PROSPECTIVE MEMORY AND FUTURE EVENT SIMULATION IN INDIVIDUALS WITH ALCOHOL DEPENDENCE

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OVERVIEW

This major research project focuses on the possible influence that chronic substance use may have on prospective memory (PM) ability.

Part one consists of a literature review examining the associations between recreational substance use and impairments in PM. This identifies 24 studies from 23 publications examining PM ability in recreational substance users. Although PM impairments are reported by most, the review highlights a number of methodological weaknesses in the existing body of research. These include an over-reliance on self report PM measures, the use of inadequate objective assessments, and limitations in internal and external validity. Suggestions are made for how methodological limitations may be overcome in future work.

Part two is an empirical paper which describes a study that aimed to overcome the limitations highlighted in part one. This compared the performance of an alcohol dependent group to that of an age and premorbid ability matched control group, on an objective PM measure called the *Virtual Week*. It was found that the event based PM performance of alcohol dependents was strongly associated with indices of both alcohol usage and severity of alcohol dependence, and significantly impaired compared to that of controls. Furthermore, an imagining technique improved controls' time based PM, but did not improve alcohol dependents' PM. These findings are discussed in terms of the relevance of strategy application to successful PM functioning, and the implications this may hold for clinical practice.

Part three consists of a critical appraisal of the research process, which explains why various methodological choices were made and how particular challenges were overcome as they arose. Certain conceptual issues are also reflected upon and their relevance to future research discussed.

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I wish to dedicate this thesis to Nan. I wish you had been here to read it.

PART 1: LITERATURE REVIEW

IS CHRONIC RECREATIONAL SUBSTANCE USE ASSOCIATED

WITH IMPAIRMENTS IN PROSPECTIVE MEMORY?

Abstract

Aim: To review the existing literature regarding the association between chronic recreational substance use and prospective memory (PM) impairment.

Method: Scientific databases were searched for primary studies that either compared the PM of substance users to that of controls, explored PM changes in substance users over time, or assessed for correlations between indices of substance use and PM performance.

Results: Although there are no consistent findings with regards to any one particular substance, studies have reported PM impairments in users of alcohol, cannabis, MDMA and methamphetamine. However, most findings result from self report measures or objective assessments with limited scope. Limitations in external validity and failures to account for confounding variables are also common issues.

Conclusions: Given the methodological limitations of existing research, conclusions regarding the association between recreational substance use and PM impairments are currently tentative. Nonetheless, this review may pave the way for improvements to future research.

Introduction

Clinical studies of memory typically focus on memory for the past, and particularly on episodic memory (knowledge about events that one has personally experienced). However, an emerging area of interest relates to how memory systems can enable humans to anticipate and plan for the future, and how this may confer evolutionary advantages. Suddendorf & Corballis (2007) postulate that that prospective memory (PM), the ability to 'enact intended actions at an appropriate moment in the future' (Ellis & Freeman, 2008; pp1), is reflective of this uniquely human cognitive process of 'mental time travel'.

PM tasks are typically classed as either *event based*, when an action is required in response to a particular event (e.g. posting a letter when passing the post office), or *time based*, when an action must be executed either at a particular time of day (e.g. calling the doctor at 4pm), or after a set period of time (e.g. calling the doctor in 20 minutes) (Kliegel, Jager, Altgassen & Shum, 2008). A time based task that relies on monitoring one's internal sense of passing time can also be known as an *internally cued* PM task (Rendell & Henry, 2009). Another, less commonly used category of PM is *activity based* PM, which requires an action to be executed following the completion of another activity (e.g. calling the doctor after posting the letter) (Einstein & McDaniel, 1990).

PM failures are reported as the most significant area of deficit in patients with brain injuries (Hannon, Adams, Harrington, Fries-Dias & Gibson, 1995) and dementia (Smith, Della Sala, Logie, & Maylor, 2000). Although most of our every-day acts of forgetting represent PM failures (Leitz et al. 2009), significant PM impairments are likely to hold broad and serious implications for occupational, interpersonal and/or health-related functioning (Fish, Manly & Wilson, 2009).

A general agreement amongst PM researchers is that PM ability is reliant on retrospective memory to retain knowledge of the task, the cue and the intention between its formation and its execution. However, PM is also assumed to rely on executive functions (EF), such as attention, planning and motivation, to co-ordinate formation, initiation and execution (Burgess et al., 2008; Kliegel, et al. 2008). Indeed, research using event-related potentials shows that, whilst similar neuropsychological processes underpin the retrieval processes involved in both retrospective and prospective memory tasks, additional processes are active during PM tasks to enable cue detection and the execution of the task alongside other activities (West & Krompinger, 2005). In line with this understanding, a person might experience PM difficulties despite in-tact episodic memory, if they encountered difficulties with the executive aspects of a PM task.

Little appears to be known about how chronic recreational substance use directly influences PM ability. Impairments in episodic memory are commonly reported amongst recreational substance users (see Fernandez-Serrano, Pérez-García & Verdejo-García, 2011 for a review), but it is unclear whether these would be sufficient to bring about significant PM deficits. Furthermore, whilst the evidence regarding the types of executive impairments present in chronic substance users is inconsistent across studies (Fernandez-Serrano, 2011), data from human lesion studies shows that PM difficulties can be displayed , even when there is intact performance on traditional EF tests (e.g. the Wisconsin card sorting test and the Towers of London) (Burgess et al., 2008). It is thus relevant to study the influence of substance use on PM in its own right, rather than assuming that the presence of PM impairments is dependent on that of episodic memory and/or traditional executive function test difficulties.   Such knowledge is likely to be important for informing the

types of interventions to include in substance misuse rehabilitation programmes, particularly if PM failures threaten clinical outcomes by interfering with treatment approaches. Indeed, the inclusion of interventions and adaptations that specifically target PM might be necessary if PM impairments were present amongst substance users, regardless of the existence of other cognitive deficits.

Brief reviews have previously been published regarding PM and alcohol use (Heffernan, 2008), and substance use in general (Kliegel, et al. 2008). However, neither was conducted systematically nor offered a critical appraisal of the existing literature. The aims of the present review are thus to provide an up-to-date overview of the current body of research regarding whether there is an association between chronic recreational substance use and impairments in PM ability, to highlight key limitations in this field, and to propose areas of improvement for future studies.

Method

All relevant English language publications relating to recreational substance use and PM, and published between 1980 and July 2010, were identified by searching key words, titles and abstracts in the databases EMBASE, Psychinfo, PsychEXTRA and PubMed. The following search terms were used: (prospective adj memory) (memory adj1 intention$) AND mdma/ 3,4 methylenedioxymethamphetamine/3,4methylenedioxyamphetamine/Ecstasy./amphet amine$./cocaine/ marijuana./cannabis/ alcohol/ or alcohol intoxication/ or alcohol abuse/ or alcohol consumption/ alcoholism./(binge adj drinking) /diazepam/ diamorphine/heroine/drug abuse/ or drug misuse/ or multiple drug abuse/ (recreational adj drug)/(recreational adj drug$)/opiate$ /(substance adj abuse)/ polydrug.

This search produced a total of 77 results following the removal of duplicates.

The results were then searched for articles that were full text primary studies and either a) compared PM of recreational substance users (abstinent or current) to that of a control group, b) were longitudinal studies exploring PM changes in recreational substance users over time, or c) were studies exploring correlations between some index of recreational substance use and PM performance.

Studies were excluded if no full text article was available, or if they focused on: only the acute effects of recreational substances; non-recreational substance use; samples taken from another clinical group (Korsakoffs, Schizophrenia, HIV); or samples identified for their primary use of a different substance.

Through this method, 23 publications were identified (see Table 1), one of which contained two individual experiments (Heffernan, Jarvis, Rodgers, Scholey & Ling, 2001b), bringing the total number of studies to 24.

In an attempt to overcome publication bias, key authors in the field, and authors of potentially relevant dissertation abstracts or conference summaries, were contacted by email enquiring about relevant unpublished work. However, no additional articles meeting the inclusion criteria were obtained in this way. Reference lists of relevant review articles were also hand searched, but this again produced no further results.

Results

Although some studies included both, most of the studies reviewed can be separated into those using self-report PM questionnaires and those using more objective measures. Self-report measures such as the Prospective Memory Questionnaire (PMQ) Hannon et al. (1995) and the Prospective Retrospective Memory Questionnaire (PRMQ) (Smith et al., 2000) typically require respondents to rate how

frequently they experience each of a range of PM errors in everyday life. In contrast, objective PM measures are obtained by setting participants one or more task(s) to complete at one or more point within a defined testing period, either at a particular time or in response to a particular environmental cue. Such task(s) can either be set to be performed within a controlled laboratory setting or within the participant's real world context. Indeed, objective PM measures vary considerably between studies, as will be discussed later in more detail. As these represent two distinct approaches to measurement, the findings from self report measures will be summarised first, followed by a more detailed examination of the findings from more objective assessment tools. In each case, the findings will be reviewed according to the particular substance to which they relate. This means that studies comparing more than one type of substance user group will be reviewed under more than one substance heading.

Studies using self report measures

1. Alcohol. Six of seven studies comparing higher dose alcohol users to lower dose controls identified some association between alcohol usage and impairments in one or more aspect of self-reported PM (Heffernan, Moss, & Ling, 2002; Ling et al., 2003; Heffernan, Ling, & Bartholomew, 2004; Heffernan & Bartholomew, 2006; Heffernan et al., 2006; Ling, Luczakiewicz, Heffernan & Stephens, 2010). All of these studies used the PMQ to assess PM. This requires respondents to rank statements describing short term, long term and internally cued PM errors e.g., "I forgot to lock the door when leaving my apartment." according to how much each has been experienced within a particular time frame. All studies found impairments

in long term PM, five in short term PM and four in internally cued PM. Importantly, however, Ling et al. (2003) were only able to analyse the long term PM scale in their study, for reasons that will be expanded upon later. No significant differences were reported in the 'strategies to remember' subscale in any of the six studies, although in three cases (Heffernan et al., 2006; Ling et al., 2003; 2010) this was entered into the analysis as a covariate.

The definition of the alcohol and control groups varied somewhat across the six studies. Four (Heffernan et al., 2002; 2004; 2006; Heffernan & Bartholomew, 2006) defined 'high dose' and 'low dose' alcohol users according to a single cut-off of weekly units. In contrast, Ling et al. (2003) defined higher and lower alcohol users as those consuming above 25 weekly units and between 1-9 weekly units respectively. Finally, Ling et al., (2010) found significant differences when comparing high alcohol users (consuming 25-40 units per week) to both low (0-8 units per week) and medium (10-25 units per week) dose users. Stipulations regarding the period over which the relevant number of weekly units were to have been consumed also varied from study to study.

Unlike all the other studies, Ling et al. (2010) additionally included a clinical sample of chronic alcohol users from an alcohol counselling service. Interestingly, participants in this group self-reported significantly fewer long term and internally cued PM errors than the 'high dose' group, and thus demonstrated fewer PM impairments when compared to the medium and low dose groups. Furthermore, when alcohol consumption was treated as a continuous variable, no linear

Table 1. *Studies examining the chronic effects of recreational substance use on prospective memory ability*

Authors	Type	Substance	Design	Sampling method	Definition of substance user group or measure of substance use	Number of participants	Age (years) mean ± sd/ /median (range)/ modal range	Abstinence periods	Tool	PM deficits
Heffernan et al. (2002)	Self report	Alcohol	Case control	Students	> 21/28 u.p/w (f/m) (5 years)	30 high dose 30 low dose	23.3 ±4.5 21.1 ± 7.7	48 hrs	PMQ	LT, ST, IC
Ling et al. (2003)	Self report	Alcohol	Case control	Web-based	u.p/w	0 u.p/w =157 1-9 u.p/w =318 10-25 u.p/w =227 ≥25 u.p/w = 61	21-25	'Not under influence'	PMQ	LT
Heffernan et al. (2004)	Self report	Alcohol	Case control	Students	>14/21 u.p/w (f/m) (1 year)	40 High 40 low & non-users	21.4±5.3 20.9±4.7	48 hrs	PMQ	LT, ST, IC
Heffernan & Bartholomew (2006)	Self report	Alcohol	Case control	Students	>14/21 u.p/w (f/m) (1 year)	45 High dose 63 Low dose	17.8±1.1 16.8 ±1.1	48 hrs	PMQ	LT, ST, IC
Heffernan et al. (2006)	Self report	Alcohol	Case control	Students	>14/21 u.p/w (f/m) (1 year)	55 High dose 31 Low dose	18.7 ±0.4 18.1 ±0.5	72 hrs	PMQ	LT, ST

Authors	Type	Substance	Design	Sampling method	Definition of substance user group or measure of substance use	Number of participants	Age (years) mean $\pm$ sd/ /median (range)/ modal range	Abstinence periods	Tool	PM deficits
Ling et al. (2010)	Self report	Alcohol	Case control	Students, social clubs, clinical setting	≥40 u.p/w 25-40 u.p/w 10–20 u.p/w 0–8 u.p/w	20 Dependent 20 High dose 20 Medium dose 20 Low dose	31-35	24 hrs	PMQ	LT, ST, IC
Heffernan et al. (2010)	Self report & Obj.	Alcohol	Case control	Students	>6-8 units, ≥2 x p/w	21 Binge 29 Non-binge	18.7 ±0.5 18.6 ±0.5	48 hrs	PRMQ PRVP	No self report but obj. EB
Montgomery & Fisk (2007)	Self report	Cannabis	Correlation	Students & snowball	'Ever used'	63 (mixed polydrug & non-polydrug users)	Not reported	7 days (MDMA) 24 hrs (other illicit)	PMQ	LT, ST, IC
Fisk & Montgomery (2008)	Self report	Cannabis	Case control	Students & snowball	'Ever used'	27 users 20 drug naive	Not reported	24 hrs (cannabis)	PMQ	ST, IC
Bartholomew et al. (2010)	Self report Obj.	Cannabis	Case control	Students	> once in lifetime & within 1 year	45 users 45 drug naive	19.0 (5.0) 19.0 (3.0)	24 hrs (cannabis)	PMQ PRVP	No self report but obj. EB

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Authors	Type	Substance	Design	Sampling method	Definition of substance user group or measure of substance use	Number of participants	Age (years) mean ± sd/ /median (range)/ modal range	Abstinence periods	Tool	PM deficits
Bedi & Redman (2008a)	Self report	Cannabis & MDMA	Case control	Mainly students	> 10 times in lifetime	45 MDMA polydrug users 48 cannabis polydrug users 40 'legal drug' users	22.8±3.0 21.7±3.5 23.1±3.7	24 hrs (alcohol/ cannabis) /10 days (other)	PMQ	None
Rodgers et al. (2001)	Self report	Cannabis & MDMA	Correlation	Web-based	Frequency of cannabis use & Lifetime MDMA use	488 poly drug and non drug	21-25	Not under the influence	PMQ	ST&IC (can.)* LT (MDMA)
Rodgers et al. (2003)	Self report	Cannabis & MDMA	Correlation	Web-based	Frequency of cannabis use & Lifetime MDMA use	679 poly drug and non drug	21-25	Not under the influence	PMQ	None (can.) LT (MDMA)
Heffernan et al. (2001a)	Self report	MDMA	Case control	Snowball	≥10 x p/m	30 MDMA 31 MDMA-naïve	Mean (range) 24.3(25) 24.8 (18)	Not under the influence	PMQ	Overall PM

Authors	Type	Substance	Design	Sampling method	Definition of substance user group or measure of substance use	Number of participants	Age (years) mean $\pm$ sd/ /median (range)/ modal range	Abstinence periods	Tool	PM deficits
Heffernan et al. (2001b). Study 1.	Self report	MDMA	Case control	Few detail	≥6 x p/m	46 MDMA 46 MDMA naive	Mean (range) 24.6 (25) 26.1 (22)	24 hrs (but 3 days cannabis)	PMQ	ST, LT, IC
Heffernan et al. (2001b). Study 2.	Self report	MDMA	Case control	Snowball	≥2 x p/m	30 MDMA 37 MDMA-naïve	Mean (range) 23.9 (21) 25.5 (31)	24 hrs (but 3 days cannabis)	PMQ	ST, LT
Hadjiefthyvoulou et al. (2010)	Self report & Obj.	MDMA	Correlation Case control	Students	Lifetime use	42 MDMA polydrug 31 non MDMA polydrug users	21.7±3.6 21.0±3.3	None	PMQ PRMQ RBMT-II LTRPM PMFT PMPT	Self report ST,IC (within MDMA group) Obj. EB & TB (group comparison)

Authors	Type	Substance	Design	Sampling method	Definition of substance user group or measure of substance use	Number of participants	Age (years) mean ± sd/ /median (range)/ modal range	Abstinence periods	Tool	PM deficits
McHale & Hunt (2008)	Obj.	Cannabis	Case control	Social science students	≥1 p/m (over last 6 months)	18 cannabis users 20 drug free for 6 month	21.6 ±1.1 21.4±1.6	24 hrs (cannabis)	RBMT-II-STIPM LTIPM	ST-TB LT-TB
Bedi & Redman (2008b)	Obj.	Cannabis & MDMA	Case control	Mainly students	≥10 times in lifetime	45 MDMA polydrug 48 Cannabis polydrug (never MDMA) 40 legal drug users	22.8±3.0 21.7±3.5 23.1±3.7	24 hrs, (Alcohol & cannabis)/ 2 hrs (caffeine)/ 10 days (other)	Reminders & crosses	None
Zakzanis & Young (2001)	Obj.	MDMA	Longitu-dinal	Students & 'word of mouth'	Ever used	15 MDMA	Mode (range) 24. 1 (14)	2 weeks	RBMT –II	None
Zakzanis et al. (2003)	Obj.	MDMA	Case control	Students & 'word of mouth'	Ever used	15 MDMA 17 non-MDMA	24.1 ±5.6 23.4 ±2.0	2 weeks	RBMT - II	EB

Authors	Type	Substance	Design	Sampling method	Definition of substance user group or measure of substance use	Number of participants	Age (years) mean ± sd/ /median (range)/ modal range	Abstinence periods	Tool	PM deficits
Rendell et al. (2007)	Obj.	MDMA	Case control	Students & local nightclub attendees	Regular use	27 MDMA 34 MDMA- naive	21.3 ±2.0 20.6 ±1.4	48 hrs (any)	VW	EB, TB
Montgomery et al. (2010)	Obj.	MDMA	Case control	Mostly students	Current use	23 MDMA poly-drug users 26 non MDMA poly-drug users	23.4±4.6 22.0±2.3	7 days (MDMA) 24 hrs (other)	JAAM	None
Rendell et al. (2009)	Obj.	Meth	Case control	Clinical sample. (controls unclear)	Diagnosis	20 users 20 drug naïve	27.5±5.2 28.2±5.0	3 months (except Alcohol)	VW	EB, TB

PMQ, Prospective Memory Questionnaire; PRMQ, Prospective Retrospective Questionnaire ; PRVP, Prospective Remembering Video Procedure; RBMT-II, Rivermead Behavioural Memory Test 2nd Edition; PMFT, Prospective Memory Fatigue Test; PMPT, Prospective Memory Pattern Recognition test; LTRPM, long term recall prospective memory task; STIPM, short term interval prospective memory task; LTIPM, long term interval prospective memory task; VW, Virtual Week; LT, Long Term Prospective Memory; ST, Short Term Prospective Memory; IC, Internally Cued Prospective Memory; u.p/w, Units per week; p/w, Per Week; f/m, female/male; HADS, Hospital Anxiety Depression Scale; Meths, Methamphetamine; Obj., Objective; EB, Event Based Prospective Memory; TB, Time Based Prospective Memory; p/m, Per Month

* Findings subsequently discredited (see Rodgers et al., 2003)

relationship was found between this and any of the PMQ subscales. As Ling et al. (2010) point out, various factors may have contributed to this pattern of results, including un-assessed group differences linked to being in the clinical rather than the 'high dose' sample (e.g. psychopathology). Nonetheless, given that this was the only alcohol study to include a clinical group, these results may call into question the clinical generalizability of the findings from all the other self-report alcohol studies reviewed. Alternative explanations for the differing pattern of results relate to the limitations of self report measures, and will be covered later on in the review.

With further regards to generalizability, the four studies that included sufficient details regarding participant ages all used samples with a mean age below 25 years (Heffernan et al., 2002; 2004; 2006; Heffernan & Bartholomew, 2006) Furthermore, in all these cases, participants were predominantly students.

The possible influence of current poly-substance use was considered to some degree in all six studies reporting alcohol-related PM deficits. Heffernan et al. (2004) excluded anyone with a history of substance use other than tobacco, and Heffernan et al. (2002) excluded those reporting the use of any illicit substances other than cannabis. In the latter, along with the four remaining studies, which did not exclude poly-substance use, MDMA and cannabis use were controlled for whenever relevant, by entry as covariates in statistical analysis.

The sole study that did not find any group differences between higher and lower dose alcohol users in self-reported PM was also the only study to use a self report PM measure that differed from the PMQ (Heffernan, Clark, Bartholomew, Ling, & Stephens, 2010). Stating that the psychometric properties of the PMQ had been 'called in to question', Heffernan et al. administered the PRMQ (Smith et al., 2000) instead. Similar to the PMQ, although containing fewer items, the PRMQ

requires respondents to rate everyday 'memory slips' e.g. do you decide to do something in a few minutes and then forget to do it?, on a likert scale, depending on how often each is experienced. Whilst the absence of an association between chronic alcohol use and PM deficits could be the product of using a different measure, alcohol consumption was also defined according to 'binge drinking' (drinking >6-8 units, 2 or more times per week), instead of weekly units. Nonetheless, as in all other studies, weekly alcohol consumption was higher in the binge drinker group (n=21, M=26.4 units) than the non binge drinker group (n=29, M=4.08 units). Furthermore, the same study found objective PM impairments in the binge drinker group, yet no association between PRMQ scores and those on the objective measure. Thus, although the PRMQ is reported to be highly reliable (Cronbach's alpha of 0.89) (Heffernan et al., 2010), this finding calls its validity into question.

2. Cannabis. Six studies investigated cannabis use and PM ability using a self report measure. Only two of these, both from the same research group, (Montgomery and Fisk, 2007; Fisk and Montgomery, 2008), produced results indicating cannabis use to be associated with PM impairments.

Montgomery and Fisk's (2007) findings arose from a regression analysis conducted on the PMQ scores of a sample consisting of 28 current poly-drug MDMA users and 35 non-MDMA users. 'Having ever used cannabis' was found to predict higher scores on all three memory scales of the PMQ. Unfortunately, the authors did not account for the missing data of 2 participants and, as they did not report beta values, it is not possible to identify the strength of the reported association. Given the very loose definition of 'cannabis use' adopted, it is perhaps surprising that an association was even identified. Indeed, it is widely known that every US president

in the last 50 years has admitted to having tried illicit substances at some point in their lives, as have many successful British politicians (see Figure 1). The poor quality of results reporting in this study thus raises questions about other potential confounds that may have contributed to this finding. Indeed, whilst the influence of alcohol use was minimised by exclusion criteria, and MDMA use was controlled for through regression analysis, the possible influence of other substances cannot be ruled out.

