

**Approach and avoidance tendencies with alcohol-
related stimuli in young heavy drinkers**

Tommaso Italiano

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Thesis declaration form

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signature:

Name: Tommaso Italiano

Date: 04.07.2014

Overview

This thesis consists of three parts.

Part 1 presents a systematic literature review of 20 studies investigating if neuropsychological measures can be used as predictors of relapse in alcohol treatments.

Alcohol misuse impairs a range of neuropsychological functions. Cognitively impaired individuals undergoing treatment for alcohol dependence would be expected to benefit less from alcohol treatment and to be more prone to relapse. The review explores the relationship between neuropsychological performance at the beginning of treatment and relapse at follow up and its prognostic value.

Part 2 consists of an empirical paper on motivational tendencies in a population of young heavy drinkers. Approach/Avoidance tendencies are considered a key factor in addiction as they underlie impulsive behaviours. Addictive behaviours are determined by the interaction between an *impulsive* system and a more *reflective*, inhibitory one, which involves neuropsychological functions. The paper explores approach/avoidance tendencies for 23 young individuals reporting problematic drinking but not seeking help. Relationships among drinking behaviours, neuropsychological variables and reported attentional control were also investigated.

Part 3 presents a critical appraisal of the work undertaken in the literature review and the empirical paper. Specifically, it discusses difficulties encountered in recruiting alcohol dependent individuals who were completing a community based detoxification. It also explores the concept of binge drinking, its definition and its relationship with neuropsychological functioning.

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Part 1: Literature Review

**Can neuropsychological performance predict relapse in
abstinent alcoholics?**

Abstract

Aims Heavy consumption of alcohol has a negative impact on a broad range of neuropsychological functions. Standard treatments for alcohol dependence rely on unimpaired cognitive skills; hence, treatment outcomes would be expected to be less favourable for cognitively impaired alcoholics. This review is the first to systematically examine whether neuropsychological performance at treatment completion can predict whether patients maintain abstinence or relapse at follow up.

Method Databases (EMBASE, PsycINFO, and MEDLINE) and additional sources (books, conference abstracts and theses) were searched for studies that reported a relationship between endpoint neuropsychological performance and treatment outcome in individuals with alcohol dependence.

Results A total of twenty studies met the inclusion criteria. The studies explored a variety of neuropsychological functions and employed a total of 64 measures.

Conclusions Nine studies found a significant relationship between neuropsychological functioning and treatment outcome. Inconsistency in the results might depend on a range of factors: differences in treatment efficacy, neuropsychological tests and their psychometric properties, length of follow up period, definition of 'relapse' and appropriateness of statistical tests used. This review suggests that the majority of studies have adopted a linear model of causality, attributing a direct effect of neuropsychological impairments on relapse. Future research would benefit from adopting mediation and moderation models, which could explore the interaction of neuropsychological functions with established predictors of relapse, such as alcohol related self-efficacy, alcohol expectancies and treatment goals.

1. Introduction

“In vino veritas” is a Latin phrase used by Ancient Romans to praise wine’s characteristic to make people speak truthfully. Many cultures and languages acknowledge the “honesty” given by alcohol, yet there are other truths concerning alcohol which are mostly neglected by public opinion. Drinking alcohol is socially accepted in the western society, where is it often associated with leisure and relaxation. Nevertheless it can negatively impact on the physical, social and psychological wellbeing of those who drink over ‘safe’ (government recommended) levels.

In the United Kingdom (UK) 24 per cent of the adult population consumes alcohol in ways potentially harmful to their wellbeing, and six percent of the adult population presents with alcohol dependence. This refers to the condition of increased tolerance to alcohol, withdrawal symptoms upon abstinence and loss of control over drinking (McManus, Meltzer, Brugha, Bebbington & Jenkins, 2009). It is established that excessive drinking can lead to various health problems, such as liver and kidney disease, pancreatitis, high blood pressure, stroke, depression and several cancers (Choices N.H.S., 2011). Alongside acute and chronic effects on health, severe psychosocial consequences, including violence, child abuse and neglect, absenteeism in the workplaces, are attributable to alcohol consumption (World Health Organization, 2009).

Although less striking, neurocognitive deficits across a broad range of severity are other significant health issues derived by excessive alcohol consumption. The most debilitating cognitive deficits are found in Korsakoff’s syndrome, Wernicke’s encephalopathy and alcohol-related dementia; these disorders also share memory impairment, confabulation and mental confusion (Krabbendam et al., 2000;

Saxton, Munro, Butters, Schramke & McNeil, 2000). However, only a minority of drinkers eventually succumb to these severe neurological diseases. More commonly, heavy drinking is associated with more subtle, often age-related, cognitive impairments (Sabia et al., 2014). Many studies have associated heavy alcohol consumption to the decline of different cognitive areas (Ratti, Bo, Giardini & Soragna, 2002; Rourke & Grant, 1999). Specifically, impairments have been repeatedly shown in attention, working memory, processing speed, impulsivity and executive functions (Pitel et al., 2007).

Contrasting theories have also been proposed in order to identify selected brain regions which underpin the cognitive impairments directly affected by the alcohol consumption. The frontal lobe and lateralization hypotheses respectively identify anterior brain areas (Uekermann, Daum, Schlebusch, Wiebel & Trenckmann, 2003) and the right hemisphere (Ratti et al., 2002) as the most vulnerable cerebral regions to the neurotoxic effects of chronic alcohol consumption. The “diffuse brain dysfunction” hypothesis is a third strong alternative, which denies susceptibility of specific brain regions to alcohol toxicity. This theory is supported by several studies that acknowledge verbal, visual and abstracting deficits as results of alcoholism (Beatty, Hames, Blanco, Nixon, & Tivis, 1996; Parsons, 1998). A recent meta-analysis of cognitive deficits in alcoholism (Stavro, Pelletier & Potvin, 2012) provided support for the diffuse brain hypothesis: it has identified multiple cognitive functions which are incompatible with the frontal lobe and lateralization hypotheses. The analysis has revealed that eleven cognitive domains are moderately impaired during short-term abstinence (up to a month) and ten of these remain impaired during intermediate abstinence (up to a year). Long term abstinence, defined by the study as longer than a year, has been linked to a general recovery of cognitive functioning

across all domains, identified by the authors as: intelligence quotient (IQ), verbal fluency and language, processing speed, working memory, attention, problem solving and executive functions, verbal learning, visual learning, visual memory and visuospatial abilities.

These long term negative effects would be expected to impact on the efficacy of alcohol treatments. The nature of these effects — i.e. their duration and the domains affected — are important to consider in relation to relapse prevention strategies, which often require intact cognitive performance in precisely those areas of cognitive functioning that are impaired as a result of alcohol dependence.

