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

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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.

Methods: This 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 were collected by 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 with 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 effect on everyday cognitive performance. Possible causes of these impairments are discussed.

Key Words: Alcohol, Prospective Memory, PMQ, Everyday Memory, Cognitive Impairment.

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 and Matarazzo, 1989; Selby and Azrin, 1998) and with 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 (Bachara et al., 2001; Grant, 1987), short- and long-term logical memory (Selby and Azrin, 1998), general working memory (Ambrose et al., 2001), and executive function (Wendt and 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 are 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 (PM) and cognitive failures. PM is the process of remembering to do things at some future point in time (Brandimonte et al., 1996). Examples of PM include remembering to attend a particular function, such as a party, or to perform a particular task, such as 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., 1996; 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 PM has failed them within a period of time. The PMQ contains a number of subscales that 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 effect of personality differences (Heffernan and Ling, 2001), as a neuropsychological instrument in the study of brain-damaged patients (Hannon et al., 1995), and in self-rated PM impairments in regular Ecstasy users (Heffernan et al., 2001). In addition, the PMQ correlates well with objective measures of PM (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.

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There is some evidence to suggest that chronic heavy alcohol users show detriments in remembering in an everyday context (Knight and 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 PM when compared with 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 PM of heavy alcohol users (those who had consumed more than the recommended weekly number of units over 5 years or longer) and found global impairments in comparison to a control group of low users or nonusers. However, in their study, the sample was relatively small (30 in each condition), and participants were compared across only two groups: high and low users. In addition, previous research has demonstrated that use of drugs can affect cognitive performance (e.g., Rodgers et al., 2001), and this use may covary with alcohol use. This study, therefore, used a Web-based methodology [for further details, see Rodgers et al. (2001) and below] to access more participants and to 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.

This investigation, therefore, partially replicates the Heffernan et al. (2002) study by using a significantly larger dataset. This allows 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 PM, by using both the EMQ and PMQ. If chronic heavy alcohol consumption does have an adverse effect on PM, then one would expect this group to report significantly greater errors in their PM functioning when compared with a low-dose/alcohol-free group.

MATERIALS AND METHODS

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 to 25 years (32%). Most respondents came from Europe (71%). Many were well educated, with some university or college education (31%). Most participants (n = 606; 79.4%) stated that they drank at least some alcohol during a typical week. One hundred fifty-seven participants (20.6%) drank no alcohol, 318 (41.7%) drank 1 to 9 units each week, 227 (29.8%) drank between 10 and 25 units every week, and 61 (8%) drank more than 25 units.

Materials

A Web site 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., http://www.drugresearch.org.uk).

Memory was assessed with two self-report questionnaires. The first was the EMQ. This is a valid and reliable self-report measure of common memory lapses in everyday activities (Sunderland et al., 1983) comprising 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 subscales 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."

PM was assessed with the 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, month, or year, depending on the specific questionnaire item. These scales range from 1 to 9, with greater scores indicating more faulty PM. 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 indicate more use of memory aids. The strategy scale was included because differences in PM are associated with differences in strategy use (Hannon et al., 1995).

Alcohol and other drug use was assessed with a version of the University of East London (UEL) Recreational Drug Use Questionnaire (Parrott, 2000). Respondents estimated their level of alcohol and other drug use (tobacco, Ecstasy, amphetamines, cocaine, lysergic acid diethylamide, 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."

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 the 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 and then resubmit the form. The number of times each participant made such a mistake was recorded.

Ethical approval for the study came via the 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 that read "I understand the nature of the study and wish to continue."

Procedure

Participants were recruited by using a variety of methods. These included messages posted to relevant Internet discussion groups, links from other on-line experiments, notices on Web 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 behavior 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, and cannabis) and that the study focused on those who use various drugs and those who do not use any of

these 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 labeled "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 labeled "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 before resubmission. Those who had answered all the items saw a debriefing page. This thanked them, outlined the purpose of the study, and 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 e-mail 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 in which participants indicated that 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- to 20-year age group claiming to have postgraduate education) was excluded on these grounds.

RESULTS

Before 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 that correspond to the subscales described previously. 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 this 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 T, Ali T, Heffernan TM, Ling J, Parrott A, Rodgers J, Scholey AB (2002) Psychometric properties of online self-report memory questionnaires: the EMQ and PMQ. 5th German Online Research Conference (GOR). Hohenheim, Stuttgart, unpublished data; Buchanan T, Ali T, Heffernan TM, Ling J, Parrott A, Rodgers J, Scholey AB (2003) Non-equivalence of online and paper-and-pencil psychological tests: the case of the Prospective Memory Questionnaire, unpublished data). 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 α values were high, demonstrating good reliability, for the PMQ long-term (PMQ-LT; $\alpha = 0.85$) and techniques to remember ($\alpha = 0.89$) scales and for the EMQ ($\alpha = 0.94$).