Figure 1. *British politicians admitting to having tried cannabis at least once*

Again using the PMQ, Fisk and Montgomery (2008) found that cannabis users reported more short term and internally cued PM difficulties than drug naïve controls. In contrast to the authors' previous study, users of substances other than cannabis were not included, so the influence of other recreational substances was

better accounted for. The significantly higher alcohol use reported by the cannabis group was controlled for statistically, as was the groups' higher score on a measure of fluid intelligence. Interestingly, the cannabis group reported using significantly more strategies for remembering than the control group, leading the authors to speculate that the PM performance of the former may have been 'bolstered' by greater strategy use. Illustrating this, the cannabis group's scores remained at the lower (less impaired) end of the PMQ scales, despite being significantly higher than controls. However, this raises the question of whether the reported differences are clinically relevant, despite being statistically significant. Furthermore, like most of the alcohol studies, both cannabis studies relied on samples with an average age of around 21 years (precise figures are not reported), and both initiated their recruitment of participants within educational institutions. Both factors limit the generalizability of the results to a broader cannabis using population.

Two of the four studies that did not find a relationship between cannabis use and PMQ scores (Rodgers et al., 2001; 2003) were web-based studies, in which self reported frequency of cannabis use was assessed alongside self rated PM, within large samples of polydrug and non-drug users. Despite being cited in Kliegel et al.'s (2008) review, as providing evidence that cannabis use impairs short term and internally cued PM, the findings initially reported by Rodgers et al. (2001) were called in to question shortly following publication (Rodgers et al, 2003). This is because the factor structure of the PMQ was found to be unstable if administered in an internet format (Buchanan et al., 2005). Subsequently, Rodgers et al. (2003), like Ling et al. (2003) (reviewed above), were only able to examine the long term PM scale from their internet-sourced PMQ data.

In the remaining two studies, neither Bedi and Redman (2008a) nor Bartholomew et al. (2010) found any differences in PMQ scores between a cannabis-using group and drug-naïve control group. Nonetheless, Bartholomew et al. did find group differences in performance on an objective PM measure, and reported a significant correlation between scores on this and the PMQ. One explanation for why differences in PMQ scores may have been harder to identify in this study may be that the cannabis consumption by the cannabis group was reported to be half that of the cannabis group assessed by Fisk and Montgomery (2008).

3. MDMA ('ecstasy'). Six eligible studies identified an association between MDMA use and impairment in one or more aspects of self reported PM as assessed by the PMQ (Heffernan, Ling and Scholey, 2001a; Heffernan, Jarvis, Rodgers, Scholey & Ling, 2001b, Study 1 & Study 2; Rodgers et al. 2001; 2003; Hadjiefthyvoulou, Fisk, Montgomery & Bridges, 2010). Four found impairments in long term PM, three in short term PM, two in internally cued PM, and a fifth found impairments in overall PMQ scores. Although an additional study (Montgomery and Fisk, 2007) reported impairments in long term and internally cued PM amongst MDMA users compared to controls, no supporting statistics were cited in their paper, and it was thus excluded from this part of the review.

Two inter-related correlation studies (Rodgers et al., 2001; 2003) reported a relationship between lifetime MDMA use and impairments in long term PM, within online samples of 490 and 679 respectively. Hadjiefthyvoulou et al. (2010) also found a positive relationship between estimated lifetime MDMA use and PMQ scores within a group of 42 MDMA users. In the latter case however, the deficits

were only reported on the short term and internally cued scales, revealing some inconsistency between study findings.

Unfortunately, not one of the correlation studies accounted for age as a potentially mediating factor, despite its likely relationship to lifetime MDMA use. Furthermore, Hadjiefthyvoulou et al. only accounted for cocaine and cannabis use, through statistical control, whilst Rodgers et al. (2001) did not control for other substance use except cannabis, and Rodgers et al. (2003) only additionally controlled for LSD use. This was despite the latter reporting correlations between lifetime MDMA use and that of amphetamines, cocaine/crack, and mushrooms.

Another major limitation of Rodgers et al. (2001; 2003), which also applies to Ling et al. (2003) (above), is that the use of web-based samples is likely to lead to data containing a lot of inaccuracies. Indeed, although all three studies report attempts to screen out 'fraudulent or mischievous data entry' (Rodgers et al., 2001, pp622) they would not have been able to check the validity of participants self report e.g. regarding age, or whether they were under the influence of substances whilst completing the questionnaire.

Rodgers et al. (2001; 2003) were the only two MDMA studies to attempt to control for the influence of 'strategy use', which they did by entering it as a coefficient in the regression analysis. This was after Rodgers et al. (2001) found strategy use to correlate negatively with both cannabis and MDMA use. Thus, in contrast to Fisk & Montgomery (2008), they proposed that substance users are less likely to report using strategies to aid PM performance.

Three case control studies conducted within the same research group consistently found higher PMQ scores in an MDMA using group than in a non-MDMA using group (Heffernan et al., 2001a; 2001b - Study 1 & Study 2).

Hadjiefthyvoulou et al. (2010) also initially found impairments on the short term scale of the PMQ, as well as poorer PRMQ scores, amongst 42 MDMA users compared to 31 non-users. However, these differences were no longer significant once alcohol and tobacco use were controlled for statistically. In the earlier three studies, the influence of cannabis, alcohol and cocaine were controlled for by entering monthly usage estimates as covariates in analysis. However, no data regarding the use of other recreational substances, including tobacco, was reported. Although this offers one explanation for the difference in findings, it is also notable that the MDMA groups in the earlier studies all reported much higher MDMA usages, of between 5 and 12 tablets per month, compared to the 0.25 tablets per week in Hadjiefthyvoulou et al. Interestingly, and on this note, the average monthly MDMA usage for the user group in Study 1 of Heffernan et al. (2001b) was almost double that in Study 2, which may account for why an impairment in internally cued PM was reported in the former but not the latter.

One study reviewed (Bedi & Redman, 2008a) could not differentiate a group of 45 MDMA polydrug users from a group of 48 cannabis users or 40 'legal drug' users, using PMQ scores. However, their MDMA user group reported even lower average lifetime MDMA use than that in Hadjiefthyvoulou et al. (2010), despite being of a comparable average age. This further highlights the relevance of how MDMA usage is defined when investigating the influence of 'chronic' use on PM ability.

Summary. There are currently mixed findings in the literature regarding the impact of alcohol, cannabis and MDMA use on self-reported PM, these being the only three substances for which relevant studies could be identified. However, most

studies regarding alcohol use and MDMA use reported PM impairments amongst substance users, most consistently in long term and short term PM. Unfortunately, in contrast to the alcohol studies, the conclusions that can be drawn from several of the MDMA studies are limited by failures to account for potentially confounding influences of age and/or poly-substance use. The evidence for PM impairments relating to cannabis use is currently limited owing to methodological weaknesses, and the greater number of available studies showing no association. On the other hand, it ought to be stressed that, with the exception of Hadjiefthyvoulou et al., (2010), the studies indicating PM impairments in association with alcohol or MDMA were all conducted within the same research group.

With regards to the alcohol and cannabis studies that report PM impairments, the generalizability of their results is limited by their samples being drawn from college populations. A further generalizability issue that becomes apparent when comparing across studies focusing on either cannabis or MDMA use, is the varying criteria through which substance use is defined. This, in addition to the distinct pattern of results reported in the sole alcohol study to include a clinical sample (Ling et al., 2010), highlights potential difficulties that may arise when attempting to generalize the results from the current self report literature to real world substance using populations.

The limitations of self report measures of PM

Although the majority of research on PM in substance users has tended to rely on self report measures, there are a number of limitations to this approach.

First of all, Uttl and Kibreab (2011) assert that PM experiences are affected by lifestyle, with busier people experiencing and thus reporting a greater number of

PM errors. Indeed, the pattern of results in Ling et al. (2010), in which clinically defined alcohol users reported fewer PM errors than a non-clinical high alcohol dose group, could well be understood from this perspective: In this study, the clinical group consisted of inpatients or outpatients shortly after discharge from hospital. In hospital, the pace of life is likely to be slow, well structured and include more prompts and fewer responsibilities. Having not had a recent hospital stay, the high dose users may have experienced more opportunities for prospective forgetting than the clinical group.

Self report measures also only assess the self-perception of PM, rather than directly reflecting it. Existing knowledge about the impact of recreational substances on cognition may lead substance users to be more hyper-vigilant to their memory errors, and thus be more likely to identify them. Indeed, Bedi & Redman (2008a) found higher levels of memory-related anxiety to be associated with more self-rated PM failures. Furthermore, estimates of cognitive performance are known to correlate highly with anxiety in general (Broadbent, Cooper, Fitzgerald & Parkes, 1982). Higher anxiety levels in substance users may thus differentially influence their self report, even if this does not represent true differences in underlying cognitive ability. On the other hand, and providing an alternative explanation for their unusual pattern of results, Ling et al. (2010) propose that, as self report relies on being aware of one's memory slips, meta-cognitive impairments resulting from heavier substance use may in fact lead to PM errors being underreported by clinical samples.

Another issue is the extent to which respondents' answers actually reflect their true perceptions. On one hand, respondents may provide the answers that they believe the researcher expects them to. Indeed, in several of the studies reviewed above, the purpose of the study was either explicitly described, or easily deducible

from the study procedure. Alternatively, respondents may wish to under-report PM errors. Indeed, Ling et al. (2010) postulate that those in their clinical sample may have been particularly motivated to portray themselves in a positive light. Illustrating this effect, Rodgers et al. (2003) were forced to exclude a subset of 84 respondents from their sample, upon identifying an unusual pattern of responding in this group. They subsequently realised that the answers given by this subset appeared to be biased by the respondents having been recruited from a drugs harm reduction website.

Finally, although most studies reviewed above stipulated some period of abstinence prior to participation, self report questionnaires require respondents to report on their memory from a period during which they may have been experiencing the acute or sub acute effects of various substances. Illustrating this, Bedi & Redman (2008a) demonstrated that more recent cannabis consumption predicted poorer PMQ scores.

Although Heffernan and Bartholomew (2006) reported the PMQ to be a 'valid and reliable self report measure' (pp139), their claims regarding validity were not supported by any published evidence (Uttl & Kibreab, 2011). Uttl & Kibreab's review of the relevant literature also indicates that no studies have demonstrated the PRMQ to be a valid measure either. Despite Bartholomew et al. (2010) and Hadjiefthyvoulou et al. (2010) both reporting correlations in their samples between the PMQ and their objective measures of PM, Uttl & Kibreab (2011) formally examined the psychometric properties of the PMQ, along with the PRMQ and several other self report PM measures, within large undergraduate samples, and concluded that, despite being reliable, no such measures validly reflected PM ability.

In view of the evident limitations associated with using self report measures for assessing PM performance, studies utilising more objective assessments of PM ability may be more suitable for identifying how recreational substance use chronically affects PM.

Objectively Assessed Prospective Memory

1. Alcohol. Only one study examining the influence of chronic alcohol use on PM using an objective assessment tool was identified (Heffernan et al., 2010). In this, PM performance of a binge drinker group (consuming >6-8 units at least twice a week) was compared to that of a non binge drinker group, using the Prospective Remembering Video Procedure (PRVP) (Seed et al., 2005). This required participants to watch a 10 minute video clip of a busy shopping area and recall and write down 18 actions or items associated with particular locations as they arose in the video e.g. remembering to note down the cost of a 'Play Station 2' when they saw a 'Dixons' store. Despite a 48 hour abstinence period, the binge drinker group recalled significantly fewer action-location combinations than the non-binge drinker group, even though the two groups did not differ in self reported PM ability. Furthermore, a significant negative correlation between PRVP performance and the number of units consumed per week was found within the binge drinker group only, leading the authors to suggest that alcohol use has an impact on PM only once a certain number of weekly units are exceeded. Importantly, the two groups did not differ in average number of years spent drinking, suggesting that higher alcohol use may impact on PM over a relatively short period of time. Furthermore, the potential influence of substances other than alcohol was controlled for as much as possible

through the exclusion of participants reporting any history of other substance use, including that of tobacco.

Unfortunately, despite identifying a significant association between alcohol use and PM impairment, these findings are limited to event based PM, as the PRVP does not offer assessment of time based PM, or any other type of PM ability. A second limitation of this study is that, as participants were sometimes tested in small groups, it is possible that some participants' prospective recollections may have been prompted by others completing their own answer sheets when relevant locations appeared on the video. Furthermore, although participants were instructed not to write down an action until the relevant location appeared on screen, no measures were reportedly put in place to prevent this from happening. Not only is the accuracy of this measure thus threatened by the potential for participants to ignore the instructions, but the procedure also failed to identify times when either an action was recalled too late, or an intention was recalled in the absence of the appropriate action.

2. Cannabis. Three studies explored the association between cannabis use and objectively measured PM. One found that cannabis users showed impairments in event based PM, whilst the remaining two did not. However, one of the latter two studies reported impairments in time based PM, an ability that was not assessed in either other study.

Bartholomew, Holroyd, & Heffernan (2010) and McHale & Hunt (2008) both compared PM in 'pure' cannabis users to that in drug naïve controls. Although McHale and Hunt did not assess group differences in past substance use, both studies excluded current users of other substances as well as heavier alcohol users.

Bartholomew et al. (2010) assessed PM using a video-based task similar to that described by Totov & Knight (2001), and that used by Heffernan et al. (2010) (described above). Cannabis users remembered significantly fewer location-action combinations (of a possible 17) than drug naïve controls, despite the majority being considered as 'light' users. However, the limitations of the PRVP mentioned above also apply to the version of the task used in this study. Furthermore, although Bartholomew et al. (2010) reported a Cronbach alpha of 0.68 for their data set, and stated that this indicated sufficient measurement reliability, this is actually a little low: Kline (1999) states that, for tests of cognitive ability, alpha value cut-offs for acceptable reliability should fall between 0.7 and 0.8.

McHale & Hunt (2008) compared the PM performance of 20 non-users to that of 18 cannabis users. Unlike Bartholomew et al.'s 'light' users, this group reported consuming an average of 2 joints three times per week. However, despite heavier cannabis use, they displayed no impairments in their event based PM performance. This finding was echoed by Bedi & Redman (2008b), who similarly reported that performance on an event based PM task could not distinguish 48 cannabis users from 40 'legal drug' users, nor from 45 MDMA/cannabis users.

The reason for the difference between the findings from Bartholomew et al. (2010) compared to those from McHale and Hunt (2008) and Bedi & Redman (2008b), could be due to the relative weakness of the event based PM measures used in the latter two studies. Whilst McHale & Hunt used the *Belonging* subtest of the Rivermead Behavioural Memory Test (RBMT) (Wilson et al. 1991), in which participants had to remember to ask for a belonging back at the end of the testing session, Bedi & Redman used the *Reminder* task, in which participant had to remind the researcher to lock the door at the end of the session. As both tasks rely simply on

the accurate performance of one action in response to a particular environmental cue, neither is capable of capturing varying degrees of PM ability along a continuum (Zakzanis et al. 2003). A second difficulty with the *Belonging* subtest, is that one out of the two marks available can be awarded if the participant recalls the action once they have been explicitly prompted by the examiner. The score on this task is thus largely impacted by points awarded for the retrospective element of the PM task alone, thus failing to capture the unique 'intention' component of PM. This effectively dilutes its validity as an index of PM ability.

Although McHale & Hunt (2008) did not find significant impairments in their cannabis group on their event-based measure, they did report group differences in performance on two tasks designed to assess different forms of time based PM. Firstly, before starting a series of other tasks, participants were instructed to press a timer exactly 10 minutes later. Cannabis users took significantly longer to press the timer than controls, and this was interpreted as evidence for impairments in short-interval time based PM. However, as with the *Belonging* and *Reminder* tasks, this single-trial assessment offers little scope for measuring time-based PM on a spectrum. Furthermore, it is unclear from the description of the task given in the article whether a clock through which to monitor the time was visible to the participant. If not, this task will have been heavily reliant on time estimation, a skill distinct from prospective remembering.

McHale & Hunt (2008) also required participants to post a stamped addressed envelope to the researcher exactly 2 days after the testing session. The authors reported that 67% of the cannabis group failed to return the envelope on time, compared to only 20% of the drug-free group, thus concluding that the cannabis group displayed impairments in long-interval time based PM. Unfortunately, as well

as also being limited by its single trial nature, this assessment may have been affected by a range of variables differentially associated with being a heavier cannabis user including differences in motivation (as pointed out by the authors themselves) and/or environmental factors that cannot be controlled. Furthermore, no control could be put in place for the acute effects of any cannabis taken during the period between the end of the testing session and the actual posting of the envelope.

On this note, it is possible that the few PM impairments reported by both McHale and Hunt (2008) and Bartholomew et al. (2010) to exist amongst cannabis users may reflect sub-acute rather than chronic drug effects. This is because research has shown that cannabis can impact on cognitive performance for up to 7 days after last use (Pope, Gruber, Hudson, Huestis & Yurgelun-Todd, 2001). Indeed, in all three studies reviewed, the minimum abstinence period stipulated was only 24 hours. On the other hand, Bartholomew et al. report actual abstinence to have varied greatly within their sample (within a range of 211 days), so chronic effects cannot be discounted completely as the source of group differences in this particular study.

3. MDMA. Six studies, five case control and one longitudinal, examined PM in MDMA users with some form of objective assessment tool. However, of the five case control studies, only three produced results suggestive of an association between chronic MDMA use and PM impairment. One reported group differences on an event based task (Zakzanis, Young and Campbell, 2003) one in two event based tasks and a time based task (Hadjiefthyvoulou et al; 2010) and one in overall PM ability, as assessed through performance on a combination of PM task types (Rendell, Gray, Henry & Tolan, 2007). However, four of the five case control studies found no group

difference in at least one measure of PM: four in event based, two in time based and two in activity based.

Zakzanis, et al. (2003) relied solely on the RBMT to assess PM ability. The tasks in the RBMT that are typically used to index PM include the *Belonging* subtest (described earlier), the *Message* subtest (requiring the participant to deliver an envelope whilst reproducing a route traced out in the room by the examiner) and the *Appointment* subtest (in which the participant is instructed to ask a particular question 20 minutes later, at the sound of an alarm). However, results from the use of the *Message* subtest will be excluded from the present review as this does not require participants to self-initiate the task and is thus considered to provide a poor representation of PM ability (Maylor, 1995).

Even when controlling statistically for educational achievement (WAIS-III Vocabulary score), Zakzanis et al. (2003) found that the performance of 15 MDMA users on the *Appointment* subtest was significantly poorer than that of 17 non-MDMA users, with a medium effect size (d=-0.73). In fact, 45% of the user group's scores fell below the lowest score obtained by a non-user. Furthermore, they found that the estimated lifetime and frequency of MDMA use within the MDMA groups were both inversely correlated with performance. Zakzanis et al. (2003) claimed that this task represented time based PM, in that it assesses the ability to recall an appointment. They consequently predicted that time based PM difficulties would be most noticeable in chronic MDMA users. However, as the *Appointment* subtest does not in fact rely on monitoring the time, but more on performing the action when prompted by an environmental cue (an alarm), it will, in the same way as the *Belonging* subtest, be conceptualised as an event-based task for the purposes of this review.

In contrast to Zakzanis et al. (2003), Hadjiefthyvoulou et al (2010) found no significant difference in scores on the *Appointment* subtest when comparing 42 MDMA users with 31 non-MDMA users, even before controlling statistically for the use of cannabis, tobacco and alcohol. However, the mean scores obtained on the *Appointments* subtest by the two studies' MDMA groups were in fact almost identical. The effect reported by Zakzanis et al. seems to be attributable to their entire control group scoring maximum marks – a ceiling effect not found by Hadjiefthyvoulou et al. Although this suggests that Zakzanis et al. only found a group difference because they used a higher functioning control group, it is unclear what factors might account for this, especially as a higher proportion of their non-MDMA group reported cocaine and cannabis use.

Further adding to the discrepancies between the findings from Hadjiefthyvoulou et al (2010) and Zakzanis et al. (2003), the former reported an MDMA-related impairment on the *Belonging* subtest, whilst the latter found no group differences on this task. The finding of a group difference on the *Belonging* subtest but not the *Appointment* subtest (as in Hadjiefthyvoulou et al.) could be explained by the former being more challenging, as it requires an action to be executed in response to a less salient cue. However, this does not readily explain the opposite findings reported by Zakzanis et al.. Beyond the already mentioned limitations of one-trial tasks, the contradiction between the findings of these two studies may highlight the limitations of using assessments that rely on input from an examiner. Indeed, it is possible that this difference in results arose from differences in the way the end of the test session and/or the significance of the alarm were signalled to participants on either or both the tasks (e.g. tone and facial expression).

Aside from impairments in the *Belonging* subtest, Hadjiefthyvoulou et al (2010) reported poorer performance in the MDMA group in two other tasks designed to assess PM. The first of these, the Prospective Memory Fatigue Test, was a 'medium term time based' PM task (remembering to complete a 'sleepiness' scale every 20 minutes - twice within a testing session), and the second, the Prospective Memory Pattern Recognition test, was a 'short term event based' PM task (remembering to press F1 each of the three times a message came up on screen to 'wait a moment'). Although the authors also initially detected a group differences in a 'long term recall' PM task (posting a results sheet back to the researchers 1, 2 & 3 weeks after testing), this disappeared after controlling for amount and frequency of cannabis use. Despite, on the one hand, lending support to the conclusions drawn by McHale & Hunt (2008) regarding the influence of cannabis use on PM, the limitations of the letter-posting task described in their study can also be said to apply to the version used in the current study.

In the third and final study to indicate PM impairment in chronic MDMA users, Rendell, Gray, Henry & Tolan (2007) compared the performance of 27 MDMA users to that of 34 non-users on an objective PM measure called the Virtual Week (VW) (Rendell and Craik 2000). This is a board game in which each round of the board represents a virtual day within a virtual week. It was originally developed to be sensitive to age-related decline in PM. At 10 different points on the board, participants are instructed to pick up an 'event card', which instructs them to make a choice from 3 options about a typical daily activity (e.g. what to have for breakfast). At the start of each 'virtual day' and at two additional points during the virtual day, participants are instructed to remember to perform particular tasks at particular points later in the day. Of these tasks, four must be carried out at a particular time of the

virtual day, which is always displayed on the board game, four must be carried out during a particular event, presented on the 'event' cards, and two must be carried out at a time on a stop watch, which represents real time. When a participant wishes to carry out a particular task they do so by letting the examiner know. The VW enables the assessment of 3 different sorts of prospective memory: time based, event based and internally cued. It also helps to distinguish between regular and irregular tasks, as two time based and two event based tasks are repeated each virtual day, whilst two of each change with every virtual day played.

Rendell et al. (2007) administered 5 'days' of the VW and found generalized impairments in the MDMA using group, but no differential impairments on particular task types. The performance of more frequent users (using MDMA more than once per fortnight) was significantly poorer that of less frequent users (using MDMA no more than once per month), which was in turn impaired compared to that of non users.