Moreover relapse prevention strategies are generally required to be applied directly following detoxification, when the cognitive impairments are a more prominent part of the protracted withdrawal syndrome (Stavro et al., 2012). Treatment and relapse prevention strategies can be effectively learnt when patients can rely on preserved abilities: memory, visual and verbal learning, abstract reasoning, response inhibition are all necessary to process the large amount of information presented in therapeutic settings (Dawson & Grant, 2000; Goldman, 1990; Weinstein & Shaffer, 1993).

Cognitive flexibility, attention and other executive functions are equally important, as they are employed in behavioural regulation and problem solving (Loeber & Hay, 1997; Lyvers, 2000). Goldman (1995) identified further, indirect effects of cognitive impairment on treatment outcome: patients with poor cognitive abilities are perceived by treatment providers as less attentive, less motivated and in greater denial when compared to unimpaired patients.

Many studies have attempted to identify and quantify the relationship between neurocognitive impairments and treatment outcome, yet there are no conclusive results and often contradictory findings have been reached. Studies have mostly

tested a direct influence of impairment on treatment outcome (Bates, Bowden & Barry, 2002) and some have linked better cognitive functioning at completion of detoxification programmes to better treatment outcomes, either in terms of reduced alcohol intake (Gregson & Taylor, 1977; Wolwer, Burtscheidt, Redner, Schwarz & Gaebel, 2001) or important functional outcomes (Walker, Donovan, Kivlahan & O’Leary, 1983). Other studies have not found evidence for a predictive role of neuropsychological functioning (Eckardt, Rawlings, Graubard, Faden, Martin & Gottschalk, 1988; Macciocchi, Ranseen & Schmitt, 1989). A partial review of these early studies (between the late 1970s and early 1990s) was conducted by Knight and Longmore (1994). They concluded that measures of correlations between neuropsychological tests and treatment outcome provided inconsistent results; when findings were significant – in a limited number of studies - they explained only a small portion of variance in the treatment outcome. The review proposed various hypotheses that could explain the inconsistency of findings: therapeutic programmes might have compensated for impairments or tests adopted might have been only partially valid. Other factors contributing to the weak association may have related to major methodological differences between studies (differences in treatment modalities, definition of relapse, severity of impairment and severity of alcohol abuse).

Despite advances in treatments for alcohol dependence, pharmacological and psychological treatment outcomes remain poor, with 70-80 % of treated alcoholics relapsing within the year of treatment completion (Schuckit, 2009). As such, identifying neuropsychological performance measures that possess prognostic value is still an important goal. For example a better understanding of the association between neuropsychological performances and treatment outcome might prompt a

more specific allocation of patients to different treatment modalities or suggest the inclusion of cognitive rehabilitation early in therapeutic pathways.

In the last twenty years additional studies have examined the prognostic value of neuropsychological functioning; to the author's knowledge, these studies have not been systematically reviewed. The present review aims to examine the available research adopting systematic methods and extending the work of Knight and Longmore (1994) to the more recent findings.

2. Method

2.1 Search Strategy

With the aim of adopting a thorough and broad strategy, relevant studies were searched in EMBASE, PsycINFO, and MEDLINE databases (via Ovid interface) on the 1st December 2013. Only studies of human subjects and published in English were included. Search terms included both text words and subject headlines and covered five relevant domains: alcohol dependence, neurocognitive abilities, treatment, treatment outcome/relapse and prediction. Search terms related to neurocognitive abilities were initially chosen on the basis of the meta-analysis previously mentioned (Stavro et al., 2012). A pilot search resulted in a very high number of studies, mainly deemed to be irrelevant for this review. As such, the terms related to neuropsychological abilities were screened according to the areas investigated by the studies already identified (and partially reviewed by Knight & Longmore, 1994). Specifically, the following terms were used: alcohol* AND neuropsychology* OR memory OR neurocognitive OR cognitive function* OR cognitive dysfunction OR cognitive deficit* OR problem solving OR executive function* OR impulsivity AND intervention OR treatment* OR rehab* OR relapse

OR detox* OR abstin* OR treatment outcome* AND predict* OR correlat*. The terms were combined in the same databases with the following subject headings: Alcoholism AND Neuropsychology OR Cognitive Ability OR Cognitive Impairment OR Neurocognition OR Neuropsychological Assessment OR Memory OR Cognition OR Cognitive Process OR Problem Solving OR Impulsiveness AND Intervention OR Treatment OR Rehabilitation OR Relapse Prevention OR Relapse (Disorders) OR Detoxification OR Alcohol Rehabilitation OR Sobriety OR Treatment Outcomes AND Prediction or Statistical Correlation. Relevant textbooks and conferences were reviewed to ensure that relevant publications were included.

2.2 Selection of studies

The selection of papers was independently carried out by two reviewers. A first screening was based on the title and the abstract of the papers. Duplicate reports and studies with missing abstracts were eliminated by using Mendeley Desktop interface. Both the reviewers conducted the second screening, read the full articles and identified the eligible studies on the basis of inclusion and exclusion criteria. Disagreements between reviewers were resolved through discussion. The studies were included only when the following criteria were met:

2.3 Inclusion Criteria

1. The relationship between treatment outcome and neurocognitive performances was quantified.
2. Treatment outcome was measured at a follow-up, at least 2 months after treatment completion and up to 24 months post-treatment.

3. Participants had undergone some form of psychosocial treatment for their alcohol misuse following their alcohol withdrawal.

4. Neurocognitive testing was performed within 3 months from treatment completion

2.4 Exclusion criteria

Studies were excluded if:

1. Participants had a co-occurring substance use disorder, with the exception of nicotine.

2. Participants had co-morbid (or history of) psychosis or other thought disorder, dissociative disorder, bipolar disorder, post-traumatic stress disorder.

Because of the high prevalence of co-morbid depression, studies that included depressed participants were not excluded, although depression was not often formally diagnosed.

3. Participants had alcohol-related neurological conditions, such as Korsakoff's, Wernicke's or alcohol related dementia.

2.5 Quality appraisal

The studies included in the review differed markedly in their designs, in the neurocognitive domains investigated and in the tests used. Statistical analyses, sample characteristics and size, and nature of treatment also differed between studies. All these factors would inevitably influence the results and the ultimate summary of the findings considered in this review. In order to assess methodological quality of studies, various checklists have been produced, yet their use has been discouraged by the Cochrane collaboration as their validity is untested or is not supported by

empirical evidence (Higgins and Green, 2011). In addition, as quality of reporting and quality of underlying research only partially overlap, the Cochrane collaboration distinguishes the methodological quality of studies and the risk of biases, which should be assessed by focusing on domains.