Table 1. Reported Alcohol Use for Each Age Group

	Alcohol use per week (units)			
Age group (years)	0	1–9	10–25	>25
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

The effect of reported alcohol use on each of the remaining memory scores (EMQ, PMQ-LT scale, and techniques to remember) and the number of mistakes made completing the questionnaire were examined by means of multivariate analyses of covariance (MANCOVA). Because 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 used 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 ($r = -0.042$; $p > 0.05$), 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 the level of reported alcohol use had a significant effect on the PMQ-LT [$F(3,753) = 6.47$; $p < 0.001$]. Inspection of the means (Table 1) showed that reported errors increased with increasing levels of alcohol use. Pairwise comparisons (with Bonferroni adjustments) indicated that the difference in the scores between those who consumed no alcohol and those who consumed more than 25 units per week was significant ($p < 0.01$). Alcohol use also affected performance on the EMQ [$F(3,753) = 4.363$; $p < 0.005$]; greater use seemed to be associated with more reported cognitive failures. Participants who had no alcohol reported fewer problems than those who had 10 to 25 units ($p < 0.05$) and 25 or more units per week ($p <$

Table 2. Mean (SD) Scores on the Prospective Memory Questionnaire Long-Term (PMQ-LT) Subscale and the Everyday Memory Questionnaire (EMQ) by Level of Alcohol Use

	Alcohol use per week (units)			
Variable	0	1–9	10–25	>25
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)

* $p < 0.01$, significantly different from ≥25 units; 0 units and 10–25 units differed at $p < .05$.

0.05). In addition, there was also a difference between low users (1–9 units) and high users (≥25 units; $p < 0.05$). There was no effect of alcohol on number of errors made when submitting responses [$F(3,753) = 0.548$; $p > 0.05$] (Table 2).

A further investigation of the influence of reported alcohol use on the PMQ-LT and EMQ helped us to understand the contribution made by heavy use of alcohol to cognitive deficits (effect sizes measure the magnitude of a treatment and were calculated using Cohen's d). A typical heavy user of alcohol is likely to report 31.16% more problems with the long-term aspects of PM 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 nonusers with heavy users of alcohol. To make comparisons between this dataset and their study, we conducted an additional analysis in which the data from no (0 units) or light (1–9 units) users were collapsed into one group and then compared with 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. Because only the PMQ-LT was found to be psychometrically satisfactory in this study, it was possible to make a comparison with only this element in a further MANCOVA, with cannabis and Ecstasy use as covariates. This analysis confirmed the findings of Heffernan et al. [PMQ-LT: ($F(1,528) = 13.18$; $p < 0.001$], with heavy users reporting more deficits than low users (2.745 and 2.245, respectively).

DISCUSSION

The findings from this study support previous research that has observed differences between heavy and low or nonusers of alcohol. Heffernan et al. (2002) found that compared with the low-dose/nonalcohol group, chronic heavy alcohol users report global impairments in PM. In this 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 affected 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 effect 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 with 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 who report heavy use of alcohol. The magnitude of the effect sizes was such that the cognitive problems experienced by heavy drinkers should be apparent to the casual observer in everyday life (Cohen, 1992).

The results of this study suggest that both PM and everyday memory errors should 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 and Azrin, 1998; Wendt and 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 nonusers, 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 anonymized data to a Web page (Buchanan, 2000). Because previous research has found that the 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 seems to indicate that the use of a Web-based methodology is a valuable one for research such as that reported in this article. 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). Although there is increasing literature on the topic, the 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 and 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 that 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, hypotheses may include a range of potential causes, including physical damage to cortical and/or subcortical regions and 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 and Halliday, 1998). It is possible that underlying neurotransmitter deficits may account for some or all of the deficits observed here. For example, the PM and everyday memory deficits reported herein may be caused by depletion in the neurotransmitter substance serotonin, known to affect mnemonic processes (Hunter, 2000; Spoont, 1992). It is equally feasible that there is an interaction between physical brain damage and neurotransmitter depletion that causes the types of memory deficits reported here and observed in other studies.

Clearly, on the basis of these data, we cannot say whether those individuals who reported drinking heavily were functioning within the normal range of memory ability before 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 (although 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 for the potentially harmful effects of heavy alcohol use. Given that the modal age of participants was 21 to 25 years, it could be argued that the participants in this study may have displayed smaller impairments than would be found in older participants, particularly those who are problem drinkers (Kril and Halliday, 1998). Future research should focus on the cognitive functioning of older, long-term problem drinkers, because it is likely that the impairments observed herein will be an underestimate of the negative cognitive effects of heavy alcohol use, particularly given the relative youth of participants in this 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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