The group differences in Rendell et al. (2007) remained significant even once sleep, psychopathology and cannabis use were entered as covariates in analysis. This is despite sleep disturbance being negatively correlated with the proportion of correct responses within the MDMA group. This draws attention to Hadjiefthyvoulou et al's (2010) failure to assess potential group differences in 'sleepiness' and its impact on task performance, despite MDMA use being associated with sleep disturbances (Schierenbeck, Riemann, Berger & Hornyak, 2008; Fisk & Montgomery, 2009). Therefore, it is unclear whether some or all of Hadjifthyvoulou et al.'s findings reflected the effects of reduced sleep in their MDMA group, rather than the chronic effects of MDMA use itself. In contrast, Zakzanis et al. (2003) accounted for the influence of sleep disturbance by stipulating that people could only participate once

they reported 7 nights of 7-9 hours sleep. Although this was reliant on participant self-report, it could explain why Zakzanis found no group differences on the *Belongings* subtest, whilst Hadjiefthyvoulou did.

The remaining two case control studies were not able to distinguish between MDMA users and non-users in objectively assessed PM ability. However, the first only included the *Reminder* task and *crosses* task to assess PM (Bedi & Redman, 2008b). Whilst the former has already been described above, the latter required participants to mark the bottom of each page of a questionnaire with a cross as they completed it. Although not explicitly stated by the authors, this appears to provide a measure of activity based PM. MDMA users performed significantly less well than 'legal drug' controls, but there was no significant difference in their performance when compared to a cannabis using group. This indicates that the effect observed could not necessarily be attributed to MDMA use alone.

With regards to the quality of the *crosses* task as a PM measure, it is unclear how many pages the questionnaire included, or the spectrum of abilities that this actually captured. Indeed, it is a repetitive task that requires minimal retrieval effort , unlike many real world PM tasks. Importantly, PM was one of many cognitive functions being assessed in Bedi & Redman's (2008b) study. The choice of these limited measures reflects how the complexity of PM and the importance of studying this phenomenon in its own right have largely been overlooked in the literature to date.

That said, Montgomery, Hatton, Fisk, Ogden and Jansari (2010) utilised a far more complex assessment of PM, the JAAM (Jansari, Agnew, Akesson & Murphy, 2004) a virtual reality assessment which requires the participant to play the role of an office worker needing to complete a range of tasks over a 40 minute period. Such

tasks are designed to index a number of different executive function (EF) abilities, including amongst others, activity based, time based and event based PM. However, despite reporting a group difference in planning ability, Montgomery et al. (2010) found no significant differences between performances of 23 MDMA users and 26 non users on any of the three PM subscales.

Whilst the smaller sample size in Montgomery et al.'s (2010) study compared to that in Hadjiefthyvoulou et al (2010) and Rendell et al. (2007) may have impacted on power, Montgomery et al., like Bedi & Redman (2008b), also stipulated a much longer abstinence period from MDMA. Whilst Montgomery et al. stipulated 7 days, Bedi & Redman stipulated 10 days. In contrast, Rendell et al. stipulated 48 hours, whilst Hadjiefthyvoulou et al. (2010) did not even specify an abstinence period. This difference draws attention to the potential impact that un-accounted for sub-acute effects may have had on the findings of studies reporting an MDMA use/PM association. Indeed, Chang et al. (2000) report decreased cerebral blood flow in certain brain areas to remain for up to 3 weeks after MDMA use.

Linked with this point, Bedi & Redman (2008b) propose that differences in time since last cannabis use may play a role in the cognitive impairments observed in most studies focusing on MDMA users. Nonetheless, although the influence of recent cannabis use cannot be ruled out in Rendell et al. (2007), Hadjiefthyvoulou et al. (2010) found no group differences in time since last cannabis use, and Zakzanis et al.'s (2003) two week abstinence period reduced the likelihood of sub-acute drug effects having an influence.

Alternatively, despite the application of a more complex PM assessment than Zakzanis et al. (2003) and Hadjiefthyvoulou et al. (2010), the reason why Montgomery et al. (2010) did not find PM impairments may be because of less

chronic MDMA use by their MDMA using group. Indeed, the average estimated

lifetime usage of MDMA in Montgomery et al.'s and Bedi & Redman's MDMA

samples, in which no MDMA-specific PM impairments were detected, was less than

half and less than a third of that in Hadjiefthyvoulou et al.'s sample respectively.

Zakzanis et al., in turn, reported a higher monthly usage figure than

Hadjiefthyvoulou et al.

In the sole longitudinal study included in this review, Zakzanis & Young

(2001) compared the performance of 15 MDMA users on the *Appointment* and

Belonging subtests at the start of a 12 month period to that at the end. They found no

significant changes in either measure over time. Whilst one limitation to their design

was the risk of a practice effect attenuating possible impairments at follow-up,

another issue was that the baseline score was taken at a point where many members

of the group had already been taking MDMA for some time (an average of 18

months). Therefore, it is possible that the influence of MDMA use on PM was

already detected at baseline, and that the tasks used were not sensitive enough to

detect further deterioration 12 months later.

All three studies reporting PM impairments were limited in the extent to

which the potential influences of other substances were considered. For example,

Zakzanis et al. (2003) reported greater use of a number of different illicit substances

within their MDMA group, yet the potential contribution of this use was not

assessed. Similarly, despite showing that significant differences remained after

controlling for alcohol, tobacco and lifetime and frequency of cannabis use, a larger

proportion of the MDMA users recruited by Hadjiefthyvoulou et al (2010) reported

cocaine and amphetamine use. These substances were not included in the analyses.

Finally, Rendell et al. (2007) only additionally assessed for cannabis use. Although

this was found to be significantly greater amongst MDMA participants, and thus controlled for in analysis, the potential influence of other drug use on the performance of the MDMA using group could not be ruled out.

4. Methamphetamine. Only one study examining the impact of methamphetamine on prospective memory was identified (Rendell, Mazur & Henry, 2009). This compared the performance of abstinent methamphetamine users, recruited from a residential rehabilitation programme, with that of drug-naïve controls, on a computerised version of the Virtual Week (VW). All methamphetamine users had been abstinent for at least 3 months, as supported by routine drug tests and confirmation from medical professionals.

Rendell et la. (2009) found that, overall, their methamphetamine group made a significantly lower proportion of correct responses than non-user controls. They also found that methamphetamine users made a significantly higher proportion of missed and very late responses than non-users.

In considering the limitations of their study, the authors highlighted that their small sample size (n=20) may have limited the power of this study to detect subtle interaction effects including within-group differences regarding different types of PM ability. Indeed, they reported that, due to a number of exclusion criteria, including co-morbid psychiatric illness and dependence on or heavy use of other substances, only 20% of users considered for the study were eventually found to be eligible. Unfortunately, this approach also means the final sample may not have been representative of a typical clinical population of methamphetamine users, in which a different pattern of impairments might have been observed. Nonetheless, these findings do offer support for the role of methamphetamine use in PM impairments

irrespective of the secondary factors associated with methamphetamine use that may additionally impact on PM ability.

The reporting of effect sizes represents a key strength relative to other studies, and it is notable that the magnitude of the group difference was sizable. Further strengths of this study include the facts that there were no group differences in age or years of education, a third party confirmed drug use and abstinence details in the user group, and there were no significant correlations between PM and self rated health, self rated sleep or measures of alcohol use.

Methodological limitations of studies using objective PM measures.
Whilst the individual strengths and weaknesses of the studies using objective measures have already been touched upon above, many of the studies that report PM impairments amongst recreational substance users share further methodological limitations that require expansion. These relate not only to external validity, in terms of the generalizabilty of results beyond the studies' samples, but also to potentially confounding variables. Issues relating to methods of statistically controlling for extraneous variables must also be considered.

External validity. The samples used in all three MDMA studies appear to have been approximately representative, in terms of their average ages, of the majority of MDMA users (National Institute on Drug Abuse, 2001). However, this is not the case in the alcohol and cannabis studies, with all the participants in Heffernan et al.'s (2010) alcohol study being between 16 and 19 years of age, and the average age of participants in both cannabis studies being below 21 years. Beyond the age-related generalizability issues relevant in any research, participant age has particular

implications when investigating the impact of chronic substance use on cognition. On one hand, the focus on younger samples may prevent the full extent of substance-related cognitive deficits from being identified, as younger users are likely to have shorter substance use histories. Indeed, research has revealed greater cognitive impairments amongst longer term compared to shorter term cannabis users (Solowij, Stephens, Roffman et al., 2002). Alternatively, studies focusing on chronic substance use in young adults and teenagers may show effects that would not be evident amongst older adults. This is because the developing brain may be more susceptible to damage from substance use than the adult brain, as the late stages of adolescence are marked by ongoing neurological development (Heffernan et al., 2006).

The lower average ages of participants in most studies reviewed is an expected consequence of convenience samples being recruited from student populations. Indeed, in all but the methamphetamine study, all participants were either students, or had been recruited through 'snowballing', following an initial approach to undergraduate sources. Unfortunately, participants recruited in this way, even if similar in age to users of a particular substance, may not represent typical users in terms of educational attainment and/or cognitive abilities, both of these factors potentially influencing performance in objective PM assessments. For example, differences between users and non-users may be more obvious in higher ability populations than in lower ability populations, where the impact of substance use on performance may be attenuated by lower ability levels.

Rendell et al.'s (2009) methamphetamine study is the only one reviewed to report objective PM impairments in association with chronic substance use, using a clinical substance-using sample. Not only did this provide a more stringent definition of drug 'use' than in other studies, which vary in their methods for classifying users,

but it also reduced the limitations imposed by opportunistic sampling. Indeed, this can often lead to samples that are unrepresentative of clinical populations in terms of age, education and ability.

Confounding variables. A number of potentially confounding variables, including acute and sub acute drug effects, psychopathology, and pre-morbid group differences are dealt with to a greater or lesser extent in the studies reviewed.

Acute and sub-acute effects. Stipulations about the length of abstinence from illicit substances required prior to participation varied considerably across the studies reviewed, from there being no clear requirements (Hadjiefthyvoulou et al., 2010) to two weeks (Zakzanis et al. (2003). Nonetheless, with the exception of the former, this was at least 24 hours in all studies. Unfortunately, the abstinence requirements with regards to legal substances such as alcohol, tobacco and prescription drugs were rarely made explicit in studies focusing on illegal substance use. Furthermore, although Rendell et al. (2009) did include a user group that received drugs screens on a regular basis, only Zakzanis et al. (2001; 2003) and Bedi et al. (2008b) required all participants to complete a drugs screen prior to participation. All other studies relied on self-report abstinence data only. The possible acute and sub-acute effects of other substances on PM task performance can thus not be ruled out in the majority of studies reviewed.

Psychopathology. There is reportedly a high co-morbidity between substance abuse and various psychiatric conditions (Regier et al., 1990). This is particularly important in the study of PM, as research has revealed PM impairments in samples of

individuals with depression (Rude, Hertel, Jarrold, Covich & Hedlund, 1999; Altgassen, Kliegel & Martin, 2009), and schizophrenia (Elvevag, Maylor & Gilbert, 2003; Henry, Rendell, Kliegel & Altgassen, 2007). Four studies included some measure of psychopathology, either in the form of the HADS (Rendell, 2009; Heffernan et al., 2010; Bartholomew et al., 2010) or the Symptom Checklist-90 Revised (Rendell et al., 2007). Through this, the authors were either able to show no relationship between psychopathology and substance use within their sample, or control statistically for this in the analysis (Rendell et al. (2007). Although like Rendell et al. (2009), Zakzanis et al. (2003) excluded those with a psychiatric condition from participating, they, like McHale & Hunt (2008) and Hadjiefthyvoulou et al. (2010), failed to include a measure of psychopathology. These studies thus failed to account for the influence that possible group differences in psychopathology may have had on the findings reported.

Pre-morbid ability. The performance of substance users on PM tasks may vary with pre-morbid differences in cognitive ability and/or years of education. Unfortunately, neither the alcohol study nor either of the two cannabis studies included an assessment for group differences in years of education. Nonetheless, in the few studies that did (Rendell et al.,2007; 2009; Zakzanis et al., 2003; Hadjiefthyvoulou et al., 2010) no statistical differences were found.

Only three studies (Rendell et al., 2009; Zakzanis et al., 2003; Hadjiefthyvoulou et al., 2010) included an assessment of intelligence alongside the PM measure. Although neither Rendell et al. nor Hadjiefthyvoulou et al. found any significant difference between groups on their intelligence measures, Zakzanis et al.

found significantly lower WAIS-III Vocabulary scores in the MDMA group, and subsequently controlled for this statistically.

In view of the recruitment strategies used in the majority of studies reviewed, years of education and pre-morbid intelligence may have in some cases been overlooked as potential confounds because participants were often from a similar academic background. However, in future studies including a clinical sample, or those recruiting participants from a wider population, such factors may be a higher priority for assessment and control.

A note on statistical control. A common strategy used by researchers to control for the influence of confounding variables is to enter these as co-variates in an ANCOVA or MANCOVA, so as to partial out their influence on the relationship between the independent and dependent variable. Indeed, this has been adopted in many of both the self report and objective measure studies reviewed here. However, Miller and Chapman (2001) quote Elashoff (1969) as saying that "analysis of covariance is inappropriate if the covariate is not independent of the [grouping variable]" (pp 389). Indeed, they stress that this approach ought to only be used for reducing variability when groups are randomly assigned, rather than pre-existing, as the 'natural' role of any variable related to the grouping variable ought not to be ignored when comparing groups. Unfortunately, controlling statistically for extraneous variables may threaten the external validity of any significant findings from such studies.

Summary. There is currently little consistent evidence to show that any specific type of objectively assessed PM is impaired in recreational users of any one

particular substance. This may principally be due to the dearth of studies assessing PM in any one substance user group. Nonetheless, even in the case of MDMA (the substance that has received the most attention) only half the existing studies found PM impairments in their substance user group.

There are also some inconsistencies in the outcomes reported, both between and within individual studies. Although these may be explained by differences in how substance-user groups are defined, many researchers have failed to utilise well designed assessment tools capable of adequately measuring different types of PM on a continuum. This thus limits the conclusions that can be drawn from such studies.

Most existing studies in this area are also limited in terms of the populations to which their findings can be generalised. Furthermore, several fail to account for the influence of one or more potentially confounding variable, such as age, poly-substance use, sub-acute drug effects, psychopathology and pre-morbid ability. Alternatively, they control for these through the misuse of ANCOVA. However, despite these limitations, the fact that some form of objective PM impairment has been reported in at least one study focusing on users of alcohol, cannabis, MDMA and methamphetamine highlights the importance of continuing to build on the existing body of research through the application of better research designs.

Discussion

The present review has identified a general paucity of research regarding the possible association between recreational substance use and impairments in PM. Furthermore, there are methodological limitations in what little research has been done, with the majority of existing studies having relied on self report measures rather than objective assessment tools.

The self-report literature currently points to a tendency for more frequent users of MDMA, and for young people consuming higher levels of alcohol, to report greater difficulties with prospective remembering. However, not only have most of these studies been conducted from within the same research team, but all those reporting a statistically significant finding have done so using the same measure: the PMQ.

Despite Hannon et al. (1995) reporting good internal consistency and test-retest reliability for the PMQ, its factor structure, when administered in a web based format, has since been called in to question (Buchanan et al., 2005). Although Rodgers et al.(2003) state that there is no reason to doubt the findings arising from pen and paper versions of the PMQ, it is important to note that this tool was developed primarily using student samples. Therefore, future studies aimed at replicating the existing 'self-report' findings would benefit from recruiting more representative user groups and subsequently examining the latent structure of the PMQ within their samples.

On the other hand, there are several reasons for why self-reported PM may not necessarily reflect actual PM ability, most notably the fact that, to date, there is no compelling evidence for their validity (Uttl & Kibreab, 2011). Therefore, from both a theoretical and clinical perspective, research using objective PM assessments is likely to offer more meaningful results.

Unfortunately, few studies have used objective measures to assess the chronic influence of recreational substance use on PM. Furthermore, of these, many have relied on measures with limited scope or detail. Indeed, whilst all ten studies containing objective PM assessments included some measure of event-based PM, five of these used single-trial tasks to do so (Zakzanis & Young, 2001; Zakzanis et

al., 2003, Hadjiefthyvoulou et al., 2010; McHale & Hunt, 2008; Bedi & Redman, 2008b). Only five studies included a time based assessment, and two of these did so using tasks with very few trials. Although the multi-trial video based procedures in Heffernan et al. (2010) and Bartholomew et al (2010) helped to overcome the limitations of single trial tasks, they were nonetheless restricted to the identification of event based PM errors. Indeed, six of the ten studies reviewed included only event based measures, thus failing to identify potential impairments in time based and activity based PM.

The studies that used either the JAAM (Montgomery et al., 2010) or the Virtual Week (VW) (Rendell et al., 2007; 2009), overcame some of the limitations of those using other measures. However, of the two, only the VW appears to have been formally assessed for reliability (Rendell & Henry, 2009), and neither for validity. Nonetheless, since Rendell et al. (2007; 2009) found PM impairments in MDMA and Methamphetamine users using the VW, Leitz et al. (2009) and Paraskevaides et al. (2010) have both used the VW to identify PM impairments relating to an acute dose of alcohol.

Hadjiefthyvoulou et al. (2010) critique the VW task on the basis that it contains an associative learning component. They propose that this adds cognitive load beyond that of the PM aspect of the task. However, every real world PM task arguably contains some element of associative learning, in that the cue (the environment or the time) needs to be associated with the retrieval of the task to be performed. A benefit of the VW is that it can be used to separate out the two components of any PM task, such as in cases when the need to complete an action is recalled but not the action itself, or when a task is recalled too early or too late. Will et al. (2009) also critique the VW, by proposing a need for more ecological PM

measures. However, there are some components of real world PM tasks, such as their personal significance (Atance & Meltzoff, 2007), that are unlikely to be adequately represented within any standardised measure. Therefore, if chronic substance use does lead to cognitive deficits, which in turn impact on real world PM ability, their extent and nature need first to be better conceptualised, before exploring their functional significance. The starting point to this is the application of reliable, in-depth laboratory-based assessments, such as the VW.

Unfortunately, a key limitation that was repeatedly identified in the course of reviewing the literature related to how the influence of past or present poly-substance use was accounted for in the studies' designs. Even in studies in which recreational substance use was more carefully assessed, this assessment relied on participants self reporting their substance use histories. Such information is highly likely to be inaccurate, either unintentionally or because of varying motivations for under or over-reporting during research (Zakzanis et al., 2003). Furthermore, when investigating the influence of 'street drugs' , it is not possible to know the make-up of each dose taken, either in terms of the quantity of the substance under study or of other unknown substances with which it may have been mixed (Rendell et al., 2007). Indeed, researchers need to be open to the possibility that the results from studies focusing on poly-drug users may reflect substance interaction effects (Rodgers et al., 2003). If the focus of research is to identify the specific neuropsychological consequences of particular substances on PM, prospective longitudinal studies would be more appropriate than correlational designs (Rodgers et al., 2003). Unfortunately, as illustrated by the limited interpretability of results from the only longitudinal study reviewed (Zakzanis & Young, 2001), such an approach is challenged by the practical and ethical implications of needing to identify participants prior to the start of their

substance use histories. Therefore, applying more stringent exclusion criteria and/or using matched controls in case control studies may offer an alternative means of controlling for various confounding variables. Hair analysis could offer one means of either ruling out or confirming particular substance use patterns over a period of time.

On the other hand, the clinical utility of research in this area risks being reduced if too much control for extraneous variables is applied. Although the PM impairments reported in this review may not in every case be attributable to the sole influence of the target substance, such findings may still be relevant to the population under study. Indeed, difficulties with PM may hold very real implications for patients undergoing rehabilitation for substance misuse. For example, PM ability is necessary for applying techniques taught in Cognitive Behavioural Therapy (Rendell et al, 2009). This approach is commonly used in the treatment of substance misuse (Curran & Drummond, 2007) and a range of other psychological difficulties (Roth & Fonagy, 2004). Therefore, not only might PM difficulties interfere with treatments aimed at reducing relapse e.g. remembering to apply coping strategies in high risk situations (Blume, 2005), but they may also impact on interventions for co-morbid emotional difficulties such as stress, this in turn increasing the likelihood of relapse following rehabilitation (Sinha, 2007). Furthermore, if, like other cognitive impairments, PM deficits were to influence perceived self-efficacy, this could increase the chance of relapse (Bates, Pawlack, Tonigan & Buckman, 2006). PM deficits may also interfere with engagement, indirectly maintain co-morbid emotional problems, or trigger psychological distress through their negative impact on occupational and social functioning. The inclusion of PM interventions in the treatment of substance misuse might thus reduce relapse rates and improve psychological well-being in former

substance users. Therefore, if the ultimate aim of research is to inform clinical practice, future studies would benefit from recruiting clinical samples such as that used by Rendell et al. (2009), even if these are not representative of the more general substance using population.

Ongoing work could also focus on identifying strategies to overcome any PM deficits associated with substance misuse. These might include internal strategies (Gollwitzer, 1999; Paraskevaides et al. 2010) or the introduction of external memory aids to prompt task completion (Sohlberg et al., 2007; Raskin & Sohlberg, 2009). However, when identifying potential intervention strategies for substance users, the influence of co-morbid psychopathology must also be considered. Indeed, studies have revealed deficits in PM performance within both samples of depressed patients (Rude et al. 1999; Altgassen et al., 2009) and non-clinical samples reporting low mood (Kliegel & Jager, 2006). The latter also report evidence to suggest that high anxiety can impair PM performance. Therefore, the role of depression and anxiety in the relationship between substance use and PM impairments needs to be better conceptualised. Nonetheless, the PM difficulties associated with anxiety and depression tend to be specific to tasks that place greater demands on effortful cognitive processes. This further highlights why studies ought to include a range of PM tasks. Indeed, it is essential that research seeks to identify deficits that may exist in any form of PM, be they linked to co-morbid psychopathology, or more directly to the neuropsychological consequences of chronic substance use.

Conclusions

Although research regarding the impact of chronic substance use on PM ability has emerged within the last decade, this is currently limited to a handful of

studies for each substance. Conclusions regarding whether the chronic use of any of the four substances so far studied (alcohol, cannabis, MDMA and methamphetamine) impact on PM, are currently at best tentative, given the methodological limitations of existing research.

By reviewing the extant literature, we can pave the way for improvements in future research. Indeed, the majority of published studies in this area have been conducted from within the same few research teams, highlighting the need for the existing findings to be independently replicated within others. Furthermore, the potential clinical implications of PM deficits for former substance users highlight the importance of also beginning to investigate the influence of opioid use and other psycho-stimulants on PM ability. Indeed, these are substances for which rehabilitation is commonly sought, and it is within the rehabilitation context that interventions for PM deficits could best be applied.

There are several challenges associated with investigating the effects of recreational substance use on PM, particularly with regards to defining substance user groups, finding appropriate matched controls, and choosing ecologically valid yet reliable measures of PM. In doing so, a balance needs to be struck between conducting research that is theoretically informative and clinically useful.

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PART 2: EMPIRICAL PAPER

PROSPECTIVE MEMORY AND FUTURE EVENT SIMULATION IN

INDIVIDUALS WITH ALCOHOL DEPENDENCE

Abstract

Aim: To identify whether individuals with alcohol dependence display deficits in prospective memory (PM) and whether such deficits are overcome by imagining future task completion at the point of encoding.

Method: The PM of 24 abstinent 'alcohol dependents' was compared to that of 24 age and ability matched social drinkers using the Virtual Week (VW), both with and without imagining at encoding.

Results: Alcohol dependents' event based PM task performance was strongly associated with indices of alcohol usage, and significantly impaired compared to that of social drinkers. Imagining did not improve alcohol dependents' PM but did improve social drinkers' time based PM.

