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## **SUBJECTIVE RATINGS OF PROSPECTIVE MEMORY DEFICITS IN CHRONIC HEAVY ALCOHOL USERS**

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## **Abstract.**

Chronic alcohol abuse has a detrimental effect on retrospective memory. Less is known about its putative effects on everyday memory. This study looked at self-ratings of prospective memory (PM) (memory for future events). After controlling for other drug and strategy use, chronic heavy alcohol users showed global impairments in PM, when compared to matched controls. The underlying mechanisms are discussed.

Key words: alcohol, prospective memory, PMQ, memory storage, memory impairment.

## INTRODUCTION

Chronic heavy alcohol consumption leads to a number of neuropsychological impairments, including memory deficits. For example, studies have revealed cognitive impairments in problem-solving abilities and decision making (Leckliter & Matarazzo, 1989; Selby & Azrin, 1998), as well as in a range of memorial functioning. In terms of memory, chronic heavy alcohol users and alcohol-dependent persons show impaired performance on a range of memory tasks, for example 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). Such research into memory dysfunction has tended to focus on laboratory and/or field tests of retrospective memory - encompassing the learning, consolidation, retention and retrieval of previously presented target material. However, few investigations have examined the extent to which these impairments impact upon memory functioning in an everyday context.

One important aspect of day-to-day memory function is prospective memory (PM) which refers to the process of remembering to do things at some future point in time (Brandimonte, *et al.* 1996). For example, remembering to attend a particular function such as a party, or to carry out a particular task such as remembering to pay a bill on time. PM has only recently been subject to systematic empirical research (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 prospective memory has failed them within a period of time. Three sub-scales provide self-reported measures of short-term habitual, long-term episodic, and internally-cued prospective memory. In addition, the PMQ gauges the number of strategies used to aid remembering via the Techniques to Remember Scale. The scale has proved to be a useful tool in estimating the effectiveness of PM in a number of settings, including assessing the impact of personality differences (Heffernan and Ling, 2001a), age-related differences (Heffernan and Elmirghani, 2000), as a neuropsychological instrument in the study of brain damaged patients (Hannon et al, 1995), and has been used to explore self-rated prospective memory impairments in regular ecstasy users (Heffernan, *et al.* 2001b).

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. The present study aimed to extend our knowledge on potential memory deficits resulting from heavy alcohol use, focusing here on self-rated errors of prospective memory. 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

## METHODS

The current Government recommended number of units of alcohol consumption per week is 28 units for males and 21 units for females (Institute of Alcohol Consumption, 2001). Thirty chronic heavy alcohol users (16 females and 14 males; mean age 23.3 years (SD 4.51)), defined as ingesting above the recommended weekly number of units in the UK over a period 5 years or more and thirty low dose/alcohol-free controls (19 females and 11 males; mean age 21.1 years (SD 7.69)), defined as ingesting below the recommended weekly number of units over 5 years or more (with 4 of these participants being non-drinkers) were compared. The range of alcohol consumption for the chronic heavy alcohol user group was 30 - 90 units per week and the range of alcohol consumption for the low dose/non-alcohol group was 0 - 20 units per week. The participants were undergraduate students studying in the North East of England. The drinking participants reported that they a) were social drinkers, b) had been drinking alcohol for at least 5 years, c) had been completely drug free for at least 48 hours, d) had not been diagnosed as alcohol dependent, e) were not suffering from any form of amnesia. Other drug use was assessed by a questionnaire gauging the number of times ecstasy, LSD, marijuana and cocaine were consumed per week. None of the participants used ecstasy, cocaine, nor LSD, but did use marijuana (N=8 in the chronic heavy alcohol group and N=5 in the low dose/no-alcohol group).

Prospective memory (PM) 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. The scale ranges from 1 (where least forgetting is evident) to 9 (where there is a great deal of forgetting), the greater the score, the more faulty one’s prospective memory. Additionally, 14 questions make up the ‘techniques to remember’ scale, providing a measure of the number of strategies used to aid remembering. The Techniques to Remember Scale ranges from 1 (few strategies used) to 9 (a high number of strategies used). On this latter scale the greater the score, the more memory aids used. Completion of the PMQ preceded the drug-use questionnaire.

## **RESULTS**

The results of the study are summarised in Table 1. Two 1-way ANOVAS showed that there were no significant differences between the groups’ in terms of their ages, nor in terms of the number of strategies used. A 1-way ANOVA confirmed that the heavy alcohol group consumed significantly greater amounts of alcohol than the low-dose/no alcohol control group. A final 1-way ANOVA showed that the ‘heavy’ alcohol group consumed significantly greater amounts of marijuana than the low alcohol control group.

**Table 1 around here**

Amounts of marijuana used per week were incorporated into analyses of covariance (ANCOVA) applied to the data from each sub-scale. The analysis of covariance was used because it allowed for statistical control of the other drug usage by entering the data for each of the other drugs used as a covariate, a method used in previous studies on substance use and cognition (Heffernan, *et al.*, 2001b). These revealed significant greater number of impairments reported by the heavy alcohol group, when compared to the low/no alcohol control group, in terms of their long-term episodic PM, their short-term habitual PM, and their internally-cued PM (See Table 1). It is concluded from these results that heavy alcohol users report global impairments in their everyday prospective memory when compared to a matched control group.

**DISCUSSION**

The findings from the study demonstrate that, compared to the low-dose/non-alcohol group, chronic heavy alcohol users report global impairments in prospective memory.