3. Results

The search strategy in the three databases yielded a total of 4841 results, from which 871 duplicates were removed. After a first screening, based on title and abstract, 81 articles were identified as possibly relevant for the study and full texts were retrieved and read by both reviewers. This process resulted in the removal of 56 studies which did not meet the inclusion criteria, whilst the remaining 25 studies were independently appraised by both reviewers. See Figure 1 for detailed screening process

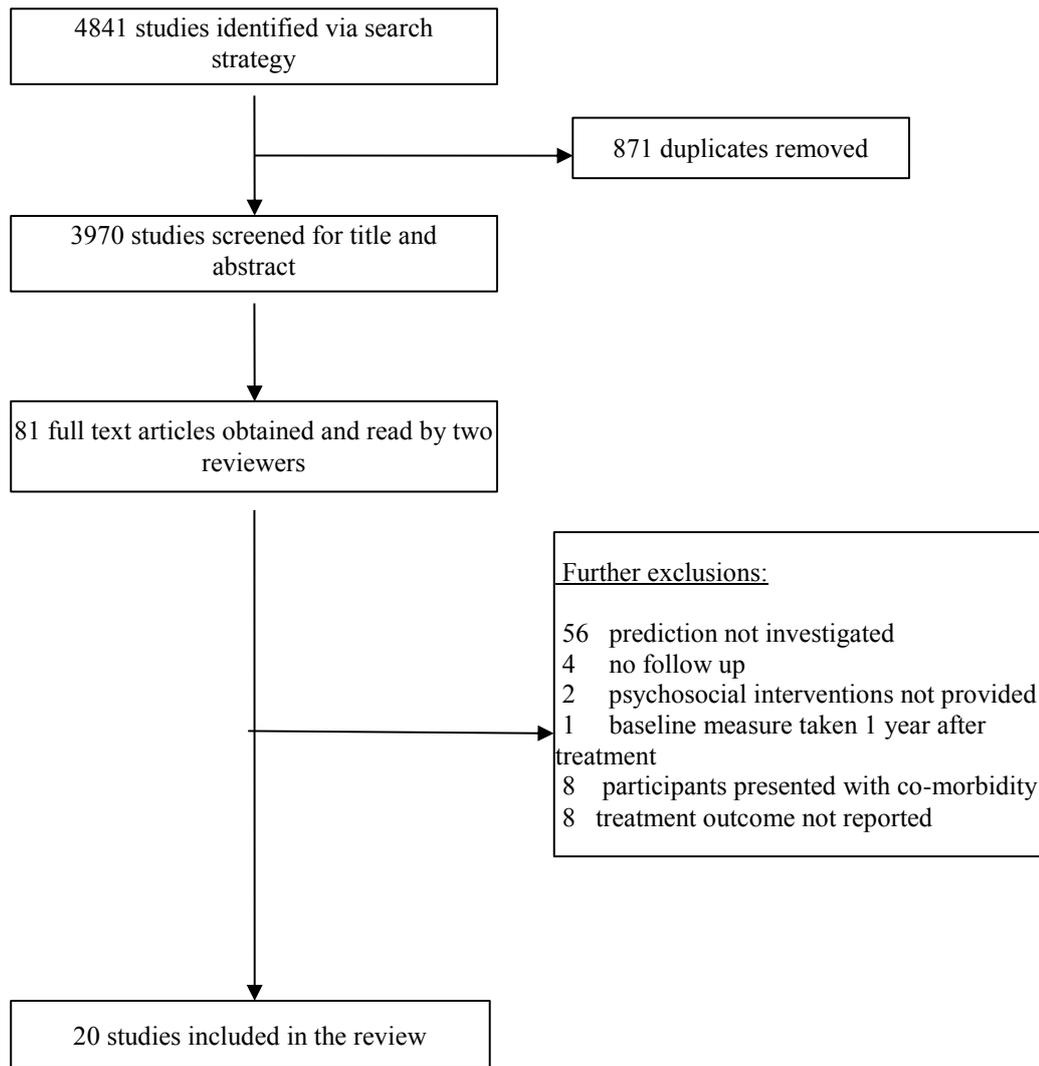


Figure 1: Flow diagram of study selection

The final screening identified 20 studies which were included in the review. Sample sizes range from 20 to 245 participants; eight studies examined only male participants, eight studies examined both male and female participants while three studies did not specify the gender of the participants. Participants' average age across all studies was 43.4 years \pm 11.2 (*SD*). Table 1 provides an overview on sample characteristics, methodology, neuropsychological functions examined, follow up procedures and findings. The neurological measures administered in the studies are listed in Table 2 with the relative frequency of their use.

Table 1*Summary of studies*

Study	Initial Sample <i>Gender and average age in years</i>	Neuro-cognitive functions examined and testing details	Follow up details	Definitions of treatment outcomes	Findings
1 Abbott & Gregson (1981)	<i>n</i> =106, 74M and 32F Age=43.4 <i>SD</i> =13.3	-Test administration at the 4-6 th weeks of hospitalisation -Global level of impairment	-Follow up at 3 (<i>n</i> =103) and 12 months (<i>n</i> =100). Self-reports and collaterals' reports	-Abstinence -light/controlled drinking -relapse (drinking at pre-treatment levels)	Both indices of cognitive dysfunction predicted time to first drink; BRF was a better predictor than PCIT
2 Allsop, Saunders & Phillips (2000)	<i>n</i> =60, all males	Test administration at 10-14 days after admission. - learning, non-verbal and working memory	Situational confidence questionnaire (SCQ) at discharge, follow ups at 6 (<i>n</i> = 57) and 12 months (<i>n</i> =49). Time-line interviews & postal questionnaire.	-Abstinence - No-Problem drinking - Problem drinking (poor outcome).	Cognitive functioning & self-efficacy predicted longer time to first alcohol consumption
3 Alterman, Kushner & Holahan (1990)	<i>n</i> =87, all males Age= 42	Test administration after ~21 days of abstinence. - Language ability, Auditory verbal Learning, Logical Memory, and Complex Cognitive Functioning.	Follow ups at 1 (<i>n</i> = 84) & 6 (<i>n</i> =72) months; Alcohol Severity Index (ASI) questionnaire.	No clear definition of relapse	General cognitive efficiency associated with lower alcohol consumption; cognitive performances did not predict treatment outcome
4 Bowden-Jones, McPhillips, Rogers, Hutton & Joyce (2005)	<i>n</i> =21 Age= 40.9 <i>SD</i> =7.6	Test administration, 21 days after detoxification - planning, impulsivity, decision making, intelligence quotient and memory.	Follow up at 3 months (<i>n</i> =21), procedures not specified.	No clear definition of relapse, although likely to be considered any post-treatment alcohol consumption	Significant differences between Abstainers (<i>n</i> =15) and Relapsers (<i>n</i> =6): higher scores on BIS, worse decision in gambling test and decision making test. No regression analysis performed
5 Durazzo, Gazdzinski,	<i>n</i> =70, 67 M and 3 F	Test administration after a month of abstinence	Follow up 227+/- 71 days after first	-Abstainers: no post treatment drinking	Abstainers (<i>n</i> =26) Resumers (<i>n</i> =44, of which <i>n</i> =32 relapsed,