Conclusion: Alcohol dependents may experience PM deficits due to difficulties with effective strategy application. Interventions aimed at improving PM performance ought thus to be incorporated into alcohol misuse rehabilitation programmes.

Introduction

Prospective memory (PM) is the ability to 'enact intended actions at an appropriate moment in the future' (Ellis & Freeman, 2008; pp1). Tasks involving PM can be event based, where an action needs to be executed in response to a particular event (e.g. picking up a pint of milk when you pass the supermarket), time based, where an action needs to be executed at a particular time (e.g. telephoning a friend at 3pm), or activity based, where an action needs to be executed following the completion of another activity (e.g. putting the casserole on once you have finished your telephone call). Furthermore, all PM tasks are proposed to have a *retrospective component* (recalling the content of the action to be completed), and a *prospective component* (remembering the moment at which the action must be completed) (Einstein & McDaniel, 1996). It is thus broadly agreed that performance on such tasks relies both on retrospective memory for the task and the cues to task completions, and on executive functions, to enable the formation, initiation and execution of the intention to carry out the task (Burgess et al., 2008; Kliegel, Mackinlay & Jager, 2008a).

Most of our everyday acts of forgetting consist of PM failures, and such failures are also commonly reported in patients with brain injury (Hannon, Adams, Harrington, Fries-Dias & Gibson, 1995) and dementia (Smith, Della Sala, Logie, & Maylor, 2000). Unfortunately, significant PM deficits are likely to have broad implications for occupational, interpersonal and health-related functioning (Rendell & Henry, 2009). However, despite much research highlighting impairments in retrospective memory and/or executive functions amongst high alcohol users (Selby and Azrin, 1998; Pitel et. al., 2007; Noel et al., 2002), no study has objectively

investigated PM function in individuals with a clinical diagnosis of alcohol dependence.

Although some studies have reported that PM difficulties exist amongst heavier alcohol users, the majority of these have relied on self-report questionnaires (Heffernan, Moss, & Ling, 2002; Ling et al., 2003; Heffernan, Ling, & Bartholomew, 2004; Heffernan & Bartholomew, 2006; Heffernan et al., 2006b; Ling, Luczakiewicz, Heffernan & Stephens, 2010). Such measures are limited by several factors, including response bias and a reliance on meta-memory.

To date, only one study is known to have used an objective measure to assess PM amongst heavier alcohol users (Heffernan, Clark, Bartholomew, Ling, & Stephens, 2010). However, although an impairment was reported, the measure used in this study was only designed to assess event based PM, and failed to distinguish correct answers either from times when an action was recalled too late, or from occasions when an intention to complete an action was recalled in the absence of the action itself. Furthermore, similar to most of the self-report studies, which rely on samples recruited from college populations, Heffernan et al. (2010) focused on teenage binge drinkers rather than a clinical sample. The external validity and clinical utility of the existing evidence proposing that heavy alcohol use affects PM ability is thus highly limited.

The paucity of good research on PM in individuals with alcohol dependence is concerning in view of the potential for PM failures to precipitate relapse following rehabilitation (Paraskevaides et al., 2010). Indeed, Blume et al., (2005) posit that long term abstinence relies on the ability to put appropriate coping skills in place when faced with situations in which one is at high risk of relapse, this relying in part on PM skills. Similarly, Cognitive Behavioural Therapy (CBT), which plays a role in

many rehabilitation programmes, relies on the implementation of delayed intentions (Rendell, Mazur & Henry, 2009). Furthermore, relapse following rehabilitation may be precipitated by the life stress brought about by the impairments in functioning associated with PM deficits. An improved understanding of PM in individuals with alcohol dependence is thus important in order to better inform treatment within rehabilitation programmes.

Although there is a dearth of research relating to PM and alcohol dependence, two recent double blind placebo trials have revealed that an acute dose of alcohol does bring about PM deficits in objectively assessed PM (Leitz, Morgan, Bisby, Rendell & Curran, 2009; Paraskevaides et al. 2010). In both cases, PM was measured with a tool called the Virtual Week (Rendell and Craik, 2000). This assesses both time based and event based PM, distinguishes between frequent and occasional PM tasks, and enables correct responses to be distinguished from late and partial responses. Interestingly, both studies revealed acute alcohol to impact on the performance of PM tasks that placed minimal demands on retrospective memory. This led to the suggestion that the PM deficits had not arisen purely from impairments to the retrospective component of the tasks.

Leitz et al. (2009) postulated that acute alcohol might affect PM by temporarily impairing the ability to engage in episodic future thinking (EFT), a process also known as future event simulation (FES). FES is the process by which we mentally pre-experience future events (Atance & O'Neill, 2001), and has recently been proposed to play an important role in several aspects of everyday functioning, including PM (Schacter, Addis and Buckner, 2008). This is tentatively supported by findings from neuro-imaging studies (Okuda et al, 2003; Szpunar, 2007).

Schacter et al. (2008) propose that FES underlies the effectiveness of a strategy known as 'implementation intentions', which has been found to improve PM in a number of clinical populations (Brandstatter, Lengfelder & Gollwitzer, 2001; Chasteen, Park and Schwarz, 2001; Kardiasmenos, Clawson, Wilken & Wallin, 2008). Implementation intentions involve committing oneself to performing a particular behaviour when a specific situation is encountered in the future (Gollwitzer, 1999). Whilst it is the formation of this 'if-then relational construct' that is proposed to be at the core of the strategy's effectiveness at cuing task completion (Cohen and Gollwitzer, 2008, pp379), many of the studies revealing that implementation intentions can overcome PM deficits required participants to imagine completing the intention (Chasteen et al., 2001; Kardiasmenos et al., 2008). In line with this, Paraskevaides et al. (2010) found that acute alcohol-induced deficits in event based PM could actually be overcome by simply prompting participants during encoding to imagine themselves performing the task in detail. They proposed that this type of imagining represented engagement in FES, which enhanced PM by developing a visual–spatial context around the plan capable of prompting task completion (see Seifert and Patalano, 2001). They further postulated, in line with the ideas from Leitz et al. (2009) that this explicit engagement in FES compensated for an alcohol-induced deficit in the ability to do so naturally.

Although FES ability has not been directly studied in relation to alcohol dependence, impairments in *autonoetic consciousness* have been reported in alcohol dependent individuals following a period of abstinence (Pitel et al., 2007). Autonoetic consciousness is said to *"mediate[s] an individual's awareness of his or her existence and identity in subjective time extending from the personal past through the present to the personal future"* (Tulving, 1984, pp1), and it is thus

closely associated with FES (Wheeler, Stuss & Tulving, 1997; Atance & O'Neill, 2001). This further highlights the importance of explicitly investigating the relationship between alcohol dependence and PM ability, as well as the possible role of FES in mediating this relationship. Indeed, if relapse following rehabilitation is in some way related to PM deficits brought about by difficulties with FES, an approach that explicitly encourages FES may, as Paraskevaides et al. (2010) suggest, offer promise as a useful adjunct to therapy in future substance misuse rehabilitation programmes.

Aims

The primary aim of the present study was to investigate whether people with a diagnosis of alcohol dependence showed PM deficits following detoxification. The intention was to improve upon previous studies by assessing PM abilities using the Virtual Week (VW) (Rendell & Craik, 2000). A second aim was to assess whether prompting FES through the use of detailed imagining at the point of encoding improved the PM performance of abstinent alcohol dependent individuals. Thirdly, given the proposed role of both retrospective memory and executive functioning in PM ability, the relationship between these skills and PM performance was assessed, in order to identify whether alcohol-related PM deficits are secondary to impairments in either or both of these cognitive functions. Finally, as alcohol dependence is associated with increased levels of anxiety (Schuckit & Hesselbrock, 1994) and depression (Boden & Fergusson, 2011) and with impairments in attention (Tedstone & Coyle, 2004), all of which may subsequently impact on cognitive test performance, measures of each were taken in order to further elucidate the factors contributing to PM impairments in individual with alcohol dependence.

Throughout the remainder of this paper, the term 'alcohol dependents' will be used interchangeably with the term 'individuals with alcohol dependence'.

Hypotheses

As the current study is the first of its kind, some aspects were somewhat exploratory in nature, particularly with regards to elucidating the mechanism underlying any PM impairments associated with alcohol dependence. However, there were a number of hypotheses to be evaluated:

Firstly, given the existing body of evidence demonstrating that alcohol dependence is associated with impairments in retrospective memory and/or executive function (Selby and Azrin, 1998; Pitel et. al., 2007; Noel et al., 2002), the first hypothesis was that the performance of alcohol dependents on measures of retrospective memory would be poorer than that of social drinkers. The second hypothesis was that performance of alcohol dependents on tasks of executive functioning would be poorer than that of social drinkers.

In view of the general agreement that PM performance relies on both retrospective memory and higher executive skills (Burgess et al., 2008; Kliegel, Jager, Altgassen and Shum, 2008b), the third hypothesis was that alcohol dependents would perform significantly less well than social drinkers on the Virtual Week (VW). Given the paucity of research regarding the influence of alcohol dependence on PM performance, no hypotheses were generated regarding the types of PM tasks on which performance would be impaired.

The forth hypothesis drew from Paraskevaides at al.'s (2010) findings regarding the effects of imagining on PM performance in healthy volunteers. This stated that participants in both groups would complete a greater proportion of irregular event

based VW tasks correctly when instructed to use imagining at encoding, than when not instructed to imagine the tasks at encoding.

Method

Participants

A power analysis was conducted using G*power computer program (Faul, Erdfelder, Lang and Buchner, 2007), specifying alpha=5% and desired power =80%. As G*power doesn't allow for 3 way interactions, the calculation was based on the weakest effect size of interest (η2= .073: medium) in Leitz et al. (2009), given that this study,had used the virtual week to examine the effects of acute alcohol on PM performance. Although this calculation suggested a total sample size of 22 (11 per group), this estimate was felt to be too conservative, in view of the expectation that supplementary analyses would be conducted, As Leitz et al., (2009) yielded interesting and significant findings of medium effect size with a sample size of 40, a total sample size of 48 (24 per group) was decided upon instead.

24 individuals with a diagnosis of alcohol dependence (8 females) were recruited from a residential substance misuse service at the Bethlem Royal Hospital, Kent, UK. A matched control group of 24 social drinkers (8 females) with no self-reported history of alcohol dependence was recruited from the University College London (UCL) subject pool and through emails to UCL postgraduates, advertisements on a community 'classifieds' website and the 'snowballing' method.

Potential participants in the alcohol dependent group were identified from information provided by clinical staff working on the substance misuse unit. Eligibility was confirmed through the use of a screening tool completed with the potential participant prior to them consenting to taking part. This consisted of

questions relating to each of the eligibility criteria so that these could be confirmed directly with each potential participant (see appendix 1). All participants had a current diagnosis of alcohol dependence and had recently completed a 7-10 day medically assisted withdrawal programme using gradually decreasing doses of either chlordiazepoxide or, in a small number of cases, oxazepam. Daily doses started from 160-100mg at the beginning of the programme, depending on the severity of dependence, and reduced to 10mg on the final day of detoxification. All participants took part in the study at least 12 hours after their final 5mg dose. According to all available knowledge, all had been abstinent from alcohol and illicit substances for at least 7 days. Exclusion criteria included: a current or recent (within the last 6 months) diagnosis of dependence on any substance other than alcohol; a diagnosis of any neurological condition; a history of traumatic brain injury or stroke; current or recent (within the last 3 weeks) experience of psychosis; a diagnosis of learning disability; reading difficulties; current use of anti-psychotic medication or benzodiazepines.

Each social drinker was selected to match an alcohol dependent participant as far as possible according to age (+/- 3 years), gender and highest level of education. Females were excluded if they reported consuming outside 2-25 units of alcohol per week, whilst males were excluded if they reported consuming outside 2-36 units of alcohol per week. The same exclusion criteria as those for the alcohol dependents were applied to the social drinkers. In order to screen out problematic drinking, individuals scoring above 2 on the CAGE alcohol screening questionnaire (Ewing, 1984) (appendix 2) were excluded from participating. This measure has a test-retest reliability of 0.8-0.95, has an average sensitivity of 0.71 and specificity of 0.90 (Dhalla & Kopec, 2007).

All participants in the social drinker group were asked to avoid consuming alcohol and any illicit substances for 24 hours prior to testing.

Measures

Prospective Memory. The Virtual Week (VW) (Rendell & Craik, 2000) is an objective assessment of PM which assesses a range of PM abilities. The version used in the current study consists of a computerised virtual board game in which participants move a counter around a board by rolling an electronic die (see Figure 1). It is administered in the form of virtual "days", each of which is represented by one 'round' of the board. The virtual time of day is represented on a 24 hour clock in the centre of the board, and changes as the counter moves around the board, to illustrate the passing of time. When a participant's counter lands on or passes a green 'E' square, they are instructed to 'pick up an Event Card', which symbolises an event occurring in their day e.g. breakfast. Each Event Card asks the participant to make a multiple choice decision e.g. what to have for breakfast.

Both at the start and at 2 points during the course of each virtual day, the participant is assigned a number of different tasks that they must remember to perform at particular points later in the day. These serve to measure PM. In the form of the VW used in the current study, each day contained four tasks to be performed at specified times of day (as displayed on the 24 hour clock) and four tasks to be performed in response to particular events (described on the 'Event Cards').
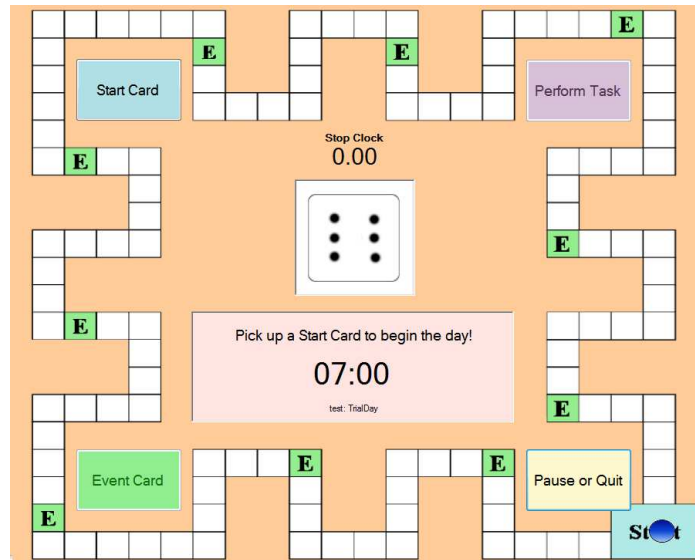
Figure 1. *Virtual Week Board Game*

Two of the time based tasks and two of the event based tasks re-occurred on every virtual day (e.g. taking antibiotics at breakfast), and were thus classed as 'regular' tasks. The remaining four tasks differed completely on each virtual day played by the participant, and were thus 'irregular' tasks. Each time a participant wished to perform a task, they could choose to select the 'Perform Task' button, which presented them with a list of possible tasks to choose from. The VW programme automatically records whether a task is correctly performed, missed or performed late.

VW scores for each task type (regular time based, irregular time based, regular event based, irregular event based) were calculated by dividing the number of tasks of that particular type completed correctly by the total number of tasks of that type administered. 'Prospective component' scores were also calculated for each task type by dividing the number of tasks for which the participant correctly recalled the prospective component (remembering that they needed to do something, even if they could not remember what), by the number of tasks of that type administered.

The computerised VW used by Paraskevaides et al. (2010), was altered so that it would be more suitable for use with the current sample. Therefore, the contents of tasks and event cards was carefully changed to ensure that alcohol cravings would not be cued ,or other negative feelings (e.g. guilt) would not be aroused in the course of the experiment. This involved removing all references to children, alcohol or eating out in restaurants from event cards and PM tasks, and replacing these with more neutral concepts.

Paraskevaides et al's tasks had been designed for administration to participants in a university population. However, given that FES is assumed to draw from episodic memories of past experiences (Schacter and Addis, 2007), tasks relating to university life e.g. going to a lecture were replaced with more generic tasks e.g. going to the launderette, so that they would be familiar to participant in either group (see appendix 3 for VW task details).

In its original format, which takes the form of an actual board game, the VW has been shown to have test re-test reliability of between.84 to .94 (depending on task type) in healthy adults (Rose, Rendell & McDaniel, 2007) and a split half reliability of 0.74 in clients with schizophrenia (Henry, Rendell, Kliegel & Altgassen, 2007). Reliability data is yet to be collected on computerised versions of the VW such as that used in the current study, but, whilst the contents of the tasks differs in many cases, the structure of the tasks remains unchanged from the original version.

The Prospective Retrospective Memory Questionnaire (PRMQ) (Smith, et al., 2000) is a self-report memory measure which requires participants to rate everyday 'memory slips' on a 5 point scale, depending on how often each is typically

experienced. It contains 8 items assessing retrospective memory and 8 assessing prospective memory, and has produced chronbach alpha values of between 0.80 and 0.89 (Uttl & Kibreab, 2011). The PM scale has shown correlations with laboratory based PM tasks ranging from -0.22 to +0.13, whilst the retrospective memory scales has shown correlations from -0.22 to -0.09 with laboratory based memory tasks (Uttl & Kibreab, 2011).

Episodic memory. The *Story Recall* task, (Wilson, Cockburn and Baddeley, 2003), requires participants to listen to a short passage in the form of a news report and to repeat back everything they can recall, both immediately and after a 20 minute delay filled with other tasks. Marks and half marks are awarded using the standard scoring of the RBMT-II, for each story component correctly or partially recalled, both immediately after administration and after a 20-25 minute delay.

Executive Function. A *Category Fluency* task that requires participants to name as many fruit as they can think of in 60 seconds, and a *Verbal Fluency* task that requires participants to name as many words as they could think of beginning with the letter 'n' in 60 seconds were used (appendix 4). Both aim to provide indices of initiation, retrieval and organisational skills.

The *Trail Making Test (TMT)* (Army Individual Test Battery, 1944) involves timing the participant to first join up a series of numbered circles in numerical order (Trails A), and then to join up the same number of circles, half of which are numbered and half of which contain letters of the alphabet, by alternating between numbers and letters (e.g. 1-A-2-B etc.) (Trails B). In both cases, the participant is instructed to complete the task as fast as they can in one continuous movement. A

number of studies have found this tool to produce reliability co-efficients of 0.8 and above (Spreen & Strauss, 1998). The trails B time/ trails A time proportion is said to provide an index of cognitive flexibility (Arbuthnott & Frank, 2000).

Attention. *A Single Digit Cancellation Task (SDCT)* (White & Lintzeris, 2010), in which participants are timed in crossing out all the number 4s randomly interspersed within a block of 400 digits, provides an index of sustained attention in the form of the time taken and the number of omissions made.

Pre-morbid intelligence. *Spot the Word* (Baddeley, Emslie, & Nimmo-Smith, 1993), a task that requires participants to identify the real word from each of 60 letter string pairs. This measure produced a correlation of 0.83 when compared with the National Adult Reading Test (another measure of pre-morbid intelligence), indicating adequate validity. It also correlates well (0.88) with a parallel form, indicating good reliability.

Anxiety. The Trait Anxiety Self Evaluation Questionnaire from the *State-Trait Anxiety Inventory (STAI)* (Spielberger, 1983), in which each of 20 statements is scored between 1 and 4 according to how the participant generally feels, provides an index of general anxiety. The test-retest reliability of this measure is reported to be 0.86 (Rule & Traver, 1983). It has also shown concurrent validity of between 0.73 and 0.85 when correlated with other anxiety scales (Spielberger, Reheiser, Ritterband, Sydeman & Unger, 1995).

Depression. The *Beck Depression Inventory (BDI-II)* (Beck, Steer & Brown, 1996) is a 21-question self-report inventory that measures the severity of depression experienced over the previous two weeks. Each question receives a score of 0 to 3. It is reported to have an internal consistency of 0.92, and a test-retest reliability of 0.93 for the outpatient population (Beck et al., 1996). It also shows good criterion validity with a correlation of 0.71 against the Hamilton Psychiatric Rating Scale for Depression (Beck et al., 1996). The BDI-II also provides cut-off scores for mild, moderate and severe depression.

Severity of Alcohol Dependence. The Severity of Alcohol Dependence Questionnaire (SADQ) (Stockwell et al, 1979) (appendix 5) contains 20 items covering physical and affective withdrawal symptoms, speed of withdrawal onset, relief drinking and frequency of alcohol consumption, each of which is scored from 0 to 3. It has a test-retest reliability of 0.85, and has been found to correlate with clinician ratings of alcohol dependence (Allen & Wilson, 2003).

Procedure

This study was approved both by the Joint South London and Maudsley and Institute of Psychiatry NHS Research Ethics Committee (appendix 6) and by UCL's Clinical, Educational, and Health Psychology Research Department Ethics Committee.

Written informed consent (appendices 7 &8) was obtained from all participants prior to them taking part. The assessments of the alcohol dependents were also intended for use in a separate follow-up study examining the relationship between PM and relapse following rehabilitation. This study is currently ongoing

(see appendix 9). Alcohol dependents thus gave consent to be contacted by telephone several months after testing, in order to answer a few questions about how they had been 'getting on'.

Participants in the alcohol dependent group were tested individually on the premises of the unit where they were currently resident. Social drinkers were tested individually at the Clinical Psychopharmacology Unit, UCL.

All participants were first asked questions regarding any current medications, recent regular use of any illicit substances and basic demographic information.

Alcohol dependents were asked how many units of alcohol they had consumed in a day prior to entering rehabilitation, whilst social drinkers were asked how many units they typically consumed in a week. Therefore, the quantities reported by participants in the alcohol dependent group were subsequently multiplied by seven in order to approximate a weekly number of units.

The VW instructions were explained to the participant and a trial day was used to orientate them to the task and give them a practice session. The participant then completed two VW days. Participants were not permitted to perform any PM task until they had articulated the contents of the task to the examiner. The examiner did not provide feedback on accuracy and participants were not given credit for performing tasks that were obviously prompted by seeing the 'Perform Task' list, nor for selecting from the list a different task to the one they had originally articulated. Participants were not permitted to select the 'Perform Task' button unless they could recall at least a close approximation to one of the tasks contained within the 'Perform Task' list i.e. no more than one key component of the task recalled incorrectly. The examiner noted occasions when participants accurately stated that a task needed to be performed (thus recalling the prospective component of the PM task), but either

performed a different task, or could not recall sufficient details regarding the contents of the correct task.

After a 10 minute break, participants were taught how to use an imagining technique designed by Leitz et al. (2009), and given the opportunity to practice it. This involves imagining oneself carrying out the task, and setting the image as much as possible in one's real life (e.g. participants were told that if the task involved going to the supermarket, they should imagine the supermarket they typically doing their shopping in) (See appendix 10 for the imagining script). Participants were then administered two further days of the VW, but were prompted by the researcher to adopt imagining for 10 seconds each time an irregular task was presented to them on the screen. Each time they used the imagining technique, they were asked to give two scores, each on an anchored 5 point scale, to represent the vividness of their image and their impression of living the experience (appendix 11). After completing the second two days of the VW, participants were administered the PRMQ verbally, and then given a second 10 minute break. After the break, they were administered the remaining tasks in the following order: Immediate Story Recall; Verbal and Category Fluency; Trails A & B; SDCT; Spot the Word; STAI; BDI– II; Delayed story recall; SADQ (alcohol dependent group only); Final questions were asked regarding typical use of memory aids, strategies used during VW, and perceived helpfulness of the imagining technique. Each testing session lasted approximately 2-2 ½ hours including the two breaks. See figure two for flow diagram of the study design.

