday memory and the neuropsychological basis of these deficits.

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Table 1: Reported alcohol use for each age group

Age group	Alcohol use per week			
	0 units	1-9 units	10-25 units	over 25 units
11-15	5	4	1	0
16-20	46	87	61	12
21-25	33	107	80	26
26-30	25	40	40	8
31-35	14	33	19	8
36-40	18	22	15	2
41-45	8	10	6	2
46-50	4	8	2	1
51-55	3	4	1	0
56-60	0	3	2	2
66-70	1	0	0	0
Total	157	318	227	61

Table 2. Mean (and standard deviation) scores on Prospective Memory Questionnaire Long-Term (PMQ-LT) subscale and Everyday Memory Questionnaire (EMQ) by level of alcohol use

	alcohol use per week			
	0 units	1-9 units	10-25 units	over 25 units
PMQ-LT	2.15** (1.05)	2.28** (0.99)	2.49 (1.07)	2.82 (1.40)
EMQ	72.07** (31.67)	75.02** (28.00)	79.67 (29.04)	88.54 (32.70)

\*\*  $p < .01$  significantly different from 25+ units group

0 units and 10-25 units differed at  $p < .05$