	Yeh & Meyerhoff (2008)	Age= 50 SD=9.6	- Executive Skills, General Intelligence, Learning and Memory, Processing Speed, Visuospatial Skills, Cognitive Efficiency and Premorbid Intelligence	assessment. Timeline Follow-Back Interview for $n=52$; face to face and phone interviews, medical records and collaterals' reports for $n=18$	-resumers: consumed alcohol -relapsed had more than 3 consecutive days of drinking with 6 or more daily drinks (males)	with more severe alcohol intake). Processing speed and unipolar mood disorder predicted relapse
6	Eckardt, Rawlings, Graubard, Faden, Martin & Gottschalk (1988)	$n=91$, all males Age= 42 SD=10	Test administration a week after the last drink -memory, perception, conceptual shifting, abstracting ability, motor performance and general intelligence	Follow up at 6-8 months after treatment ($n=72$). Self-administered questionnaire.	Relapse: consuming alcohol more than 3 times in 6 months.	Different statistical analyses used (ranking procedure and not). Different tests had different relationships with treatment outcome. Relapse associated to <i>better</i> performances in memory and sustained attention tests.
7	Gregson & Taylor (1977)	$n=90$, all males Age= 44.6 SD=11.6	Test administration on 4 th /6 th week of hospitalization -global cognitive impairment	Follow up at 1, 3 and 6 months after treatment ($n=90$). Self and collaterals' reports.	Complete Abstinence ($n=32$) vs post-treatment drinking ($n=58$, relapse)	Performance on PCIT was the best predictor of treatment outcome among many variables.
8	Loeber, Duka, Márquez, Nakovics, Heinz, Mann & Flor (2010)	$n=48$, 29 M and 19 F Age= 46	Test administration at least 5 days after the last medication dose -attention and executive functions, decision making and risk taking behaviour, memory and learning	Follow up at 3 ($n=35$) and 6 ($n=28$) months. Interviews; biological measures taken for 12 participants.	Relapse ($n=19$) not clearly defined, likely to be any post treatment alcohol consumption	Iowa Gambling Test scores only predictor of relapse.
9	Macciocchi, Ranseen & Schmitt (1989)	$n=161$, Age=38.2 SD=12.2	After detoxification a battery test administered -attention, concentration, problem	Follow up at 12 months ($n=132$). Interviews with	Abstinence: no alcohol consumption after treatment completion,	No significant relationship between NP tests and treatment outcome were found

			solving, memory, abstract reasoning	participants and collaterals.	otherwise relapse	
10	Moriyama, Mimura, Kato, Yoshino, Hara, Kashima, Kato & Watanabe (2002)	<i>n</i> =22, all males. Age= 51.6 <i>SD</i> =3.7	Test administration 7 weeks after detoxification -different components of executive functioning.	Follow up 8 months after assessment (<i>n</i> =22). Interview based on the DSM-III-R. Interviewer blinded to NP results.	Abstinence (<i>n</i> =10) if drinking not resumed in previous 6 months, otherwise Relapse (<i>n</i> =12)	Two ways factorial analysis of Variance (ANOVA) (drinking X Occupation). No significant differences between abstainers and resusers in NP.
11	Morrison (2011)	<i>n</i> =34, 20 M and 14 F Age= 47.2	Test administration 5/10 days after admission -verbal, non-verbal and working memory, executive Functioning and verbal fluency	Follow up 3 months after treatment completion (<i>n</i> =34). Time Line Follow Method	Abstinence (<i>n</i> =7): no alcohol consumption after treatment completion, otherwise relapse (<i>n</i> =27)	Trail B only significant predictor of relapse when NPs scores are inserted in a regression analysis.
12	Noel, Sferrazza, Van Der Linden, Paternot, Verhas, Hanak, Pelc & Verbanck (2002)	<i>n</i> =20, Age=45.5 <i>SD</i> = 7.5	Test administration after a week after last medication and 14/22 days from last drinking. -working memory, impulse control, abstract ability and verbal learning	Follow up 2 months (<i>n</i> =20) after treatment completion. Interviews.	Relapse defined as drinking more than 4 drinks a day, 4 drinking days a week or drinking levels requiring detox.	Resusers' performance poorer than abstainers in Hyaling test and Alpha span but no differences in episodic memory, abstract reasoning. No estimate of prediction through regression analysis.
13	Parsons, Shaeffer & Glenn (1990)	<i>n</i> =143 (76 M and 67 F) Age=37 <i>SD</i> =9	Test administration after 3/6 weeks of abstinence -verbal, visuo-spatial, memory, perceptual motor and semantic memory	Follow up at 12-16 months after initial testing (<i>n</i> =103). High attrition rate; re-testing of 103 subjects, divided in Resusers (41, 28M and 13F) and Abstainers (62, 30M & 32F).	Abstainers (<i>n</i> =62, less than 10OZ of alcohol in the previous 6 months) vs Resusers (<i>n</i> =41, more than 10OZ of alcohol in the previous 6 months (17drinks)	Both resusers and abstainers had significantly poorer scores than non-alcoholics in NP measures. Depression and self-reports of attention-deficit accounted for most of the variance in treatment outcome.
14	Pitel, Rivier, Beaunieux, Vabret, Desgranges & Eustache	<i>n</i> =54, Age= 48.6 <i>SD</i> =13.8	Test administration at completion of withdrawal programme. -episodic memory, executive functions, slave system of working memory, attentional	Follow up at 6 months (<i>n</i> =34). Use of self-reports, telephone contact and then face-to-face	Abstinence (<i>n</i> =14): no alcohol consumption; Relapse (<i>n</i> =2): any post-treatment alcohol consumption.	No differences were found in NP performances between relapsers and abstainers.