Statistical analyses

Prior to conducting any statistical analyses, all data were examined for assumptions of normality. In the case of Virtual Week results, the data from one

participant in the alcohol dependent group was removed from the data set because they obtained a complete score of 0 across the whole VW task, indicating that this might reflect their understanding of the task rather than PM performance.

Analyses of VW data were made using repeated measures ANOVAs. Bonferroni corrected post hoc t-tests were conducted, and the findings for data for which normality assumptions were not met were verified using non-parametric tests prior to reporting the t-test result.

Data from immediate and delayed story recall were also analysed using repeated measures ANOVA. Group comparisons for most other variables were made using independent samples t-tests, with the removal prior to analysis of outliers that had a z score >2.75. However, in cases where data was highly skewed (with a z score of >2.5) or showed a binomial distribution, non-parametric Mann Whitney U tests were used instead. Bonferroni corrections for multiple comparisons were made where appropriate.

Pearson correlations were conducted to identify any associations between VW performance and specified, relevant variables. However, in cases where the distributions of the two variables were too dissimilar, the non-parametric Spearman's rho was conducted instead.

Identification
- Alcohol dependents identified by direct care staff
- Social drinkers responded to advertisements/emails etc.

Screening
- Check eligibility criteria in person/over the phone (social drinkers)
- CAGE (social drinkers only)

Informed consent
- Talk through information sheet and give opportunity to answer questions
- Talk through and sign consent form

24 Social Drinkers

24 Alcohol Dependents

Testing Phase 1:
- Demographic/substance use info
- Instructions and trial 'day' of VW
- 2 'days' of VW including:
  ➤ 4 x event based regular tasks
  ➤ 4 x time based regular tasks
  ➤ 4 x event based irregular tasks
  ➤ 4 x time based irregular tasks

10 minute break

Testing Phase 2:
- Imagining instructions and practice
- 2 more 'days of VW including:
  ➤ 4 x event based regular tasks
  ➤ 4 x time based regular tasks
  ➤ 4 x event based irregular tasks (with imagining)
  ➤ 4 x time based irregular tasks (with imagining)
- Prospective Retrospective Memory Questionnaire

10 minute break

Testing Phase 3:
- Immediate Story Recall
- EF Measures: Verbal and Category Fluency & Trails A & B
- SDCT
- Spot the Word
- Emotional measures: STAI & BDI– II
- Delayed Story Recall;
- SAD-Q (alcohol dependents only)
- Final questions re: strategy use & helpfulness of imagining

Debrief

Figure 2: Flow diagram illustrating the study design

<center>**Results**</center>

Group demographics

An independent samples t test revealed no significant difference in age between the social drinker group ($M = 41.9$, $SD = 8.63$ years) and the alcohol dependent group ($M = 42.0$, $SD = 8.74$ years), $t(46) = 0.050$, p $= .960$. As the data for *units of alcohol consumed per week* and *Spot-the-Word* violated assumptions of normality, group comparisons on these variables were conducted using Mann-Whitney U tests. These revealed no group difference in pre-morbid ability (*Spot-the-Word*) between the alcohol dependent group ($Mdn = 50.5$, IQR $=10.0$) and social drinker group ($Mdn = 51$, IQR $= 6$) $U = 250$, p $= .430$, r $= .113$. However, as expected, the alcohol dependent group reported consuming significantly more units of alcohol per week ($Mdn = 220$, IQR $= 112$) than the social drinker group ($Mdn = 10$, IQR $= 13$), $U < 0.001$, p $< .001$, r $= .859$. SADQ scores in the alcohol dependent group (M $= 37.79$, SD $= 12.76$) ranged from 14 to 58, with 17/24 obtaining a score of 30 or more, thus meeting the cut-off for moderate to severe alcohol dependence (Meehan, Webb & Unwin, 1985) . This is despite all members of this group having received a clinical diagnosis of alcohol dependence.

Substance use

A 2x2 χ^2 analysis revealed that a significantly greater proportion of alcohol dependents than social drinkers were current smokers χ^2 (1, N=48) $= 14.3$, p$<.001$, with four participants in the social drinker group reporting current tobacco use compared to 19 participants in the alcohol dependent group. Furthermore, the social drinkers consumed an average of 15.0 (SD=4.08) cigarettes per day, compared to 22.9 (SD=12.3) in the alcohol dependent group.

No social drinkers reported regular use (≥ once per month) of any illicit

substances in the previous six months. Of the alcohol dependent group reporting

recent regular use of illicit substances, eight reported use of cannabis, three of

cocaine, two of crack cocaine, one of MDMA, and one of amphetamines. The

cannabis users reported using cannabis an average of 3.50 (SD=2.35) times per week.

Pre-imagining Virtual Week

Table 1. *Comparisons of social drinkers to alcohol dependents on proportion of*

irregular and regular PM tasks completed correctly in the pre-imagining VW

PM task type	Social drinker M (SD)	Alcohol dependent M (SD)	t	df	P
Irregular					
Event based	0.74 (*0.29*)	0.37 (*0.33*)	-4.11	45	<.001*
Time based	0.41 (*0.29*)	0.30 (*0.25*)	-1.28	45	.207
Regular					
Event based	0.87 (*0.20*)	0.45 (*0.35*)	-5.22	35	<.001*
Time based	0.80 (*0.24*)	0.66 (*0.33*)	-1.62	40	.112

* Significant finding

The data from the two pre-imagining VW days (i.e. those administered prior

to the introduction of imagining at encoding) were first analysed to assess any group

differences in PM performance. The dependent variable was the proportion of tasks

that were completed correctly. A 2x2x2 repeated measures ANOVA with the

between subjects factor of group (alcohol dependent, social drinker) and within

subjects factors of task regularity (irregular, regular) and task type (event based, time

based) revealed a significant interaction between group and task type, $F(1, 45) =$

11.1, p = .002. There was also a significant interaction between task regularity and

task type F(1, 45) = 20.5, p < .001. There was no significant interaction between task

regularity and alcohol group, F(1, 45) = .600, p=.442, and no significant three way

interaction between task regularity, task type, and alcohol group, F(1,45) = .034,

p=.854.

Significant main effects of group F(1,45) = 19.6, p < .001 and task regularity

F(1,45) = 60.2, p<.001 were also found, with the overall performance being poorer in

the alcohol dependent group than in the social drinker group, and poorer in irregular

tasks compared to regular tasks. There was no significant main effect of task type,

F(1,45) = 2.30, p=.136.

Figure 3 highlights the interaction between alcohol group and task type.

Bonferroni adjusted post hoc pairwise comparisons, using estimated marginal means,

showed that social drinkers performed significantly better on event based (M=0.81,

SE=.054) than on time based (M=0.60, SE=.047) tasks, F(1,45)=12.0, p=.001, whilst

there was no significant difference between event based (M=0.41, SE=.055) and time

based (M=0.48, SE=.048) task performance in the alcohol dependent group,

F(1,45)=1.62, p=.210.
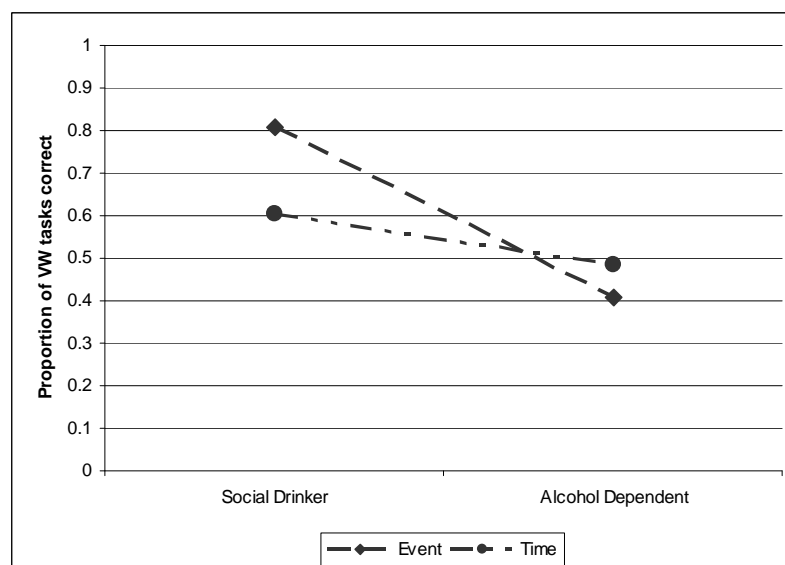
*Figure 3: Interaction between alcohol group and task type on VW proportion correct
data*

Figure 4 highlights the interaction between task regularity and task type. Bonferroni adjusted post hoc pairwise comparisons, using estimated marginal means, showed that, when PM tasks were irregular, performance was significantly better if they were event based (M=0.56, SE=.045) than if they were time based (M=0.34, SE=.040), $F(1,45)=14.3$, $p<.001$. However, there was no significant difference between event based (M=0.66, SE=.041) and time based tasks performance (M=0.73, SE=.043) when tasks were regular, $F(1,45)=2.06$, $p=.158$.
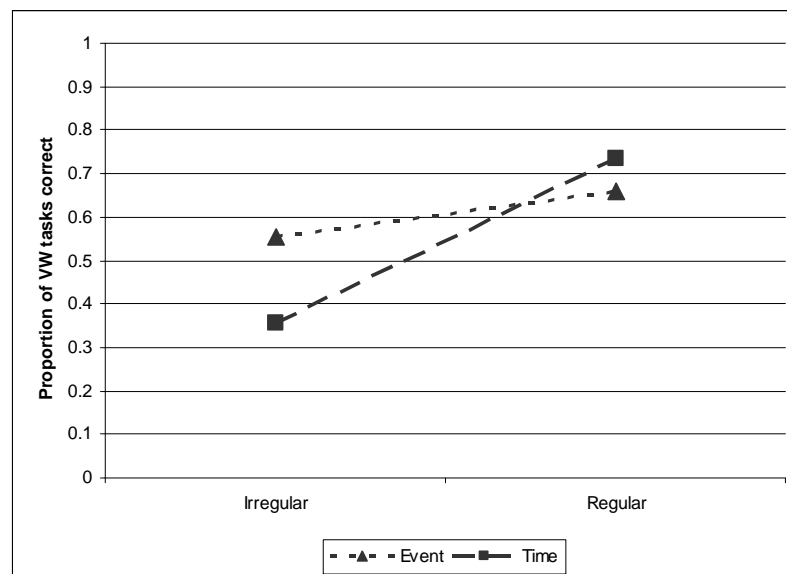
Figure 4: Interaction between task regularity and task type on VW proportion correct data

As can be seen from Table 1, post hoc independent samples t-tests with the Bonferroni adjusted α level of .0125 revealed significant impairments in the alcohol dependent group compared to the social drinker group in both regular and irregular event based task performance. In contrast, the two groups did not differ significantly in their performance on either regular or irregular time based tasks.

Virtual Week with imagining

Proportion correct. To assess the impact of imagining on PM performance, the proportion of irregular VW tasks completed correctly before the introduction of imagining at encoding was compared to that with imagining at encoding. A 2x2x2 repeated measures ANOVA with the between subjects factor of group (alcohol dependent, social drinker) and within subjects factors of encoding condition (Pre-imagining, imagining) and task type (event based, time based) revealed a significant interaction between group and task type $F(1, 45) = 5.79$, $p = .020$. There was no significant interaction between group and encoding condition, $F(1,45) = .412$, $p=.524$, or between task type and encoding condition, $F(1,45) = .966$, $p=.331$ and no significant three-way interaction between group, encoding condition and task type, $F(1,45) = 2.58$, $p=.115$. Significant main effects of group $F(1, 45) = 17.1$, $p < .001$, task type $F(1, 45) = 20.6$, $p < .001$ and encoding condition $F(1, 45) = 11.4$, $p = .002$ were all identified.

Figure 5 highlights the interaction between group and task type. Bonferroni adjusted post hoc pairwise comparisons, using estimated marginal means, showed that social drinkers performed significantly better on irregular event based tasks (M=0.77, SE=.055) than irregular time based tasks (M=0.50, SE=.046), $F(1,45)=24.7$, $p<.001$, whilst there was no significant difference between irregular event based (M=0.42, SE=.057) and irregular time based task performance(M=0.34, SE=.047) in the alcohol dependent group, $F(1,45)=2.23$, $p=.143$.

As can be seen in Table 2, post hoc paired sample t-tests using the adjusted α level of .0125 showed that only time based PM task performance in the social drinker group improved significantly with the introduction of imagining at encoding. This is seen clearly in Figure 7. There were no significant improvements in event based PM

in the social drinker group, and no significant improvement in either event based or time based PM in the alcohol dependent group.
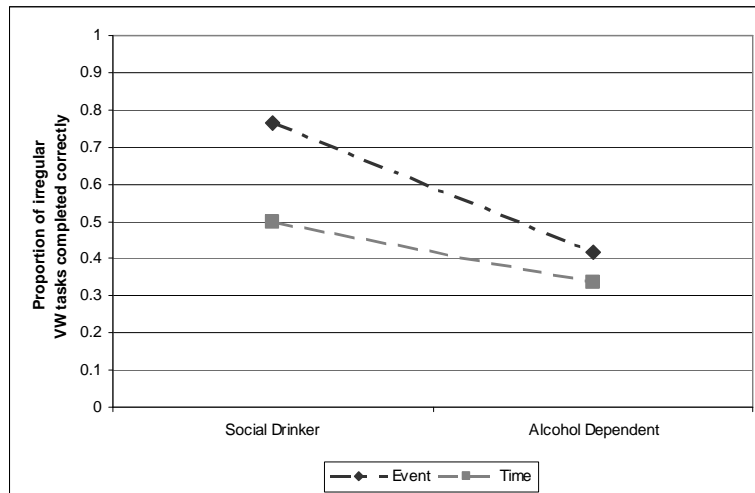
Figure 5: Interaction between alcohol group and task type for proportion of irregular VW tasks completed correctly

Table 2 *Post hoc group comparisons of proportion of irregular PM tasks completed correctly pre-imagining and with imagining at encoding*

Task type	Pre-imagining M (SD)	Imagining M (SD)	t	df	P
Social drinker (n=24)					
Event based	0.74 (*0.29*)	0.79 (*0.23*)	0.96	23	.347
Time based	0.41 (*0.29*)	0.59 (*0.25*)	3.09	23	.005*
Alcohol dependent (n=23)					
Event based	0.37 (*0.33*)	0.47 (*0.36*)	1.68	22	.107
Time based	0.30 (*0.25*)	0.37 (*0.25*)	1.30	22	.208

Significant finding

Wilcoxon signed ranks tests revealed no significant change in the proportion of irregular time based tasks completed correctly by the social drinker participants between days 1 (*Mdn* = 0.50, IQR = 0.50) and 2 (*Mdn* = 0.25, IQR = 0.88) of the VW, *Z* = -.566, p = .572, and no significant change between days 3 (*Mdn* = 0.50, IQR=0.50) and 4 (*Mdn* = 0.50, IQR= 0.50) of the VW, *Z* = -.233, p = .816.
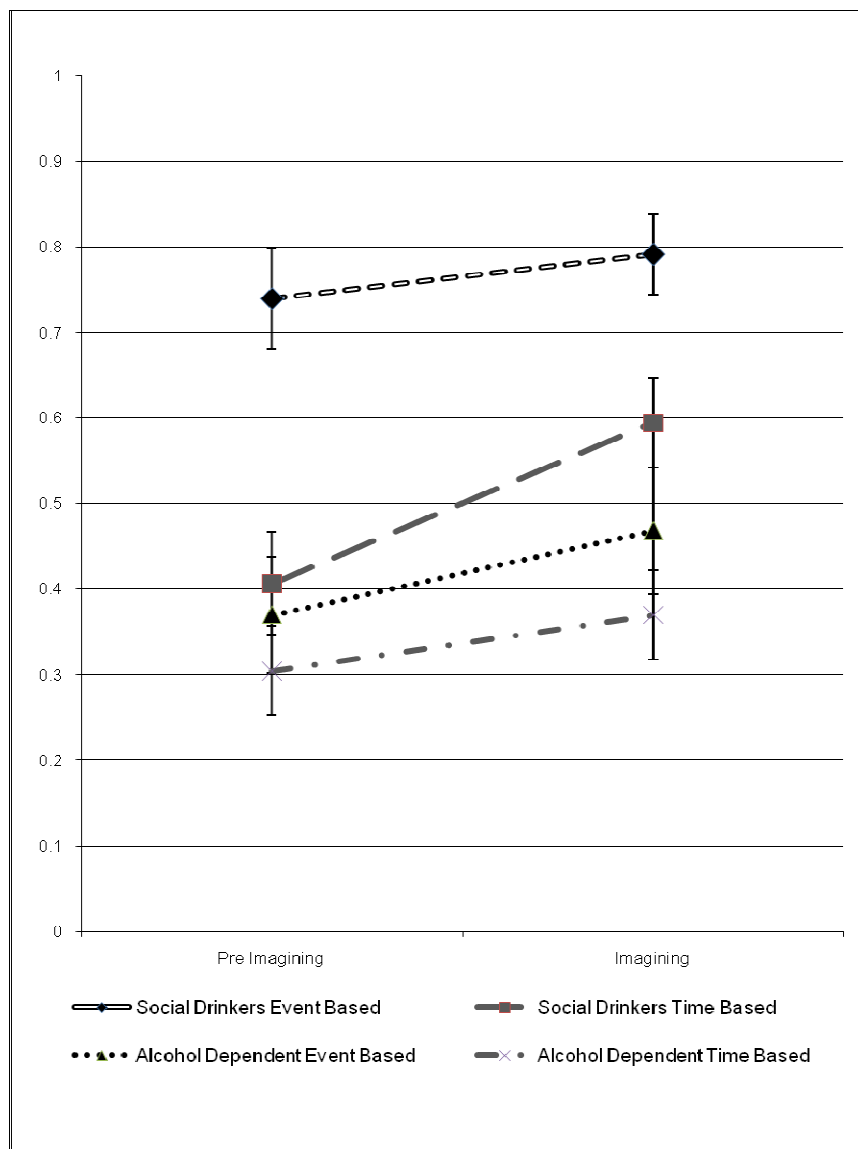
Figure 6. *Proportions of irregular PM tasks completed correctly by each group pre-imagining and with imagining at encoding. Bars represent ± standard error.*

The prospective component of PM tasks. A 2x2x2 repeated measures ANOVA with the between subjects factor of group (alcohol dependent, social drinker) and within subjects factors of encoding condition (pre imagining, imagining) and task type (event based, time based) was repeated with the proportion of irregular tasks for which the prospective component was recalled correctly as the dependent variable. This revealed a significant interaction between group and task type $F(1, 45) = 4.59$, $p = .038$, but not between group and encoding condition $F(1,45)=1.32$, $p=.258$ or encoding condition and task type $F(1,45)=3.71$, $p=.061$ or between group, encoding condition and task type $F(1,45)=3.71$, $p=.061$. Significant main effects of both encoding condition, $F(1, 45) = 8.67$, $p = .005$ and group $F(1, 45) = 15.1$, $p < .001$ were found, but there was no main effect of task type, $F(1, 45) = 1.79$, $p = .188$.

Figure 6 highlights the interaction between group and task type. Bonferroni adjusted post hoc pairwise comparisons, using estimated marginal means, showed that social drinkers performed significantly better on the prospective component of irregular event based tasks (M=0.82, SE=.052) than on that of irregular time based tasks (M=0.68, SE=.043), $F(1,45)=6.18$, $p=.017$, whilst there was no significant difference between recollection of the prospective component of irregular event based (M=0.52, SE=.053) and irregular time based tasks (M=0.55, SE=.044) in the alcohol dependent group, $F(1,45)=.319$, $p=.575$.

As can be seen in Table 3, post hoc paired sample t-tests showed that recollection of the prospective component of tasks only improved with the introduction of imagining in the social drinker group, and only on time based tasks.

Independent samples t-tests on data for recall of the prospective component also revealed significant group differences on the pre-imagining VW in irregular

event based tasks t(45) = 4.12, p<.001, but not irregular time based tasks t(45) = 0.52, p=.608.
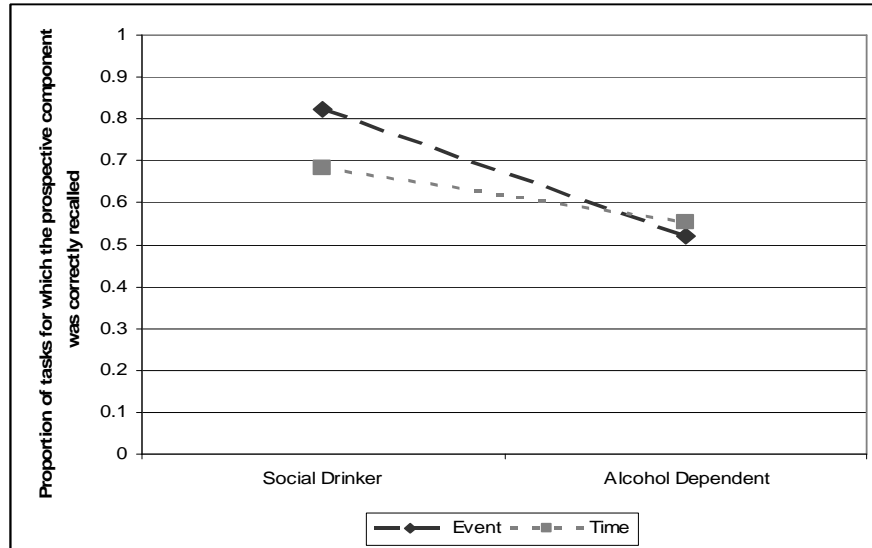

Figure 7: Interaction between alcohol group and task type for proportion of the prospective component of the VW correctly recalled

Table 3. *Post hoc group comparisons of proportion of irregular PM tasks for which the prospective component was recalled correctly with and without imagining*

Task type	Pre- imagining M (SD)	Imagining M (SD)	t	df	p
	Social drinker (n=24)				
Event based	0.83 (0.26)	0.81 (0.24)	-0.46	23	.647
Time based	0.57 (0.25)	0.79 (0.22)	3.60	23	.002*
	Alcohol dependent (n=23)				
Event based	0.50 (0.29)	0.54 (0.35)	0.68	22	.505
Time based	0.53 (0.29)	0.58 (0.25)	0.85	22	.406

*Significant finding

Vividness and Impression of living the experience ratings. As separate *vividness* and *impression of living the experience* ratings were given for each of eight different tasks, a mean vividness rating and a mean impression of living the experience rating was calculated across all eight tasks for each participant. Group comparisons using these values revealed significantly higher *vividness* ratings in the alcohol dependent group (M=3.83, SD=0.63) than in the social drinker group (M=3.35, SD=0.66), t(46) = 2.56, p = .014). However, no significant difference was found between the alcohol dependent (M = 3.44, SD = 0.75) and the social drinker group (M = 3.19, SD = 0.67), t(46) = 1.22, p = .228) in *impression of living the experience* ratings.