Specifically, the chronic heavy alcohol group reported significantly greater levels of prospective forgetting for long-term, short-term, and internally-cued prospective memory. The self-reported deficits in this group persisted, even after controlling for the use of other drugs and the number of strategies used to aid remembering. These findings are novel and add weight to the growing body of evidence that suggests chronic heavy alcohol use impairs cognitive function, and in particular memory (e.g. Ambrose, *et al.* 2001; Bachara *et al.* 2001; Grant, 1987; Selby & Azrin, 1998; Wendt & Risberg, 2001). These results suggest that prospective memory - an important aspect of everyday cognitive functioning - should be included in the list of neuropsychological sequelae resulting from a history of heavy alcohol consumption. The statistical similarity between the two groups in terms of their use of strategies to aid remembering suggests that the heavy chronic alcohol users are either unaware or are not compensating for their memory deficits.

The mechanisms underlying the range of cognitive impairments associated with chronic heavy alcohol use are not fully understood at present. It is known that alcohol causes brain shrinkage, particularly in alcohol-dependent people where the damage induced may be permanent (Kril & Halliday, 1998). Alcohol has been found to reduce the number of cholinergic neurons in the basal forebrain leading to reduced hippocampal function - a structure heavily implicated in memory consolidation (Garcia-Moreno, *et al.* 2001). Alcohol also appears to inhibit prefrontal lobe functioning (Wendt & Risberg, 2001). Prospective memory may also be under the influence of pre-frontal and frontal cortical control (McDaniel, *et al.* 1999; Okuda *et al.* 1998), and prospective memory performance

is strongly correlated with frontal lobe executive processes (Shapiro, *et al.* 1998). It seems possible therefore, that damage in the pre-frontal and frontal regions of the brain may be responsible for the self-reported deficits observed in the present study. Although this is feasible, alternative explanations cannot be ruled out, such as the role of the hippocampus in prospective memory and/or the putative depletion of specific neurotransmitter substances known to impact upon mnemonic processes, such as serotonin (Hunter, 2000; Spooner, 1992). It seems quite possible that a complex interaction exists between the effects of excessive alcohol use, regional brain functioning and neurotransmitter depletion.

Although the use of other drugs did not statistically affect heavy alcohol-related prospective memory impairments, one cannot rule out the possibility that biological interactions between alcohol and other drugs may contribute to the effects seen here. One way to address this issue would be to include a 'heavy alcohol-only' group who were otherwise drug free, in addition to a matched control group. It is also necessary to consider the use of self-report measures in studies of this kind. The reliance on self-reports of remembered errors in a group where memorial deficits are already known raises the possibility of a 'memory paradox' in which heavy alcohol users may forget their memory lapses. But, given the direction and strength of the group differences found in the present study it could be argued that, if anything, this possibility adds strength to the present findings. It is likely that alcohol users may well have underestimated their memory deficits.

These findings have implications on the potentially harmful effects of chronic heavy alcohol use. Future research may wish to employ more objective methods for assessing prospective memory, such as laboratory based prospective memory tasks, or perhaps, video simulations which assess prospective remembering (Titov & Knight, 2001). It is clear that further research is needed to clarify the relationship between chronic heavy alcohol use, impairments in prospective memory and the neuropsychological basis for such impairments, such as the cortical and sub-cortical regions involved in such processes.

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Table 1. The results from all of the measures from the chronic heavy alcohol users and low-dose/no alcohol controls.

	<u>Low alcohol controls (N=30)</u>	<u>Heavy alcohol users (N=30)</u>	<u>F</u>	<u>P</u>
<u>Age</u>	<u>23.3</u>	<u>21.1</u>	<u>1.82</u>	<u>ns</u>
<u>Alcohol consumption (in units per week)</u>	<u>5.60±5.13</u>	<u>30.1±17</u>	<u>57.6</u>	<u>&lt;0.0001</u>
<u>Marijuana (weekly)</u>	<u>0.12 ±0.44</u>	<u>1.10 ±2.22</u>	<u>5.62</u>	<u>&lt;0.05</u>
<u>Long-term PM</u>	<u>2.66 ±0.79</u>	<u>3.33 ±1.11</u>	<u>4.14</u>	<u>&lt;0.05</u>
				<u>Effect Size: 0.07</u>
<u>Short-term PM</u>	<u>1.37 ±0.43</u>	<u>1.92 ±0.82</u>	<u>7.06</u>	<u>&lt;0.01</u>
				<u>Effect Size: 0.12</u>
<u>Internally-cued PM</u>	<u>2.84 ±1.21</u>	<u>4.10 ±1.59</u>	<u>6.24</u>	<u>&lt;0.01</u>
				<u>Effect Size: 0.11</u>
<u>PMQ strategies</u>	<u>3.30 ±1.46</u>	<u>3.45 ±1.35</u>	<u>0.15</u>	<u>Ns</u>

Note: First and second columns are means and standard deviations of comparison of heavy alcohol users with low alcohol/no-alcohol controls on all the measures from the study. Columns three and four are the F-values and Ps derived from analyses of covariance of each measure sub-scale of the Prospective Memory Questionnaire (PMQ) including the effect size for each sub-scale, and the one-way analyses of variance applied to the PMQ strategies scores and the average amounts of marijuana and alcohol consumed per week; ‘Long-term PM’, ‘Short-term PM’, ‘Internally-cued PM’ refer to scores from the appropriate three sub-scales of the PMQ; ‘PMQ strategies’, score on strategy use scale of the PMQ.