	(2009)		abilities	interviews.		
15	Sheehan, T (1989); unpublished dissertation	<i>n</i> =161, all males Age= 43 <i>SD</i> =10.4	Test administration on 3 rd week of treatment. -intellectual impairment, with focus on vocabulary and abstract thinking.	Follow Up at 6 months (<i>n</i> =144). Hazelden Follow up Questionnaire. Self-reports compared with others' reports.	Relapse defined as any post-treatment alcohol consumption.	No interaction found between intellectual impairment, drinking locus of control and treatment outcome. Relapsers had lower scores in encoding (SDMT) and self-efficacy.
16	Sussman, Rychtarik, Mueser, Glynn & Prue (1986)	<i>n</i> =56, all males Age=47.1 <i>SD</i> =12.5	Tests administration on 3 rd week of abstinence -memory assessment with test designed to be ecologically valid.	Follow up at 3 months (<i>n</i> =47). Phone interviews conducted by blind evaluator, evaluating subjects' drinking status and social functioning.	Relapse defined as any post-treatment alcohol consumption.	Abstainers (<i>n</i> =22) performed better than drinkers (<i>n</i> = 25) on the PRT but no differences were found on the MFD. Logistic regression analysis with dichotomous variable resulted in a highly significant model
17	Tapert, Ozyurt, Myers & Brown (2004)	<i>n</i> =43, all males Age= 43 <i>SD</i> =9.7	Test administration on the first week of admission. -information processing/attention, cognitive flexibility, verbal intellectual functioning, psychomotor functioning, vigilance & attention to detail.	Follow ups at 3 months and 12 months. Personal and collaterals' interviews and blood draws for biological confirmation of outcome. Sample size at follow up not indicated.	Relapse not defined but dependent variable was the percentage of days between 3 and 12 months follow ups in which alcohol consumption occurred.	Coping Strategies analysed in interaction with neuropsychological performance. Cognitive performances moderated relationship between coping and treatment outcome but better cognitive scores were associated to poorer outcomes.
18	Walker, Donovan, Kivlahan & O'Leary (1983)	<i>n</i> =245, all males Age= 45.7 <i>SD</i> =11.9	Test administration in the first week of hospitalization (+/-23 days after last drink). -memory, fluency, attention and cognitive flexibility; all summed up in a Brain-Age Quotient.	Follow Up (<i>n</i> =191) measures taken at 3, 6 and 9 months. Self-reports.	Relapse not defined but number of drinks per day and number of heavy drinking days considered. Outcomes not clearly	Neuropsychological scores divided into 3 groups: High, medium and low. Higher scores were associated to abstinence, full time employment, higher income

19	Wicks, Hammar, Heilig & Wisén (2001)	n=29, Age (Median)=49	Test administration during admission (participants still on medication) - assessment focused on attention, cognitive flexibility, executive functions.	Follow up (n=18) approximately 2 months after discharge. Face to face interviews with Time Line Follow Back (TLFB) method.	reported. No reported definition of abstinence/relapse but number of drinking days used as dependent variables.	TMT did not correlate with treatment outcome, whilst WCST was highly correlated with non-drinking days. No measure of prediction
20	Wolwer, Burtscheidt, Redner, Schwarz, Gaebel (2001)	n=120, 84 M and 36 F Age= 42.4	Test administration after 10/12 days of inpatient detoxification. -verbal, non-verbal and working memory, attention, visuospatial abilities, verbal fluency, cognitive and reactive flexibility, crystallised and fluid intelligence.	Follow up at 3 and 6 (n=115) months. Drinking behaviours weekly recorded; at 3 months a phone interview and at 6 months another assessment.	Outcomes: -abstinent (no alcohol consumption, 34% of subjects) -improved: no signs of pathological drinking (29% of subjects) -relapsed: 37% of subjects (more than three lapses or regular consumption of large quantities	Trend of improvement for patients without Cognitive Impairment (only in abstinence criteria, not noticeable in Improved). TMT A was the only significant predictor of treatment outcome

Notes: Information not reported in the papers (average age, standard deviation, frequency of genders) are omitted in the table.

NP = neuropsychological; see Table 2 for tests' abbreviations.

Individuals who abstain after treatment are here defined as *abstainers*, individuals who relapse are *relapsers*. Parsons et al. (1990) called participants who relapsed *resumers*. Durazzo distinguished *resumers* (participants reporting any alcohol consumption after treatment) from *relapsers* (*resumers* who returned to heavy drinking).

Table 2

Frequency of neuropsychological measures used in the reviewed studies

Neuropsychological abilities investigated	Name and References	Studies using the test
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Global Intelligence/Global Functioning	Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981)	9, 13, 17, 18
	Wechsler Adult Intelligence Scale 3rd Edition (WAIS-III; Wechsler, 1997)	2, 5, 11
	National Adult Reading Test (Nelson et al., 1991)	4
	Eckardt Test Battery (Eckardt et al., 1978; Eckardt et al., 1979)	6
	Progressive Matrices of Raven (Raven, 1960)	12
	Patterned Cognitive Impairment Test (PCIT; Gregson & Taylor, 1977)	1, 7
	MWT-B-Crystallized Intelligence Test (Lehrl, 1977); KAI- Fluid Intelligence Test (Lehrl et al., 1992)	20
	Conceptual Level Analogy Test (Willner, 1970)	13
	Shipley Institute of Living Abstraction Age (Shipley, 1940)	13,15
	Rod and Frame Test (BRFT; Abbott & Gregson; 1981)	1
Memory	Recurring Figures Test (Kimura, 1963); Recurring Words Test (Stollmann, 1990); Corsi Block Span (Milner, 1971); Continuous Performance Test (Rosvold et al., 1956)	20
	Free and Cued Selective Reminding Test (FCSRT) (Grober & Buschke, 1987; Grober et al., 1988; Van der Linden et al., 2004); Multimodal Span Task (Quinette et al., 2003)	14
	Product Recall Test (PRT; Sussman et al., 1986); Memory for Design Test (MFD; Graham & Kendall, 1960)	16
	Brief Visuospatial Memory Test-Revised (Benedict, 1997); Ward-7 Full Scale IQ (Axelrod et al., 2001)	5
	Alpha –span task (Belleville et al., 1998)	12
	Russell-Neuringer delayed recall modification of the Logical Memory Test (Russell, 1975); Symbol Digit Paired Associate Learning Task (Kapur and Butters, 1977)	3, 13
	Wechsler Memory Scale (WMS; Wechsler, 1945)	2, 3
	CPT-A Working Memory Test (Wolwer et al., 1999)	20
	Selective Reminding Test (Buschke, 1973)	9
	Paired Associates Test (Fowler et al., 2002)	4
	Auditory Verbal Learning Test (RAVLT; Rey, 1964)	3,8,11
	Benton Visual Retention Test (BVRT; Sivan, 1992)	8
Executive Functions	Verbal Fluency Task (Cardebat et al., 1989) Attentional Assessment Test (Zimmerman & Fimm, 1993); 2-Back Paradigm (Quinette et al., 2003); Integration Task (Quinette et al., 2006);	14
	Tower of London Planning Task (Owens et al., 1990); Decision Making Task (Rogers et al., 2000)	4
	Design Fluency (Jones-Gotman et al., 1977); German Lexical Verbal Fluency (Horn, 1983); Attention-Load Test d2 (Brickenkamp, 1981)	20