As there was an improvement in the social drinker group in time based task performance following imagining, groups were compared using Mann Whitney U tests on the mean *vividness* rating and mean *impression of living the experience* rating given for the four time based tasks. There was no significant difference in *vividness* ratings between the alcohol dependent (*Mdn* =3.88, IQR = 1.19) and social drinker group (*Mdn* =3.25, IQR = 1), *U* = 205, *p* = .084, *r* = -.250, nor any significant difference in *impression of living the experience* ratings between the alcohol dependent (*Mdn* = 3.63, IQR = 1.44) and social drinker group (*Mdn* = 3.00, IQR = 1.25), *U* = 225, *p*= .189, *r* = -.190.

Self-reported memory (PRMQ)

The *retrospective memory* scale and *prospective memory* scale of the PRMQ were analysed separately. In the analysis of the *prospective memory* scale, one of the social drinker participant's scores was removed because it was an outlier.

On the *retrospective memory* scale there were significantly higher scores in the alcohol dependent group (M = 23.3, SD = 5.53) than the social drinker group (M = 19.0, SD = 3.18), t(36.7) = 3.30, p = .002, indicating poorer self-rated retrospective memory in the alcohol dependent group. In contrast no significant difference was found between the alcohol dependent group (M =24.3, SD=6.46) and the social drinker group (M=21.7, SD = 2.27), in self-reported prospective memory, although there was a trend towards the alcohol dependent group reporting more PM difficulties t(28.8) = -1.85, p = .074.

Executive function

Table 4. *Group means (SD) for Trails A, Trails B/Trails A proportion and Category Fluency, and group medians (IQR) for Trails B and Verbal Fluency*

Test	Social drinker		Alcohol dependent	
Trails A (secs)	19.7	(5.22)	31.70	(9.57)
Trails B (secs)	39.0	(21.20)	46.70	(28.60)
Trails B/ Trails A	2.0	(0.58)	1.76	(0.57)
Verbal Fluency	10.0	(6.00)	9.50	(6.00)
Category Fluency	17.5	(3.62)	16.20	(3.48)

Due to a change in the research design early on in the study, two of the alcohol dependents were not administered any of the executive function tasks. Furthermore, one outlier was removed from the social drinker group and one from the alcohol dependent group prior to analysis of the *Trails A* data, whilst one outlier was removed from the social drinker group prior to analysis of the *Trails B/A*

proportion data. Mean/median scores on all the measures of executive functioning used are displayed in Table 4.

An independent samples t-test revealed a significant group difference in *Trails A* time t(30.3) = -5.10, p < .001, whilst a Mann-Whitney U test revealed a significant group difference in *Trails B* time, U = 148, p = .011, r = -.376, with a medium effect size. However, there were no significant group differences in *Trails B/A proportion*, t (43) = 1.41, p = .170, nor in *Category Fluency* scores t(44) = 1.25, p = .220, or *Verbal Fluency* scores U = 201, p = .160, r = - .205.

Story recall

Table 5. *Group Mean (SD) for Immediate and Delayed Story recall*

Delay	Social Drinker		Alcohol Dependent	
	M	(SD)	M	(SD)
Immediate	10.23	(2.92)	8.38	(2.85)
Delayed	8.63	(2.67)	6.62	(3.40)

Due to an administration error, delayed story recall scores were not available for three alcohol dependents. Group means are shown in Table 5. A 2x2 repeated measures ANOVA, with a between subject factor of group (alcohol dependent, social drinker) and a within subject factor of delay (immediate, delayed), revealed no significant interaction F(1,43) = 0.141, p = .709, indicating that there was no greater difference between immediate story recall and delayed story recall in the alcohol dependent group than the social drinker group. However, there were significant main effects of both group F(1,43) = 5.03, p = .030, and delay F(1,43) = 64.3, p < .001

with the social drinker group performing better than the alcohol dependent group and immediate memory performance being greater than delayed memory performance.

Digit Cancellation

Due to researcher error, the number of omission errors on the Single Digit Cancellation task (SDCT) was not recorded for one of the participants in the social drinker group and accurate timings on the SDCT were not recorded for that same social drinker, or for three of the alcohol dependents. Furthermore, in the analysis of SDCT time, one of the alcohol dependent's scores was removed because it represented an outlier.

An independent sample t-test revealed significantly longer SDCT completion times in the alcohol dependent group ($M = 75.8$, $SD = 19.6$) than in the social drinker group ($M = 56.1$, $SD = 7.04$), $t(23.2) = 4.25$, p < .001. However, a Mann-Whitney test showed that there was no significant difference between the social drinker group ($Mdn = 1$, IQR = 3) and the alcohol dependent group ($Mdn = 1$, IQR = 3) in the number of SDCT omission errors made, $U = 253$, $p = .608$ $r = -.075$.

Depression

An outlier on the BDI-II scores of one participant in the social drinker group was removed prior to conducting an independent samples t-test, which revealed significantly higher BDI-II scores in the alcohol dependent group ($M=25.3$, $SD=11.3$) than in the social drinker group ($M=6.65$, $SD=5.09$), $t(32.2) = 7.34$, $p <$ .001. Table 6 shows a breakdown of the participants in each group according to which clinical category their BDI-II score corresponded to. It was not possible to conduct a χ^2 analysis on this data because 62.5% of cells had an expected count of

less than five, however there is a clear trend toward more severe depression in the alcohol dependent group and minimal depression in the social drinker group.

Table 6. *Number of participants in each group scoring in each of the clinical categories on the BDI-II*

Score range	Clinical category	Social Drinker (n=24)	Alcohol Dependent (n=23)
0-13	Minimal	19	5
14-19	Mild	4	2
20-28	Moderate	1	6
29+	Severe	0	10

Table 7. *Independent samples t-tests comparing VW performance of alcohol dependents scoring above the cut-off for severe depression to those scoring below it*

VW Task	Below cut-off (n=13)		Above cut-off (n-10)		t	df	p
	M	(SD)	M	(SD)			
Regular Event Based	0.50	(0.37)	0.38	(0.32)	0.86	21	.400
Regular Time Based	0.69	(0.31)	0.63	(0.38)	0.47	21	.640
Irregular Event Based	0.44	(0.34)	0.28	(0.30)	1.23	21	.230
Irregular Time Based	0.31	(0.25)	0.30	(0.26)	0.07	21	.940

Independent samples t-tests, displayed in Table 7, revealed no significant difference in either time based or event based PM scores between participants in the

alcohol dependent group who scored 29+ on the BDI compared to those who scored below 29.

Trait Anxiety

An independent samples t-test showed a significantly higher score on the STAI in the alcohol dependent group ($M = 53.1$, $SD = 10.1$) than in the social drinker group ($M = 38.7$, $SD = 11.6$), $t(46) = -4.64$, $p < .001$, indicating higher trait anxiety in the alcohol dependent group.

ANCOVA analyses

The contribution of episodic memory and attention. Delayed story recall and SDCT time were entered as covariates into the analysis of pre-imagining VW data. As can be seen from table 8, the significant main effect of alcohol group and interaction between task type and group remained significant once accounting for the influence of these variables. However, the main effect of regularity and the interaction between task regularity and task type became non-significant.

Table 8:Analysis of covariance for pre-imagining VW data with delayed story recall and SDCT time entered as covariates

Source	d.f	F	p
Between Groups			
Alcohol group	1	6.713	.014*
Within group error	36		
Within Groups			
Task regularity	1	3.02	.091
Task type	1	.134	.716
Task regularity*Task type	1	.064	.801
Task regularity*Alcohol group	1	.719	.402
Task type*Alcohol group	1	9.62	.004*
Task regularity*Task type*Alcohol	1	.266	.609
Error	36		

*Significant finding

The contribution of depression and anxiety.

Table 9: Analysis of covariance for pre-imagining VW data with BDI-II score as a covariate

Source	d.f	F	p
	Between Groups		
Alcohol group	1	4.07	.050*
Within group error	43		
	Within Groups		
Task regularity	1	15.5	<.001*
Task type	1	.553	.461
Task regularity*Task type	1	12.1	.001*
Task regularity*Alcohol group	1	.134	.716
Task type*Alcohol group	1	4.41	.042*
Task regularity*Task type*Alcohol	1	1.47	.232
Error	43		

*Significant finding

Table 10: Analysis of Covariance on pre-imagining VW with BDI-II and STAI-trait as covariates

Source	d.f	F	p
	Between Groups		
Alcohol group	1	3.59	.065†
Within group error	42		
	Within Groups		
Task regularity	1	7.35	.010*
Task type	1	.167	.685
Task regularity*Task type	1	2.62	.113
Task regularity*Alcohol group	1	.042	.839
Task type*Alcohol group	1	4.15	.048*
Task regularity*Task type*Alcohol	1	1.42	.240
Error	42		

†Trend; *Significant finding

BDI-II score and STAI score were entered as covariates into the analysis of

pre-imagining VW data.

As can be seen in table 9, when BDI-II score was entered as a covariate on its own, all significant main effects and interactions remained significant.

STAI trait anxiety score was then entered as a covariate alongside BDI-II score. Table 10 shows how this led to the main effect of alcohol group becoming a trend, and the interaction between task regularity and task type becoming non-significant.

Correlations between VW task performance and other measures

All correlations were carried out with an adjusted alpha of 0.01 to minimise Type I error rate. VW performance was assessed using the proportion of tasks completed correctly.

Pre-imagining VW performance. Correlation analyses conducted on the whole data set revealed no significant association between self-reported PM (assessed by scores on the *prospective memory* scale of the PRMQ), and objectively measured PM, assessed by total proportion correct on the pre-imagining VW, $r_s = -.279$, p = .058. There was no significant correlation overall between *Trails B/A proportion* and either regular event based task performance $r_s = -.147$, p = .336 or irregular event based task performance $r_s = -.250$, p = .871.

Correlation analyses were conducted separately within the social drinker group and within the alcohol dependent group to identify any associations between either irregular or regular event based task performance on the VW prior to the introduction of imagining, and *Trails A* time; *Trails B* time; the PRMQ *retrospective memory* score; *units of alcohol consumed per week;* and *SADQ score* (in the alcohol dependent group only).
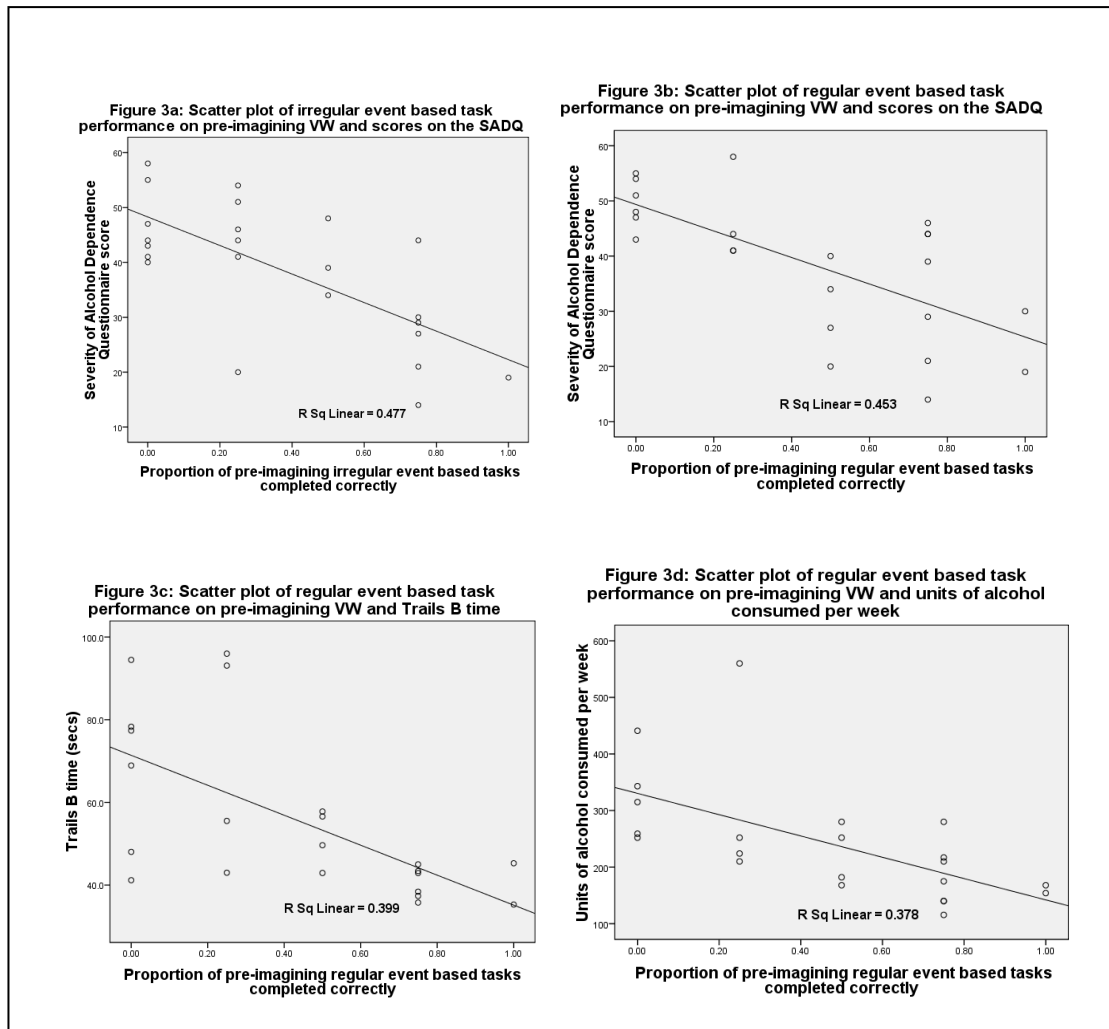
Figure 8. *Scatter plots depicting significant correlations within the alcohol dependent group between scores on event based VW tasks and other variables*

Within the alcohol dependent group, significant negative correlations were found between SADQ scores and performance on both irregular event based tasks, r_s = -.630, p = .001, and regular event based tasks r_s = -0.676, p < .001 (see Figures 3a & 3b). Significant negative correlations were also found between performance on regular event based tasks and both, *units of alcohol consumed per week*, r_s = -.721, p < .001 (see Figure 3d) and Trails B time r_s = -.641, p= .001 (see Figure 3c). Performance on regular event based tasks shared 46% of the variance with SADQ scores, and 52% of the variance with units of alcohol consumed per week.

Performance on irregular event based tasks shared 40% of the variance with SADQ scores.

No significant correlations were found within the alcohol dependent group between either regular or irregular event based task performance and any of the other variables examined. Furthermore, no significant correlations were found within the social drinker group between performance on either regular or irregular event based tasks and any of the variables examined.

Responses to open questions

  Questions regarding strategy use. The answers given by participants regarding the strategies they adopted to aid performance on the VW prior to being given the instructions to use imagining were categorised into different strategy types. These were answers given to the following question:

> *"You'll remember that for the second two days of the VW task you were asked to imagine the tasks you had to do in detail. During the first two days you were not asked to imagine the tasks.*
>
> *a) During the days when you were not imagining the tasks, were you doing anything to help you to remember the tasks you needed to complete?*
>
> *b) If yes, what sort of things were you doing?"*

The number of participants in each group reporting to use each type of strategy is shown in Table 11.

  The strategy that was most commonly reported involved forming associations between key components of the task. However this seemed to be more frequently reported by social drinkers than by alcohol dependents. Another common strategy was repeating tasks to oneself until they were completed.

Table 11 Different strategy types reportedly used by social drinkers and alcohol

dependents to aid VW performance, prior to the introduction of imagining

Reported strategy	Social drinkers	Alcohol dependent	Total
Linking key points together e.g. time, name, single words.	10	4	14
Repeating times/tasks to self as went along.	6	4	10
Relating concepts to real life but not necessarily visualising.	2	3	5
Imagining myself carrying out the task in the relevant context.	4	0	4
Visualising carrying out task (not necessarily in the relevant context).	2	2	4
Visualising key words/times written down.	2	2	4
Memorising a list of times.	2	2	4
Checking the time periodically.	2	2	4
Spending time committing the task to memory before carrying on.	1	3	4
Mentally listing tasks in time order.	1	2	3
Associating time with position on the board.	2	0	2
Checking event cards for possible tasks.	2	0	2
Counting how many tasks I had left to do as I went around.	1	0	1
Waiting for things to jog my memory.	0	1	1
No answer recorded.	0	1	1

The number of participants in each group reporting using ≤1 and ≥2 strategies during completion of the VW is shown in Table 12. Although nearly twice as many social drinkers as alcohol dependents reported using 2 or more different memory strategies during the virtual week, a 2x2 χ^2 analysis revealed no significant association between alcohol group and the number of strategies used, χ^2 (1, N=47) =1.98, p=.159.

Table 12 Number of social drinkers and alcohol dependents reporting the use of ≤1

and ≥2 strategies whilst carrying out the VW

Number of strategies	Social drinkers (n=24)	Alcohol dependent (n=23)	Total
≤1	13	17	30
≥2	11	6	17

Views regarding helpfulness of imagining. Opinions regarding whether or not imagining was helpful are shown in table 13. When 'yes' and 'maybe' responses were grouped together, a 2x2 χ^2 analysis revealed no significant difference between groups in terms of the proportion stating that the imagining had or had not been helpful χ^2 (1, N=47) = .045, p=.831.

Comments made by participants regarding their perception of the 'helpfulness' of imagining during the VW were grouped together according to key commonalities. The number of participants in each group expressing each type of viewpoint regarding; (a) reasons why it was not helpful, and (b) ways in which it was helpful, are also shown in table 13. These were free responses to the question:

"Did you find the imagining strategy helpful or not?"

Although three alcohol dependents explained how imagining had at times not been helpful, all three nonetheless reported that imagining had generally aided their performance. Furthermore, four of the social drinkers who offered reasons for why imagining was sometimes not helpful nonetheless stated that it had or may have been helpful in aiding their performance overall. The most common reason offered for why imagining had sometimes not helped related to tasks being hard to visualise. Nonetheless, of the participants who did not find imagining helpful, only one made reference to the issue of not being able to visualise the task well enough.

Table 13 Answers given by social drinkers and alcohol dependents regarding the

perceived helpfulness of imagining

Answer to questions: "Was imagining helpful?"	Social drinker (n=24)	Alcohol dependent (n=23)	Total
Yes	13	16	29
Maybe	3	0	3
No	8	7	15
Reasons why imagining was not helpful			
Hard to visualise things that weren't relevant to my life.	4	3	7
Not as effective as memorising list of times.	1	0	1
Didn't imagine the times so that didn't help with tasks.	2	0	2
Found it hard to relate real life to computer game.	2	0	2
I'm not a visual person.	1	0	1
Reasons why imagining was helpful			
It gave me longer to think about it.	4	1	5
It made me focus more.	2	1	3
It reinforced it.	1	1	2
It helped to remember the task contents	1	0	1

Half of the social drinkers offering reasons why imagining had helped them stated that it had given them longer to think about the tasks. This was also reflected by one of the three alcohol dependents offering examples of how imagining had helped them. The second most common reason given was that imagining had helped participants to 'focus more'.

In addition to the comments shown in table 13, four social drinkers and one alcohol dependent also stated that they had found imagining actively unhelpful. All four social drinkers stated that it had distracted them from the task, whilst the sole alcohol dependent participant stated that they had found it unpleasant to imagine going out, because they were agoraphobic.

Everyday use of memory aids. The number of participants in each group who stated that they typically used each of four different memory aids in their everyday life is shown in Table 14. Although not compared using statistical tests, more social drinkers reported using each memory aid, the difference being most notable in the case of diaries.

Table 14. Number of social drinkers and alcohol dependents reporting the use of calendars, diaries, notebooks and alarms in everyday life

Memory aid	Social drinker	Alcohol dependent
Calendars	16	14
Diaries	17	10
Notebooks	15	14
Alarms	14	9

The number of participants in each group reporting the use of ≤1 or ≥2 everyday memory strategies from the four options presented (as seen in table 14) is shown in table 15. A 2x2 χ^2 analysis revealed a significant association between alcohol group and the number of memory aids reported to be used day-to-day, χ^2 (1, N=48) = 4.55, p=.033. Cramer's V analysis revealed that 9% of the variation in strategy use can be accounted for by alcohol group.

Table 15. Number of memory aids reported by social drinkers and alcohol
dependents to be used in everyday life

Number of memory aids	Social drinker	Alcohol dependent
≤1	2	8
≥2	22	16

Discussion

This is the first study to have objectively assessed prospective memory (PM) ability in a clinical sample of alcohol dependents. It is also the first to explicitly investigate the potential of an imagery technique, designed to prompt future event simulation (FES), to influence PM ability in any clinical group.

Alcohol dependence and PM performance

This study found that recently abstinent alcohol dependents performed significantly less well than social drinkers on event based PM tasks. Furthermore, the negative correlations in the alcohol dependent group between performance on event based PM tasks and both severity of alcohol dependence and units of alcohol consumed per week, suggests that greater alcohol use is associated with greater event based PM impairments.

The alcohol dependent group's impairments on regular as well as irregular event based tasks indicate that alcohol-related PM deficits were not simply due to difficulties with retrospective memory, as regular tasks depend much less on retrospective memory than irregular tasks (Rendell, Gray, Henry & Tolan, 2007).

Further support for this lies in the fact that between group differences in VW performance remained significant, even when episodic memory was accounted for by the inclusion of delayed story recall as a covariate in analysis. Indeed, the significant group differences in irregular PM performance when recollections of the prospective components of the PM tasks were assessed further indicates that PM impairments in the alcohol dependent group arose, at least in part, from difficulties identifying the points at which tasks needed to be carried out, rather than solely from difficulties recalling the contents of these tasks.

Although Trails B time correlated negatively with regular event based task performance within the alcohol dependent group, this is unlikely to reflect a link between PM impairments and deficits in executive functioning, as there was no such correlation with performance on irregular event based tasks. More importantly, there was no significant association between Trails B/A proportion and either PM performance or group membership. The greater Trails A and Trails B times in the alcohol dependent group are thus most likely to represent psychomotor slowing.

The alcohol dependent group showed significantly higher depression and anxiety scores and took longer to complete an attentional task (SDCT). However, important main effects and interactions remained significant when the shared variances between SDCT time and VW performance, and between BDI-II score and VW performance were partialled using ANCOVA. This indicates that the group differences in VW performance were not due to higher depression or poorer attention in the alcohol dependent group. Furthermore, although the significant main effect of alcohol group was reduced to a trend when trait anxiety was controlled for alongside depression, the remaining significant interaction between group and task type

suggests that the relatively poorer event based task performance in the alcohol dependent group was influenced by factors other than trait anxiety.

The findings relating to depression are consistent with previous research showing that depression tends not to be associated with event based PM impairments (Livner, Berger, Jones & Backman, 2005; Kliegel & Jager, 2006). Furthermore, the significant correlations found within the alcohol dependent group between event based PM task performance and the two alcohol use variables (with over 50% of the variance in regular task performance being shared with units of alcohol consumed per week), highlight the likely primacy of neurological changes associated with alcohol dependence, rather than the effects of co-morbid psychopathology, in influencing PM performance amongst alcohol dependents.

Although there was no significant association between alcohol group and the number of strategies used during the VW, the alcohol dependents' poorer performance on event based tasks may relate to difficulties developing strategies capable of aiding the detection of cues to task performance. In the VW, event based tasks are prompted by information on the event cards, and are thus focal to the ongoing activity. According to McDaniel & Einstein's (2000) multi-process model, when a PM task is focal to the ongoing activity, task cues can automatically enter awareness without being actively sought out. Certain strategies, which social drinkers may have been more likely to generate e.g. forming associative links between key components of the task, may have increased the salience of relevant event based cues, and thus their automatic detection.

In line with this view, the lack of group differences in time based task performance may be because this is less amenable to influence by the memory strategies more commonly adopted by social drinkers. Indeed, as time based tasks

rely on consciously monitoring the clock for relevant time cues, they are less focal to the ongoing activity than event based tasks, as the clock is presented separately from the event cards. Therefore, the strategies that may support event based task performance, may not serve to enhance the detection of time based cues in the same way.

However, in many ways the event based tasks in the current study do not meet the criteria for automatic cue detection outlined by McDaniel and Einstein', and thus may be more appropriately completed through the alternative more effortful strategic pathway proposed by the multi-process model. In line with this, the group differences observed in the present study could be interpreted in terms of better strategy use in the social drinker group. Effective strategies could include deploying attentional resources in such a way as to improve the detection of task cues when they arise. Indeed, two social drinkers reported monitoring each event card for relevant cues throughout the course of the VW, whilst this was not reported by any alcohol dependents. Importantly, such a strategy is not included in the VW instructions, nor during the trial day, whilst that of monitoring the clock for cues for time based tasks is more explicitly imposed on participants during the trial day. The lack of group differences on time based tasks may thus, once again, be because their successful performance is not enhanced by self-initiated strategies.

The suggestion that alcohol dependents performed less well than social drinkers on event based tasks because they were less likely to initiate active monitoring strategies, is neatly illustrated by a statement made by one alcohol dependent participant (p27), who simply stated that he "waited for events to happen" in order to "jog [his] memory". Although only two social drinkers reported actively monitoring event cards, this was in response to a question regarding 'remembering

tasks', rather than 'detecting task cues'. Therefore, more participants may have used this approach, but not perceived it to constitute a memory strategy, and thus not reported it.

The effects of imagining on PM performance

A key finding in the social drinker group was the improvement in time based task performance following the introduction of imagining at encoding. The absence of a significant difference in this group's performance on such tasks between days one and two and between days three and four, provides some evidence against these findings being a consequence of practice effects. Although no improvement was found on event based tasks following imagining, the groups' initial scores were relatively high, meaning that a possible ceiling effect cannot be ruled out. Indeed, the social drinker groups' performance on time based tasks was relatively poor compared to their performance on event based tasks in the pre-imagining condition.

The replication of this pattern of results when instances of recalling the prospective component of a task were counted as correct responses suggests that imagining enhanced the prospective component of such tasks (knowing that a task needed to be carried out at the point when the relevant time arose). This echoes suggestions by Paraskevaides et al. (2010). However, they drew from Seifert and Patalano's (2001) predictive encoding model to propose that imagining increased the salience of cues to task completion. As mentioned earlier, the completion of time based tasks is unlikely to be automatically triggered when the relevant times arise, as the clock is not focal to the on-going activity. Although imagining could on one hand enhance the use of time monitoring by somehow increasing the perceived importance of the task (see Meeks and Marsh, 2010), it is also feasible that imagining enhanced

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the actual memory for the times at which the tasks needed to be carried out. Indeed the superiority of the social drinker group's performance on irregular event based tasks compared to irregular time based tasks in the pre-imagining condition indicates that new times were harder to commit to memory than new events, and thus that imagining somehow enhanced retention.

Although this study found no improvement in the PM performance of the alcohol dependent group when the imagining technique was introduced, this is an important finding that indicates that the social drinkers were better able to make use of the imagining technique than alcohol dependents. However, the absence of a group difference in mean vividness scores for time based tasks indicates that this was not due to social drinkers having better visualisation skills. An alternative explanation is that the alcohol dependents were less strategic in their use of the imagining period as a means of enhancing PM performance. For example, social drinkers may have been more likely to incorporate times into their images (Paraskevaides et al., 2010), even though the imagining instructions did not explicitly instruct them to, having more readily anticipated the importance of correctly recalling these specific times.

FES and PM performance

Like Schacter et al., (2008), Atance and O'Neill (2001) propose a link between FES and PM. However, they suggest that, rather than allowing the formation of a mental representation that automatically cues task completion in the appropriate context, FES facilitates anticipation of what will be necessary to prompt task completion at the relevant point. This thus allows the individual to develop a suitable mnemonic to cue the intention to carry that task out at that point. An

example the authors give is anticipating which room in the house you will go to first on return from work, and thus placing your medication bottle in that room, so that you are prompted to take your medication as soon as you get home. If the significant differences observed in the current study, both with and without imagining at encoding, do result from social drinkers engaging in more effective strategies than alcohol dependents, such findings could be understood in terms of social drinkers being better at anticipating what will aid cue detection. This in turn could be a consequence of superior FES abilities. However, these ideas are currently speculative and further research would be needed to examine the influence of alcohol dependence on both FES and strategy formation skills. Future studies may also wish to focus on the possible inter-relationship between FES and strategy formation, and, in turn, the influence of both factors on PM performance.

Alcohol dependence and self-reported PM

The current study is the first to compare the self-reported PM ability of a clinical group of alcohol dependents to that of an age and ability matched control group. However, despite significant group differences in VW performance, the two groups did not differ significantly in their score on the Prospective Memory Scale of the Prospective Retrospective Memory Questionnaire (PRMQ). Furthermore, scores on the two measures were not significantly correlated, indicating that the PRMQ lacks validity as an assessment of PM in alcohol dependents. Indeed, it became clear during the administration of this tool that the self-report of prospective memory problems by participants in the alcohol dependent group could differ considerably depending on whether they included occasions of intoxication in the time period that they were reflecting back on. Alcohol dependents may also have reported fewer PM

difficulties than they otherwise would have, had it not been for their recent

experiences of living within an artificial clinical environment. This may have

imposed fewer demands on their PM abilities than more real life settings. Such issues

further emphasise the need to move away from relying on self-report measures of

PM ability in research, particularly when studying the impact of chronic substance

misuse.

On the other hand, the lack of a group difference in scores on the prospective

memory scale of the PRMQ may highlight impaired insight amongst alcohol

dependents regarding their PM deficits. This contrasts with an apparent awareness of

their retrospective memory difficulties. Relatively poorer insight amongst alcohol

dependents regarding PM impairments may be further indicated by the slightly lower

number of alcohol dependents than social drinkers reporting the use of diaries and

alarms to aid every day PM. There was a significant association between alcohol

group and the number of everyday memory aids reportedly used, with social drinkers

being more likely to report using a greater number of strategies than alcohol

dependents.

Limitations and directions for future research

There were a number of limitations in the current study which may offer

useful directions for future research.

Firstly, any study that focuses on the impact of imagining on cognitive

performance faces the task of establishing whether participants actually engage in

imagining according to the instructions they are given. Although the inclusion of the

vividness and reliving scales was expected to gauge the extent to which imagining

was actually taking place, these were inevitably limited in this function by their self-

report nature. Consequently, it is unclear whether the positive effect of imagining was simply due to allowing participants longer to commit the target times to memory, as suggested by the majority of comments made by participants regarding why imagining had proved helpful to them. Researchers conducting future investigations into the effects of imagining on PM performance may therefore wish to control for the potential influence of the extra encoding time that comes with using the imagining technique, by including an encoding period of comparable length in the pre-imagining condition. They could also account for possibly slower processing time in alcohol dependents by giving the clinical group longer than the control group to engage in imagining. Furthermore, practice effects would be better ruled out as the source of the improvements in the social drinker group by including a control condition containing no imagining at any point. Finally, given the existing literature surrounding the use of implementation intentions, it would be interesting for future studies to compare the influence of these two approaches on PM performance.

Questions regarding strategy use and the perceived effects of the imagining technique were a useful source of information in the current study. However, these were asked much later in the testing session than the administration of the VW, which may have thus reduced the accuracy of participants' recall. Although strategy use is proposed in the current study to be of relevance to PM performance, the mechanisms through which imagining led to an improvement are still not clearly understood. Therefore, more detailed data regarding the strategies employed by participants during both the VW in general, and the imagining period in particular, might offer a means through which the explanations proposed for the current pattern of results could be more thoroughly evaluated. On the other hand, alcohol dependents may lack meta-cognitive awareness, as suggested by their apparently

limited insight into their PM impairments. If so, the results from investigations of this nature would need to be interpreted with caution.

Although a trait anxiety measure was included, participants in both groups sometimes appeared more nervous than others during testing. It may thus have been useful to have included a state anxiety measure in the procedures, as this would have enabled any variations in performance relating to test anxiety to be assessed, particularly as trait anxiety appeared to be involved in the group differences found.

With regards to making better use of the VW, the inclusion of more 'virtual days' might improve the sensitivity of the VW to change, and potentially remove the apparent ceiling effect in the event based performance of social drinkers. Future studies could also include processes to identify times when participants could not remember whether or not they had already carried out a task. This would enable the influence of source monitoring errors on PM performance to be assessed, given that such errors have been linked to PM deficits in patients with schizophrenia (Elvevag et al., 2003).

Whilst a number of studies have found that depression tends not to be associated with impairments in event based PM, the same body of evidence reports depression to be associated with impairments in time-based PM (Rude et al., 1999; Kliegel & Jager, 2006). This is attributed to the tendency for time based tasks to rely more on self-initiation and effortful cognitive processing, both of which are negatively influenced by depression (Kliegel & Jager, 2006). However, despite the majority of alcohol dependents in the present study scoring in the moderate and severe depression ranges, the alcohol dependent group showed no impairment in either regular or irregular time based tasks compared to social drinkers. Although there was an apparent floor effect in the alcohol dependent group's scores for

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irregular time based tasks, this does not explain the lack of group differences, as there was no floor effect for regular time based tasks. It is hence possible that time based tasks were simply not sufficiently demanding for depression to have an impact. If so, it would be interesting for future studies to investigate the performance of alcohol dependents on more cognitively demanding time based PM tasks. Indeed, the original VW included time *check* tasks, which required participants to perform a task at two points in real time (as distinct from virtual time), indicated by a separate stop clock. Time *check* tasks are arguably more cognitively demanding than time *based* tasks, as they require internal monitoring of one's sense of passing time which, unlike the virtual time, is not linked in any way to the daily activities presented on the event cards (e.g. lunch) (Rendell & Henry, 2009). Their inclusion in future research might thus highlight additional PM impairments associated with alcohol dependence, be this related or unrelated to the higher levels of depression commonly reported within this population (Davidson, 1995).

Preliminary work on the present study included the Tower of London as an index of executive functioning (EF), but this was later replaced by the Trails and verbal and category fluency tests in order to minimise possible fatigue effects arising from the length of the testing session. Unfortunately, EF is a broad term that cannot be fully captured by a handful of brief tests. In view of the current findings, future studies may wish to utilize EF measures relating more directly to strategy formation. However, if, as in the present study, a clinical sample is to be included, the practical, ethical and validity implications of longer testing sessions ought first to be considered carefully.

As a history of other-substance use was not used as an exclusion criterion, group differences cannot be solely attributed to alcohol dependence. Furthermore,

recent substance use may have been under-reported in both groups. However, this is a common limitation in studies relating to substance use, and is difficult to address. On the other hand, in view of the high co-morbidity of alcohol dependence and other substance use (Stinson et al., 2005), the clinical sample used in the current study is likely to have been representative of the clinical population, thus maximising the external validity of the findings. Furthermore, a key strength of this study was that the clinical group was matched with the control group for age, gender and pre-morbid ability, which enabled the influence of these variables on task performance to be carefully controlled.

On a final note, as the tasks in the current version of the VW were significantly adapted to make them suitable for use with alcohol dependents, the reliability of this version of the measure is yet to be formally established. The relevance of this issue of reliability is further enhanced by the fact that existing reliability data regarding the VW is based on the non-computerised version rather than the computerised version, which has been used more recently. Future studies using the VW may thus wish to investigate the reliability of this particular version of the VW, in clinical and/or non-clinical populations.

Clinical implications

The findings from this study could hold important implications with regards to the psychological interventions delivered as part of alcohol misuse rehabilitation programmes. At present these often consist of behavioural and cognitive-behavioural treatments such as cue exposure, contingency management and coping skills training (Curran & Drummond, 2007), with few programmes including a cognitive rehabilitation component (Allen, Goldstein & Seaton, 1997). However, PM deficits

may affect the outcomes of common treatments. As well as potentially reducing the likelihood that effective coping strategies will be initiated in high risk situations, PM impairments may, like other cognitive impairments, interfere with engagement in treatments, and the influence of perceived self-efficacy on treatment outcome (Bates etc.). Such impairments may also indirectly maintain co-morbid emotional problems, by impacting on occupational and social functioning and/or the implementation of CBT, a common treatment of choice for a range of psychological difficulties (Roth & Fonagy, 2004). Untreated emotional disturbance may in turn precipitate relapse following detoxification (Sinha, 2007).

Rehabilitation programmes for alcohol dependence may be enhanced through the inclusion of treatments aimed at remediating PM deficits. Emerging evidence within the TBI literature suggests that both meta-cognitive approaches, through which individuals are trained to respond to a non-specific external cue by self-monitoring for future goals (Fish et al., 2007), and restorative approaches, whereby PM tasks are administered repetitively with progressively increasing time intervals (Raskin & Sohlberg, 2009), offer some promise in this area. However, alcohol dependents may display more subtle PM impairments than those with TBI, and thus benefit from less resource-intensive approaches.

In line with the most common methods of addressing PM impairment in clinical practice (Sohlberg et al., 2007), the use of compensatory strategies, including diaries, notebooks and electronic devices to organise and prompt task completion ought to be encouraged within all substance misuse rehabilitation programmes. However, given the proposed role for strategy self-initiation in the group differences reported, individuals undergoing rehabilitation may benefit in particular from opportunities to rehearse the planning and self-initiation of effective memory

prompting strategies within a range of novel situations. Finally, as the main effect of group on PM performance was reduced when accounting for trait anxiety, focussed assessments and treatments for co-morbid anxiety disorders may need to become a greater priority in substance misuse rehabilitation programmes.

Although the current study was unable to demonstrate that imagining overcame alcohol-related deficits in PM ability, there is still scope for investigating this further. Given that some participants in the current study reported difficulty imagining the VW tasks that they could not relate to e.g. going to a launderette, imagining may be more effective as a means of improving PM when applied to personally meaningful experiences such as individual high risk situations. Indeed, the advanced planning of strategies aimed at coping effectively in particularly risky contexts may well serve to prevent future relapses.

Summary

The current study indicates that individuals receiving treatment for diagnosed alcohol dependence demonstrate impairments on an objective test of PM. These event-based PM deficits were significantly associated with both degree of alcohol dependence and units of alcohol consumed per week. In view of the clinical implications of recently abstinent alcohol dependents suffering PM impairments, future studies ought to focus on informing possible interventions for overcoming PM deficits, so that these can subsequently be incorporated within existing rehabilitation programmes.

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PART 3: CRITICAL APPRAISAL

Introduction

Conducting my major research project taught me many valuable lessons about carrying out clinical research in practice. In the following critical appraisal, I will reflect on my initial reasons for choosing this area of study, and on some of my positive experiences of the research process. Furthermore, I will highlight the changes I made to certain aspects of the methodology, which I had adopted from previous studies, and the reasons why I felt these changes were needed. I will also raise a number of challenges that I encountered at various points along the way, and describe the means through which I chose to overcome them at the time.

In the course of reflecting on the research process, I have found myself considering certain conceptual and methodological issues in more detail than is perhaps appropriate for inclusion in an empirical paper. I will therefore also use this critical appraisal as an opportunity to expand upon some of these ideas. Whilst some may serve to enhance the clinical applicability of my findings, others may expound our theoretical understanding of possible links between future event simulation (FES) and PM ability.

Reasons for choosing the study

Although prospective memory (PM) in chronic alcohol users may not represent a typical area of interest for clinical psychologists, several factors influenced my decision to study this phenomenon as part of my DClinPsy. Firstly, I wanted to choose a doctoral thesis that suited my academic interests: I had a long standing interest in neuropsychology, and in the interaction between physiology, pharmacology and behaviour, this having been reflected in my research project and module choices during my BSc in psychology. Secondly, I was keen to pursue a

clinical career in neuropsychology, and thus enthusiastic about conducting research that might inform the development of new approaches to neuro-rehabilitation. This seemed particularly important, given that neuro-rehabilitation currently appears to be an underdeveloped field of research and practice. Finally, as I had no formal research experience, I hoped that working within a well established research team would teach me more about clinical research, and help to enhance my skills as a 'scientist-practitioner'.

Working within a research team

Working as part of a research team, I was fortunate to be able to draw on the clinical and research expertise of a number of experienced individuals, in the design and implementation of the study. Furthermore, having an MSc student to help me with data collection enabled me to increase my initially anticipated sample size by 50%. It also increased the chances of a researcher being available to test eligible participants in the often small window between patients completing detoxification and leaving the unit, especially as I was only able to attend the unit two days per week. However, transparent communication regarding researcher availability, participant recruitment and test administration procedures, proved essential for working successfully with another team member. I found it particularly important to create detailed but user friendly scripts to guide testing sessions with the Virtual Week (VW) in order to ensure consistency of testing procedures across researchers. Shadowing the other researcher until I felt comfortable that they were able to carry out testing sessions independently also helped me to feel more confident about this.

Recruiting and testing within an inpatient setting

The process of identifying, recruiting, and screening participants for my clinical sample was far more time consuming than I had anticipated. I learnt that there were many unexpected factors associated with recruiting a clinical sample, which I had not taken into consideration when estimating the time needed to complete the testing phase. This included administration time, time spent getting to know potential participants in order to facilitate recruitment, and even the time spent looking for participants when they did not arrive at their allocated testing slots. Interestingly, instances such as these may have represented functional impairments arising from PM failures. Furthermore, there were several weeks in which no patients in the unit were either eligible or willing to take part, and I had to use my study days to work on other parts of my thesis instead.

Recruiting my clinical sample from an inpatient setting was nonetheless advantageous in that it increased the likelihood of participants attending their pre-booked testing slots, or at least being easy to locate if they forgot to attend. It also decreased the likelihood of test performance being affected by acute substance use. Nevertheless, there were a number of challenges associated with testing inpatients. The main one was 'catching' potential participants in the short period between detoxification and discharge, which was often as little as 4 days. Unfortunately, as it was not possible to have a researcher on the unit every day of the week, some eligible and willing patients were not able to take part. Furthermore, given that testing was understandably lower in the list of priorities than compulsory clinical activities, such as therapy groups, medication and meal times, the testing slots had to be fitted into very narrow 'windows' of time that sometimes changed at short notice. Managing these difficulties relied on careful forward planning as well as flexibility

around testing times. I also learnt to make the most of any time between sessions to recruit new participants for the following weeks.

Engaging nursing staff in the initial stages of the study by delivering a presentation and attending staff meetings proved invaluable in streamlining the recruitment process. Within these forums, a number of staff members made useful suggestions for how to facilitate recruitment. For example, one suggested attending patient meetings to promote the study, whilst another directed me to a patient information board as a starting point for participant identification. Nonetheless, many key workers were often too busy to verify whether their patients were eligible for the study and I became reliant on a small number of particular staff members to check participant eligibility each time this was necessary. Although I was constantly conscious of not causing disruption to the clinical work of these individuals, I was fortunate to be conducting research within a trust which placed emphasis on research and development. Had I been recruiting patients in a trust where staff were less socialised to clinical research, my work may have been met with greater resistance.

I relied heavily on my interpersonal skills in the face-to-face aspect of participant recruitment. This was also aided by my spending time in communal patient areas whenever I could. However, in doing so, I was careful to remain both cognizant of my professional boundaries and explicit about my role as a research psychologist rather than a clinician. This had to be balanced with responding sensitively to participants' emotional concerns if and when these arose during involvement with the study. Diplomacy was also necessary when faced with low level animosity from patients who were not eligible to participate (and hence receive remuneration for doing so), some feeling strongly that they were being discriminated against due to their other substance misuse. Nonetheless, contrary to some of my

expectations, I generally found this group engaging and enjoyable to work with, and was often moved by patients' individual stories.

A key difficulty I discovered in the course of the study was managing my concerns about the effect that testing might inadvertently have on participants' self esteem. I was particularly sensitive to times when participants commented on their poor performance, or appeared slightly anxious whilst completing the VW. I thus did my best to put participants at ease during testing, offering encouragement throughout, and periodically checking on how they were feeling.

Fortunately, only one of the participants that I tested withdrew from the study. Nonetheless, in the weeks that followed, several of the patients whom I approached to take part expressed concerns about 'failing', and made reference to comments that had been made by this particular individual. I tried to allay their concerns by acknowledging that the VW was not intended to be easy, whilst being careful not to refer to how this individual had actually performed. Fortunately, in most cases this proved to be sufficient encouragement.

Of course, an unavoidable risk of recruiting within an inpatient setting relates to patients discussing the contents of the measures included in the procedure. However, although this poses a threat to the validity of measures such as the VW, I noticed no obvious signs that any participant's performance was influenced by anything that they were told prior to taking part. To the contrary, on the whole, I found that patients talking to each other about the study actually aided the recruitment of those who might otherwise have been ambivalent or anxious about participating.

Recruiting matched controls

When compared to other studies in the area of PM and substance use, the use of an age and ability matched control group was a particular strength of this study. However, the desire to match controls as closely as possibly meant that I regrettably had to turn down many willing volunteers, simply because they did not match an existing participant. This sometimes led to frustrating 'lulls' in the recruitment process, which were often further added to by participants cancelling at the last minute. Furthermore, a lot of my time was spent screening potential participants, only to find that they failed to meet even the basic criteria explicitly stated in the advert or email to which they were responding. I also had to turn away a number of otherwise-suitable participants simply because of the number of units of alcohol that they reported consuming per week, the upper limit having originally been set as 14 for females and 21 for males. Given time constraints, and the difficulty I was experiencing with recruitment, I eventually decided to increase to half way between the official 'safe' and 'hazardous' drinking limits for the UK. I also began recruiting participants more pro-actively, by contacting social drinkers that either I or my friends knew to be in the particular demographic groups that I was trying to target. 'Snowballing' further helped in this aspect of recruitment.

Changes made to the VW administration procedures

Although similar instructions and procedures as those in previous studies (Leitz, Morgan, Bisby, Rendell & Curran, 2009; Paraskevaides et al., 2010) were followed for administering the VW, a number of small changes were made, with the aim of improving the validity of the computerised VW.

Firstly, rather than only being permitted to click on the 'perform task' button when they correctly identified the task to be performed, participants were permitted to perform any tasks they wished, whenever they wished, even if the researcher knew they were wrong. As the VW automatically distinguishes between correct and incorrect answers, this simply prevented the researcher from having to feed back to participants when the task they had requested to perform was incorrect. Such feedback might otherwise have held clues (i.e. through a process of elimination) regarding which tasks were left to be performed during the rest of the virtual day.

Another way in which my procedure differed from that used in previous studies was that the researcher manually recorded all occasions when the prospective component of the task (knowing that a task needed to be performed) was recalled in the absence of the retrospective component (the contents) of the task. Although more complicated than simply relying on the VW to record all the necessary data, this provided a useful source of information when later interpreting the pattern of results obtained.