	Levine Hypothesis test (Levine, 1966)	13
	Hayling Test (Burgess, 1997)	12
	Behavioral Assessment of the Dysexecutive Syndrome (BADS) (Wilson et al., 1996)	10
	Gambling Task (Bechara et al., 1994; 2000)	4, 8
	California Verbal Learning Test-II (Delis et al., 2000)	5, 12
	Wisconsin Card Sorting Test (WCST; Heaton et al., 1993)	5, 8, 19, 20
	Stroop Color-Word Test (Golden, 1978)	5
	Halstead-Reitan Trail Making Test Part B (TMT B; Reitan, 1958; Reitan & Wolfson, 1993)	2, 3, 5, 8, 9, 10, 11, 13, 17, 18, 19
	Short Categories Test (Wetzel & Boll, 1987)	5, 9
Processing Speed	Halstead-Reitan Trail Making Test Part A (TMT A; Reitan, 1958; Reitan & Wolfson, 1993)	2, 3, 5, 8, 9, 10, 11, 13, 17, 18, 19
	Symbol Digit Modalities (SDMT; Smith, 1973)	10, 15
	Visual Search Test (Rennick, 1979)	17
Visuo-Spatial & Motor Abilities	Luria-Nebraska Item 99 (Golden et al., 1978)	5
	Grooved Peg Board (Lafayette Instrument, 1989)	5, 13
	Rey-Osterrieth Complex Figure Test (Rey, 1941; Osterrieth, 1944 in Lezak, 1980)	2, 11, 20
	Line Orientation Task (Benton, 1978)	20
Verbal Abilities	Face-Name Learning Test (Schaeffer & Parsons, 1987); Word Finding Test (Reitan, 1972)	13
	Peabody Picture Vocabulary Tests (Dunn, 1965); Peabody Individual Achievement Test (Dunn & Markwardt, 1970)	3
	Halstead Category Test booklet (DeFillippis & McCampbell, 1979)	3, 13
	Controlled Oral Word Association Test (COWAT) (Benton et al. 1983)	11
	Shipley Institute of Living Verbal Age (Shipley, 1940)	13, 15

3.1 Neuropsychological functions and treatment outcomes

3.1.1 Memory and Learning

A total of 10 studies included measures of memory and learning in their test battery. Sussman et al. (1986) specifically focused on memory and designed the Product Recall Test (PRT), with the intention of having an ecologically valid measure of participants' memory skills. The free recall test, which imposed minimal demands on encoding, assessed the ability to remember images of common products; it was administered alongside the Memory Design Test (MDT), which requires recall of 15 novel patterns and assessed "visual memory-motor" recall. The PRT, but not the MDT, was able to discriminate patients who relapsed from the ones remained stable at two months follow up and consequently had a predictive value. The authors acknowledged that the test had not been validated and post-treatment data were collected only three months after discharge. A later follow up might have provided a different ratio of abstainers/relapsers. In addition the tests used required to encode and retrieve very different items and differences between the tests might have not depended on the level of ecological validity they achieved.

Three other studies, which also assessed other neuropsychological functions, found some association between memory and treatment outcomes. Morrison (2011) reported a strong association between working memory, measured with the Letter Number Sequencing Test from WAIS-III, verbal memory, measured with the Rey Auditory Verbal Test (RAVLT) and post treatment abstinence; yet memory did not maintain a predictive value when it was included in a regression analysis alongside the scores of Trail Making B and the Depression subscale of Hospital Anxiety and Depression Scale-Depression (HADS; Zigmond and Snaith, 1983).

A similar relationship was reported by Parsons et al. (1990); memory, as well as other neuropsychological variables assessed, could significantly differentiate abstainers and relapsers at one year follow up. However, the authors calculated an index of general performance, which covered a small amount of variance when included in a regression analysis, alongside depression and self-reports of childhood attention deficit disorder.

Wolwer et al. (2001) found that participants who relapsed after six months after treatment completion performed significantly poorer in tests assessing verbal learning, memory and visuospatial abilities than participants who maintained abstinence. A stepwise regression analysis did not find verbal learning and working memory performances as significant predictors of relapse.

Memory and executive functions were investigated in the study conducted by Noel et al. (2002). The authors administered a test battery and measured the frontal cerebral blood flow through a SPECT scan. The participants were interviewed two months after treatment completion, the closest time to the end of treatment of all the reviewed studies. Relapsers obtained significantly lower scores in working memory. Noel et al. associated poor working memory and poor impulse inhibition to early relapse; although the findings were supported by the neurological examination and variables such as mood, anxiety and education were also considered, potential caveats should be noticed. The study adopted quite a loose definition of abstinence, as up to four daily drinks were tolerated, and a regression analysis was not performed to quantify the predictive value of the neurocognitive measure, possibly because the authors deemed the sample size insufficient for such analysis.

3.1.2 Processing Speed

A total of six studies included measures of processing speed in the test batteries administered. However, only two studies (Durazzo et al, 2008; Allsop et al., 2000) reported a significant relationship between treatment outcome and processing speed, as assessed using the WAIS symbol digit subtest. Durazzo et al. (2008) found that, among a range of measures, processing speed was the only one that distinguished abstainers from relapsers at six month follow up. Processing speed and pre-treatment depression explained 26% of the variance of their outcome. Allsop et al. (2000) found that symbol digit matching, was the most consistently sensitive test of overall cognitive impairment (Goldman, 1983) and, along with post-treatment self-efficacy, was the only neurocognitive factor that predicted relapse. These findings should be treated with caution as the study was limited by a high attrition rate and consequently, insufficient statistical power.

The other studies reported more general results: Tapert et al. (2004) and Parsons et al. (1990) described an association between measures of processing speed and treatment outcomes, but in regression analyses processing speed could not predict relapse. A number of other studies did not find any significant relationship between measures of processing speed, and treatment outcome (Macciocchi et al., 1989; Moriyama et al., 2002; Sheehan, 1989).