Finally, unlike previous studies, participants were also permitted to perform any task for which they articulated a 'close approximation' to the actual task contents e.g. 'Ring Dan's sister about dog walking' rather than 'Ring David's sister about dog walking'. These were counted as a 'correct response', alongside tasks recalled word-perfectly, which was mainly intended to avoid penalising participants for failing to recall names. Indeed, in real life, forgetting a person's name is unlikely to interfere with the performance of a PM task, as compensations can often easily be made for such errors. This change to the procedure from previous studies may explain the apparent ceiling effect in social drinkers' event based task performance, which was not apparent in previous studies. Future studies may hence wish to separate perfectly

correct responses from 'close approximations', so as to examine any group differences arising when accurate task performance relies just as much on the perfect recall of a task as on its performance in the correct circumstances.

Ideas for the next step

Despite the potential clinical implications of the findings from my study, further work would be necessary before aiming to translate the existing research findings into clinical interventions. Indeed, whilst I tested participants immediately after detoxification, some studies have shown that cognitive impairments seen in alcohol dependents immediately after detoxification ameliorate themselves over as little as a few weeks (Goldman, 1986; Mann, Gunther, Stetter & Ackermann, 1999). Therefore, an important research question to address prior to pursuing developments in intervention strategies is whether PM deficits in alcohol dependents remediate naturally over time. It would also be important to better understand the effects that PM failures actually have on alcohol dependents following rehabilitation, particularly in terms of the likelihood of relapse. Fortunately, some of the data from my study will also contribute to a follow-up study that aims to identifying whether PM deficits are in fact predictive of relapse following rehabilitation.

Reflections on methodological issues

A key lesson I learnt from the process of conducting this research was that certain limitations in a study's design can sometimes only become evident once testing has already begun. Consequently, there are some changes to the methodology that I would make if I were to repeat this study. There are also other changes that might be worth considering depending on the main hypotheses being tested. The

former relate not only to the general methodology, but also to the use of the VW, whilst the latter relates to the nature of the PM measure that would be most appropriate for exploring particular hypotheses relating the relationship between FES and PM ability.

Utilising behavioural observations

Some of the strategies that I observed participants actively engaging in to aid their performance proved interesting to reflect on when trying to understand the quantitative findings. However, as these observations were not formally recorded at the time, I could not explicitly draw from them when interpreting the data. If behavioural data had been properly documented, it may have shed more light on the group similarities and/or differences in strategy use, than the self report data that was collected. Indeed, the latter is unlikely to have reflected all that I observed. Future studies might thus benefit from including a more formal means of recording behaviours of, as well as comments made by, participants during completion of the VW. Nevertheless, this approach would need to be piloted first, as such a process would likely place significant cognitive demands on a sole researcher.

Changes to the Virtual Week

Despite the original non-computerised version of the VW being a valid and reliable measure of PM ability (Rendell, Mazur, & Henry, 2009) two limitations in its design became clear in the course of the study. The first related to the inclusion of the 'perform task' button, which, importantly, forms part of the computerised VW, but not the original VW board game. Although this offered a useful means of capturing the participant's performance electronically, it was also the source of some

complications. The researcher often had to make a judgement in the course of testing as to whether the participant had recalled a task independently, or simply seen it on the perform task list whilst performing another task immediately beforehand. This relied heavily on subjective opinion and was thus a potential source of error in the data. Another source of error may have arisen from individual differences in how participants scanned the perform task list each time they selected a task from it. Indeed, for some, this list may have offered a source of regular prompts in the course of the game regarding the tasks that needed to be performed, whilst others may not have paid it so much attention. The original board game version, which has been used in similar studies (Kardiasmenos, Clawson, Wilken, & Wallin, 2008; Rendell, Gray, Henry & Tolan, 2007), simply relies on the researcher to record the participant's performance. Although placing greater load on the researcher, future studies in this field may benefit from reverting back to this approach, so as to reduce potential noise in the data.

A second limitation relates to the structure of the PM tasks included in the VW. A comment typically made by participants in the course of testing, and explicitly made by seven participants when asked about the imagining technique, was that the tasks were difficult to imagine because the contexts in which they were set were too novel, or included fictional characters that they were unable to visualise. More careful design of individual VW tasks might in future help to reduce such barriers to imagining.

Alternative measures

If this study were to be replicated, it would be relatively simple to remove the 'perform task' list from the VW and to alter the PM tasks to make them easier to

visualise. However, in view of the mechanisms through which FES has been proposed to influence PM, there may in fact be more appropriate tools than the VW for assessing this relationship. Indeed, Paraskevaides et al. (2010) hypothesise that FES enables prospective remembering by forming a mental representation of the context in which the task will need to be completed, which then prompts task completion when that context is encountered in reality. However, each mental representation successfully formed using imagery is likely to be visual in nature, whilst the information presented on the VW event cards is written, and thus not in the same modality. Unless each time a person reads an event card, they vividly picture the details of the virtual context that they are told they have entered, it is questionable whether a pre-formed visual representation of that context would be automatically triggered by reading the card. This is reflected in the comments made by two of the social drinkers in the present study, who said that it was hard to relate real life images to the virtual format of the game.

An alternative PM assessment system to the VW is the JAAM (Jansari, Agnew, Akesson & Murphy, 2004). This is a virtual reality role-playing exercise in which participants play the role of an office worker having to perform a number of different tasks over a 40 minute period. As this is presented in a visual format, it may be more appropriate than the VW for assessing Paraskevaides et al.'s (2010) hypothesis regarding how mental representations prompt task completion. Furthermore, the JAAM, additionally includes tasks to assess skills such as planning, creative thinking and adaptive thinking. These might well be useful for assessing how PM relates to other executive functions.

It is unclear from its description in the literature whether the JAAM would be suitable for testing Atance and O'Neill's (2001) alternative hypothesis regarding how

FES relates to PM. This hypothesis proposes that simulating future events allows a person to anticipate what to manipulate in the relevant environment in order to prompt PM task completion. A version of the JAAM, or a similar tool, that enabled participants to manipulate their environment could be useful in future research investigating the inter-relationship between alcohol dependence, PM and FES. Linked to this, many participants in my study commented that, in real life, they would be using external strategies to support their memory for the types of tasks presented in the VW. This raises the question of whether the use of external memory aids alone could eliminate PM impairments in alcohol dependents. Therefore, a standardised PM assessment that included the option to use memory aids would ideally provide relevant insights into the types of rehabilitation strategies that might be easily incorporated into existing rehabilitation programmes for a successful outcome.

Conclusions

As I have highlighted, there were some areas of my study which could be improved, or at least built upon, in future work. However, there were also strengths to this study, some of which resulted from my successfully replicating aspects of previous studies, others from my anticipating difficulties and making relevant adjustments, and others from adapting to challenges as and when they arose.

The experience of conducting my major research project has been a rewarding one, which has given me the desire to incorporate research into my clinical psychology career. Indeed, given the clinical implications of the findings from my study, and the various ways in which I believe this work could be extended, I would ideally like to pursue this area of research beyond my doctoral thesis. Also,

if I were to work clinically within a related field, this might present opportunities to translate relevant findings into practice, and to subsequently conduct clinical outcome investigations.

However, regardless of whether or not such opportunities present themselves, my participation in the whole research process from beginning to end has equipped me with knowledge and skills that I hope I can apply to any future research projects that I may be involved in.

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APPENDICES

Appendix 1: Screening questionnaire for alcohol group

Name_____

Initial screening questionnaire for alcohol group

As you have said you are interested in taking part in this study, I will just need to go over a couple of questions with you to make sure that it is appropriate for you to take part. Just answers these questions honestly and accurately.

1. In the last 6 months been dependent on any substances other than nicotine or caffeine? **Y/N**

2. When did you take your last dose of Librium (or other withdrawal medication)

If still taking Librium (or other withdrawal medication) when are you due to take your last dose?

3. What date are you due to leave the unit?

4. Have you ever been diagnosed with amnesia or other condition related to how your brain functions e.g. epilepsy? **Y/N**

5. Have you suffered any seizures in the last 2 weeks? **Y/N**

If so, are you being investigated for epilepsy? **Y/N**

6. Have you ever suffered brain damage? **Y/N**

7. Have you ever suffered a stroke? **Y/N**

8. Do you have a learning disability? **Y/N**

9. Have you experienced delusions (unusual thoughts) or hallucinations (hearing voices or seeing things that other people cannot see) in the last 3 weeks? **Y/N**

If so, was this related to alcohol withdrawal? **Y/N**

10. Are you taking medications to help with delusions (usual thoughts) or hallucinations (hearing voices or seeing things that other people cannot see)? **Y/N**

If yes, what is the name of this mediation?

11. Can you speak English fluently? **Y/N**

12. Do you have any reading difficulties? **Y/N**

13. What group are you in? **A/B**?

Appendix 2: CAGE Alcohol Screening Questionnaire (Ewing, 1984)

Appendix 3 : Virtual Week Tasks

Task type	Monday	Tuesday	Wednesday	Thursday
Regular Event based tasks	Take antibiotics at breakfast	Take antibiotics at breakfast	Take antibiotics at breakfast	Take antibiotics at breakfast
	Take antibiotics at dinner	Take antibiotics at dinner	Take antibiotics at dinner	Take antibiotics at dinner
Regular Time based tasks	Take Ventolin at 11 am	Take Ventolin at 11 am	Take Ventolin at 11 am	Take Ventolin at 11 am
	Take Ventolin at 21.00	Take Ventolin at 21.00	Take Ventolin at 21.00	Take Ventolin at 21.00
Irregular Event based tasks	Phone the bank at 12 noon to arrange an appointment	Go for a hair cut at 13.00	Meet Michael at your favourite coffee shop at 16.00	Deliver a cheque to the window-cleaner's house at 15.00
	You will need to put the casserole in the oven at 17.00	Return to the post office at 16.00	Phone David's sister at 18.00 about dog walking	Go to the doctor's for a blood test at 16.00
Irregular time based tasks	Drop in the dry cleaning when you go shopping	Collect your sister's membership pass whilst at the pool	Get change from the change machine at the launderette	Ask Jill for the CD she borrowed during afternoon tea
	Return Brian's book when at the library	Next time you speak to Kate tell her that Margaret has broken her leg	Buy some inner soles when shopping next	If using washing machine set it on gentle wash

Appendix 4: Instructions for verbal and category fluency

Appendix 5: Severity of Alcohol Dependence Questionnaire (Stockwell, 1979)

Appendix 6: Approval letter from NHS Research Ethics Committee

NHS

National Research Ethics Service

The Joint South London and Maudsley and The Institute of Psychiatry NHS Research Ethics Committee

South London REC Office (2)
1st Floor, Camberwell Building
94 Denmark Hill
London
SE5 9RS

Telephone: 0203 299 5033
Facsimile: 0203 299 5085

24 March 2010

Miss Alison Griffiths
Trainee Clinical Psychologist
Camden & Islington NHS Foundation Trust
Research Department of Clinical, ED
University College London
Gower Street
WC1E 6BT

Dear Miss Griffiths,

Study Title:	**Prospective memory and episodic future thinking in clients undergoing treatment for alcohol dependence**
REC reference number:	**10/H0807/21**
Protocol number:	**1**

The Research Ethics Committee reviewed the above application at the meeting held on 19 March 2010. Thank you for attending to discuss the study.

Ethical opinion

The members of the Committee present gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

For NHS research sites only, management permission for research ("R&D approval") should be obtained from the relevant care organisation(s) in accordance with NHS research governance arrangements. Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

This Research Ethics Committee is an advisory committee to London Strategic Health Authority

The National Research Ethics Service (NRES) represents the NRES Directorate within the National Patient Safety Agency and Research Ethics Committees in England

Where the only involvement of the NHS organisation is as a Participant Identification Centre, management permission for research is not required but the R&D office should be notified of the study. Guidance should be sought from the R&D office where necessary.

Sponsors are not required to notify the Committee of approvals from host organisations.

- The Committee noted a few corrections were needed to the PIS.
  Pg 46, paragraph 3, under the heading 'What will happen if I don't want to carry on with the study?' spelling error should be amended to 'benefits to which you may otherwise be entitled..'

- The Committee felt that the self help leaflet should be mentioned in the PIS.

- Pg 43, 'Memory for the future' was deemed a confusing concept that could be better re-phrased as 'remembering to so something in the future.'

- Pg 46, The Committee wanted clarification as to the reference of loss of benefits to which you may otherwise be 'entailed' (entitled) If was considered that this may not be relevant to this particular study.

- The Committee suggest the Consent form Include a request for feedback with contact details.

It is responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Approved documents

The documents reviewed and approved at the meeting were:

Document	Version	Date
Covering Letter		10 February 2010
REC application		08 February 2010
Protocol	1	21 January 2010
Investigator CV		01 January 2010
Participant Information Sheet: Alcohol Group	1	30 January 2010
Participant Information Sheet: Control Group	1	30 January 2010
Participant Consent Form: Alcohol Group	1	30 January 2010
Participant Consent Form: Control Group	1	30 January 2010
Letter of invitation to participant	1	20 January 2010
Evidence of insurance or indemnity	6	23 September 2008
Referees or other scientific critique report		20 November 2009
Questionnaire: BDI-II		
Questionnaire: Self - Evaluation		
Questionnaire: Prospective Memory		
Questionnaire: Severity of alcohol dependence		
Questionnaire: Initial Screening - Prospective memory in social drinking and alcohol dependency	1	20 January 2010
Val Curran CV		10 February 2010
Questionnaire: Initial screening for alcohol group	1	20 January 2010

Questionnaire: Initial questions - prospective memory in social drinking and alcohol dependency	1	20 January 2010
Questionnaire: Final questions - prospective memory in social drinking and alcohol dependency	1	20 January 2010

Membership of the Committee

The members of the Ethics Committee who were present at the meeting are listed on the attached sheet.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Now that you have completed the application process please visit the National Research Ethics Service website > After Review

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

We would also like to inform you that we consult regularly with stakeholders to improve our service. If you would like to join our Reference Group please email referencegroup@nres.npsa.nhs.uk.

10/H0807/21	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project

Yours sincerely

Mr T Eaton
Chair

Email: faye.cuffie@nhs.net

Enclosures: *List of names and professions of members who were present at the meeting and those who submitted written comments*
"After ethical review – guidance for researchers"

The Joint South London and Maudsley and The Institute of Psychiatry NHS Research Ethics Committee

Attendance at Committee meeting on 19 March 2010

Committee Members:

Name	Profession	Present	Notes
Mrs J Bostock	Lay member	Yes	
Prof Nelarine Cornelius		Yes	
Professor T Craig	Professor of Psychiatry	Yes	
Mr T Eaton	Lay member	Yes	
Professor A Farmer	Professor of Psychiatry	No	
Dr N Fear	Senior Lecturer in Military Epidemiology	No	
Miss Clare Flach		No	
Dr Daniel Freeman	Senior Lecturer in Clinical Psychology	No	
Dr T Joyce	Psychologist	No	
Dr Richard Kanaan		Yes	
Dr V Kumari	Senior Research Fellow in Basic Biomedical Science	Yes	
Dr M Leese	Senior Lecturer in Statistics	Yes	
Mr R Maddox	Lay member	Yes	
Dr V Mouratoglou	Consultant Psychologist, Mental Health of Older Adults	No	
Evan Stone QC		No	
Mr J Watkins	Social Work Representative	No	
Cllr Ian Wingfield		Yes	

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South London and Maudsley NHS

NHS Foundation Trust

Effects of alcohol use on remembering to do something in the future.

Information sheet

You are invited to participate in a research study investigating how alcohol dependence may affect "prospective memory". Prospective memory is remembering to do something in the future, for example, going to your appointment with a doctor at 4pm or returning the DVD you borrowed to your friend. Before you decide to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss this with the investigators, friends, relatives and/or your key-workers if you wish. Please ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Part 1 tells you the purpose of the study and what will happen if you decide to take part.
Part 2 gives you more detailed information about the study.

Thank you for reading this.

Part 1

The purpose of the research

This study is designed to improve our understanding of the effects of drinking on prospective memory - remembering to do something in the future. Most of our everyday forgetting involves prospective memory failures – forgetting to do something that you had intended to or had promised someone you would do. We know that alcohol impairs people's memory for their past but we don't know how it affects remembering to do something in the future. It is important that we find this out so we can see if there are ways of improving a person's prospective memory. To achieve this, this study will assess prospective memory in a group of individuals with a diagnosis of alcohol dependence and in a group of social drinkers.

Why have I been chosen?

You have been chosen because you have a history of alcohol dependence.

Do I have to take part?

No. It is up to you to decide whether or not to take part. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time. If you decide not to take part, or if you withdraw from the study, this will not affect the standard of care you receive.

What happens to me if I take part?

Initial Visit: We will arrange to see you in the ward where you have been admitted for medically assisted alcohol withdrawal. A member of our team will discuss the study with you and check that you are eligible to take part. This first visit will take approximately 15 minutes.

Main study: We will again arrange to see you on the ward. We will ask you questions about alcohol and about your mood and emotions. There is no right or wrong answer to these questions. You will also be asked to do some

straightforward memory and concentration tasks and to play a game on a computer. This study will last approximately two hours.

Follow-up: A member of our team will contact you by telephone within 6 months following your discharge from the ward, in order to see how you are getting on. This call should last no more than 15 minutes.

What are the possible risks of taking part?
There are no foreseen risks in taking part in this study.

How might this help me?
You will receive no medical benefit from taking part in this study nor will you receive individual feedback on your performance in any of the tasks. This study is designed to help identify possible strategies to enhance memory for intentions, and we hope that our findings will better inform the treatment of alcohol-related memory problems in the future. If you do take part, and the study reveals certain strategies to be beneficial for enhancing memory for intentions, you will, if you wish, receive a self help leaflet outlining details of the strategies and how to use them.

What about the results?
The results will be presented to all those who volunteered to take part once the study is complete. If you wish, results will be sent to you in a newsletter with a reference to a publication. You will not be referred to by name or identified in any report or publication, nor will the data be traceable back to you. By taking part in this trial, you agree not to restrict the use of any data even if you withdraw from the study.

What if there is a problem?
Any complaint about the way you have been dealt with in this study will be addressed. The detailed information on this is given in Part 2.

Will my taking part in this study be kept confidential?

Yes. All the information about your participation in this study will be kept totally confidential. The details are included in Part 2.

Expenses and payments
We will pay you £15 for taking part in the full study session.

Contact details: Prof. Valerie Curran, Professor of Psychopharmacology and Consultant Clinical Psychologist at University College London, is ultimately responsible for the study. She and her research team will be happy to answer any questions you may have and can be contacted during working hours on xxxx xxxx. Members of her research team dedicated to the study can be contacted by email to answer any questions about the study at xxxx xxxx. The researchers you will see are Alison Griffiths and/or Kash Karimi. Before you take part in the study you will be asked to sign a consent form. If you do not feel happy about signing this, you do not have to take part in the study. If you want to pull out of the study once it has started you are also free to do so. A copy of this information sheet and consent form will be given to you to keep.

Note that:

The Consultant Psychiatrist in the ward and the direct clinical care team are the only individuals with full access to your clinical records.
This completes Part 1 of the Information Sheet.

If the information in Part 1 has interested you and you are considering participation, please continue to read the additional information in Part 2 before making any decision.

Part 2

How many people will take part?

Forty patients diagnosed with alcohol dependence will be recruited over a twenty months period from inpatient substance misuse units in the South London and Maudsley NHS Trust.

What if new information becomes available?

You will be provided with any new information that becomes available during the study that may affect your willingness to continue to take part in the study. If this occurs, we may need to again obtain your written consent to confirm that you wish to continue taking part.

What will happen if I don't want to carry on with the study?

Taking part in this research study is voluntary. If you do decide to take part, you are free to withdraw at any time without penalty and without your treatment or the standard of care you receive at The Bethlem Royal Hospital, South London Maudsley NHS Trust or King's College Hospital NHS Trust being affected in any way. If you do withdraw, no more data will be collected about you. It is possible that those organising the study or the Ethics Committee may decide to stop the study at any time.

What if something goes wrong?

If you are harmed by taking part in this research project, there are no special compensation arrangements, but if you are harmed by someone else's negligence, then you may have ground for legal action. If you wish to complain, or have any concerns about any aspects of the way you have been approached or treated during the course of this study, the normal National Health System complaints mechanisms should be available to you.

Confidentiality

All data collected will be securely transferred to and stored on UCL premises and computers. As the study is confidential, all data collected will be secured against any unauthorised access. Although the overall results will be published in a

scientific journal, no individual participants will be identifiable from this. Confidential information linking your identity with clinical details will be separated after the trial, unless we inform you otherwise, in which case we will ask consent to retain such information.

As you are being remunerated for your participation, your name and address will be passed to UCL Finance for administration purposes.

All data will be collected and stored in accordance with the Data Protection Act 1998.

Who is organising and funding the research?

This study is jointly organised by the South London and Maudsley NHS Trust and University College London and funded by University College London [Project ID 10/0045].

Who has reviewed this study?

The joint SLAM/IOP REC has reviewed the study and we have received written approval. It has also been approved by the UCL research ethics committee [Project ID 10/0045].

Any questions?

Prof. Valerie Curran is ultimately responsible for the study. She and her research team will be happy to answer any questions you may have and can be contacted on xxxx xxxx during working hours or by emailing xxxx xxxx.

If you decide to take part in the study, you will be asked to sign a consent form. Before you sign the consent form, you should ask questions about anything that you do not understand. You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for taking the time to read and consider this information.

South London and Maudsley **NHS**

NHS Foundation Trust

Remembering to do something you meant to do:

does drinking affect this?

Consent Form

- I ………………………………………………………………….confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions and discuss the study.

- I agree that I have received satisfactory answers to all my questions or have been advised of an individual to contact for answers to pertinent questions about the research and my rights as a participant

- I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

- I understand that only my direct healthcare team will have access to my medical notes and that the members of the research team will not have access to them.

Continued overleaf

- I agree to have the rehabilitation program I am attending informed about my involvement in this research study.
- I understand that the personal information generated from this study will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.
- I consent to the information I have submitted being securely transferred to and stored on University College London premises and computers
- I understand that I am being paid for my assistance in this research and that some of my personal details will be passed to UCL Finance for administration purposes.
- I agree to take part in the above study.
- I agree to be contacted by telephone in the next few months to check how things are going
- I agree/do not agree (*delete where applicable)* for the results of the study and details of any effective memory strategies to be sent to me at the end of the study to: *(Please include post or email address details if applicable)*

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Signed (participant)   Date

I ……………………………………………………………………. confirm that I have fully explained the study to the participant and have answered all questions asked honestly and fully.

_____   _____

Signed (researcher)   Date

Appendix 9: Details regarding the division of tasks on tasks on this project

Alison Griffiths was the chief investigator and conducted the majority of the work on this project independently. However 10 of the alcohol dependent participants were tested by Kash Karimi, MSc student. All 24 alcohol dependent participants tested in for this consented to receiving a follow-up call. The data collected through this call, along with the data collected in the current study, will be used in the MSc study led by Kash Karimi. This is currently ongoing**.**

Appendix 10: Imagining Script

Appendix 11: Vividness and Impression of living the experience Scales