3.1.3. Executive Functions

Executive functions were more extensively investigated across studies using a wide range of assessment tools. A total of 15 studies included at least one measure of executive functions in their test batteries, with the Trail Making Test (TMT; Reitan, 1958) being the most commonly used (see Table 2).

Wolwer et al. (2001) examined performance of 120 alcohol dependent participants using a broad test battery including the Wisconsin Card Sorting Test (WCST) and the two versions (A&B) of the TMT as measures of executive functioning. The authors reported that participants without cognitive impairment (identified on the basis of the performances on the test battery) displayed a statistical trend towards improvement in drinking-related outcomes at six months when the outcome considered was complete abstinence. A stepwise regression analysis identified the Trail Making Test A as the only neurocognitive measure that significantly predicted treatment outcome. This finding is in line with the association between simple processing speed and outcome outlined in section 3.1.2.

A measure of impulse control (Hayling task; Burgess, 1997) was included in the test battery administered by Noel et al. (2002) to 20 participants (see paragraph 3.1.1). At the follow up relapsers and abstainers significantly differed in impulse control and also showed lower Tc-Bisiccate SPECT uptake in bilateral middle frontal gyrus area (BA 47), which the authors described as a neurological correlate of impaired executive functions. The authors referred to the Supervisory Attentional System (SAS) model, developed by Norman and Shallice (1980) to explain that drinking behaviours are often based on automatic responses to environmental triggers. Their findings were congruent with the SAS model and Noel et al. concluded that a deficit in inhibition and impulse control of automatic behaviours is likely to represent a risk factor for relapse.

Bowden-Jones et al. (2005) included Tower of London Planning Task, Decision Making task and Gambling Task as measures of executive functions in a battery test administered to a sample of 21 participants. Significant differences between abstainers and relapsers were found at a three month follow up: compared to

the abstainers, relapsers made worse decisions in the gambling task and in the decision making test. The predictive power of performance on these tasks was not assessed, possibly because the sample size was insufficient for reliable statistical analyses.

Wicks et al. (2001) administered the TMT and WCST to 27 participants during their inpatient treatment and recorded the participants' drinking behaviour two months after treatment completion. Only the WCST was highly correlated to non-drinking days, although prediction was not reported. Morrison (2011) examined a sample of 34 participants attending an inpatient detox. Executive functions were measured by the TMT B, alongside measures of memory abilities and verbal fluency. The author reported that when drinking behaviours were measured three months after treatment completion, the TMT B was the only measure that significantly predicted relapse in a regression analysis.

None of the other studies that investigated executive functions found an association with outcome (Allsop et al., 2000; Alterman et al., 1990; Durazzo et al., 2008; Loeber et al., 2010; Macciocchi et al., 1989; Moriyama et al., 2002; Parsons et al., 1990; Pitel et al., 2009; Tapert et al., 2004; Walker et al., 1983; see Table 1)

3.1.4 Verbal Skills

A total of six studies tested the participants for verbal skills but only Parsons et al. (1990) reported a significant association between these skills and treatment outcome. Parsons used three tests to assess a verbal factor, along with other neuropsychological factors (problem solving, learning/memory, perceptual-motor and an overall performance index). The author commented that verbal abilities were among the neuropsychological factors that significantly differentiated abstainers and

resumers 12-16 months after treatment completion. However, both verbal abilities and the other cognitive factors accounted for a very small amount of variance in a regression analysis aiming to quantify the predictive power of neuropsychological performance.

3.1.5 Intelligence and global cognitive functioning

A total of nine studies evaluated the association between intelligence/global functioning and treatment outcome. Gregson and Taylor (1977), who were among the first researchers considering neuropsychological variables as potential predictors of post treatment drinking behaviours, administered the Patterned Cognitive Impairment test (PCIT) to 90 male alcoholics. The test was designed to measure cognitive impairment and samples a range of neuropsychological domains to provide a good estimate of the participants' global functioning. The authors recorded drinking behaviours at three and six months after treatment completion and reported that better scores on the PCIT were associated to longer abstinence; among variables such as previous hospitalizations and socio-economic status, relative cognitive functioning was reported to be the best predictor of treatment outcome. Four years later, Abbott & Gregson (1981) examined a sample of 106 alcoholics (74 males and 32 females) and again used the PCIT and the Booklet version of the Rod and Frame Test (BRF), developed for the study. The study differed from Gregson and Taylor's in how treatment outcome was defined: Abbott and Gregson differentiated abstinence, controlled drinking and relapse; however, in the analysis the number of days between discharge and first drinking was reported as the dependent variable. Abbott and Gregson found that at three and twelve months follow ups both indices of cognitive impairment could significantly discriminate relapsers from controlled

drinkers and abstainers and could predict relapse, although in a stepwise regression analysis only the Booklet version of the Rod and Frame Test (BRF) was a significant predictor. The study appears robust in the description of its methodology and in considering a broad range of confounding variables.

Walker et al. (1983) assessed 254 male veterans with six tools which provided a Brain-Age Quotient (BAQ), an age-adjusted index of problem solving abilities. The authors reported that participants with higher BAQ scores were more likely to remain abstinent and to have full-time employments and higher income. They commented that in a multiple analysis of covariance the BAQ displayed a limited predictive value. Alterman et al. (1990) reported that general cognitive efficiency was the only neuropsychological index that was associated to lower alcohol intake six months after treatment; cognitive efficiency emerged as one of many factors that in a canonical correlation analysis were associated to lower alcohol consumption, yet in itself it was not a predictive variable. The other five studies (Bowden et al., 2005; Durazzo et al., 2008; Eckardt et al., 1988; Parsons et al., 1990; Wolwer et al., 2001) did not report significant associations between general cognitive performance and treatment outcome.

3.1.6 Interactions of neuropsychological variables with coping, self-efficacy, treatment

Most of the studies considered in the review assessed the influences of neuropsychological performance on treatment outcome, investigating the implicit assumption that there is a linear relationship between neurocognitive functioning and the patients' ability to remain abstinent or control their drinking after completing treatment.

Although several studies acknowledged the presence of additional predictors and included them in regression analyses, only five studies made explicit the links between neuropsychological performances and other variables.

Walker et al. (1983) hypothesised that neurocognitive factors could interact with the length of inpatient treatment attended by alcohol dependent subjects. The authors tested the hypothesis by randomly allocating 245 male veterans to two weeks and to seven weeks inpatient detoxification programmes and by administering a test battery that provided a Brain-Age Quotient. An analysis of covariance (ANCOVA) indicated that only a small amount of variance in the treatment outcome could be attributed to the neuropsychological performance, length of staying and their interaction: these factors could not significantly predict treatment outcomes at three, six and nine months follow ups.

Locus of control and self-efficacy related to drinking behaviours have been investigated in their interaction with cognitive functioning to predict treatment outcome (Sheehan, 1989). On the third week of treatment 161 participants were administered the Drinking Related Internal-External Control Scale (DRIE, Donovan & O'Leary, 1978), which is a measure of locus of control and the Situational Confidence Questionnaire (SCQ, Annis, 1982), a measure of self-efficacy in alcohol restraint behaviours, the Symbol Digit Modalities Test (Smith, 1973), a measure of processing speed in which subjects have to pair abstract symbols with specific numbers, and the Shipley Institute of Living Scale (Shipley, 1940), a measure of verbal abilities. Six months after discharge participants were interviewed on their drinking behaviours and corroborating reports obtained from significant others; severity of alcohol consumption was recorded, and relapse was considered as *any* post-treatment alcohol consumption. Although relapsers obtained scores significantly

lower than abstainers on a Symbol Digit Modalities Test, only modest significant interactions were found between cognitive impairment, self-efficacy and locus of control in determining treatment outcome. The author concluded that cognitive impairment – alongside the other factors – cannot be considered a predictor of relapse.

Wolwer et al. (2001) hypothesised that treatment outcome could be predicted by neurocognitive functioning but other factors such as personality disorders might also impact on post-treatment drinking behaviours. These authors did not mention an interaction of neuropsychological factors and personality disorders but allocated the participants to three groups with different therapeutic modalities- cognitive behavioural therapy, coping skills training and standard treatment – after the inpatient detoxification programme. Wolwer et al. expected that treatment modalities would lead to better outcomes when they compensated for cognitive and personality factors. The findings suggested that cognitive functioning (specifically, memory, verbal learning and visuo-motor abilities) could differentiate relapsers and abstainers at six months follow up but they did not interact with treatment modalities.

A moderation model was adopted by Tapert et al. (2004); they hypothesised that the interaction between neurocognitive functioning and coping skills predicts post-treatment drinking following treatment for alcohol dependence. The sample comprised of 43 male participants, who were administered a neuropsychological battery three/four weeks after their hospital admission and then completed the Ways of Coping Questionnaire (WOC) (Folkman and Lazarus, 1988) at a three months follow-up. The delayed questionnaire administration was aimed at increasing the ecological validity of the measure, which identified five coping strategies: self-blaming, problem-focused, support-seeking, wishful thinking and avoidance. The

model was tested through a hierarchical linear regression, which also included age, education and pre-treatment drinking levels. Neurocognitive functioning was reported to interact significantly with two coping attributes: self-blaming and problem-focused coping. In both cases the results were surprising, as both these strategies were associated with more drinking days after treatment when the scores of neurocognitive tests were higher. The authors suggested that the findings might have been affected by some of the WOC's items, which were abstract and vague; specifically, problem solving strategies are likely to be scenario specific and hence not assessed by questions related to the management of negative emotions. Other factors which potentially influenced the results were the small sample size and the limited amount of neuropsychological tests administered.

Allsop et al.(2000), in the study above mentioned, considered both neuropsychological functioning and self-efficacy, measured at the end of treatment through the administration of the Situational Confidence Questionnaire (Annis, 1982), as potential predictors of relapse. The regression analysis conducted confirmed self-efficacy and cognitive functioning, as measured by the symbol digit test, could predict relapse at 6 months follow up; self-efficacy remained predictive at 12 months follow up, whilst cognitive functioning was associated to earlier lapses but not to relapse at the second follow up. Although an interaction between the two variables was not shown by the statistical analysis, the authors suggested that patients with poor cognitive functioning may have difficulty in learning new skills and developing self-efficacy to cope.

4. Discussion

4.1 Neuropsychological factors

In 1977 Gregson & Taylor's study pioneered a research trend which continued enthusiastically through the 1980s, as potential predictors of treatment outcome for alcohol addiction were identified. This enthusiasm seemed to fade when studies began providing inconsistent findings. Although the interest on the neuropsychological correlates of alcohol consumption is still strong, fewer studies are currently focusing on their predictive value. Interestingly, the main research designs in the area have changed little, even when possible limitations in the adopted methodologies had already been identified in early reviews (Knight and Longmore, 1994).

The studies here reviewed confirm that the relationship between neuropsychological measures and treatment outcome, as defined by Eckardt et al.(1988), is variable and fragile. In many studies neuropsychological measures were significantly associated to treatment outcomes and could differentiate relapsers from abstainers at follow up; yet, only nine studies identified neuropsychological measures as able to predict treatment outcome on the basis of regression analyses. The studies varied in the measures employed and the neurocognitive abilities assessed: one study found memory as predictive of relapse (Sussman et al., 1986), two studies found processing speed as predictive (Durazzo et al., 2008; Allsop et al., 2000); executive functioning was identified as predictive in one study (Morrison, 2011) and global cognitive functions were predictive in four studies (Gregson and Taylor, 1977; Abbott and Gregson, 1981; Walker et al., 1983, Parsons et al., 1990). Overall then these results seem to suggest that global cognitive functioning is more likely to provide prognostic information. However this conclusion is suggested cautiously, as

there are methodological limitations of current studies which may limit generalisation to a broader population.

Some early studies pre-date agreed diagnostic criteria for alcohol use disorders (American Psychiatric Association, APA, 1980, 1987, 1994); it is unclear if all the participants, recruited as “alcoholics”, would meet criteria for alcohol dependence as used in more recent studies. Gregson and Taylor (1977) and Abbott and Gregson (1981) used the Patterned Cognitive Impairment test (PCIT), which seemed able to detect early cognitive deterioration; however, the authors did not provide information on areas investigated by the test. PCIT required to remember and correctly order designs of ten symbols (Knight and Longmore, 1994). Walker et al.(1983) and Parsons et al.(1990) conversely administered a battery of different measures, which they summarised in a cognitive index. Walker et al. combined six measures (Category Test, Tactual Performance test, Total Time, TMT, TPT Localization, Digit-Symbol and Block Design) to obtain a Brain-Age Quotient (Reitan, 1974). Parsons et al. combined more than 15 measures covering clusters of verbal and visuo-spatial memory, perceptual motor, problem solving and semantic memory. Altogether the cognitive indexes explained only a limited amount of variance, which reduced the predictive value of the single measures.

Most researchers have attempted to clarify the impact of neuropsychological impairments on the capacity to maintain abstinence by adopting a model of a linear relationship between neurocognitive abilities and the treatment outcomes. A linear model would ascribe to cognitive difficulties a causal role when patients fail to apply relapse prevention strategies (Bates, Bowden, & Barry, 2002). Drawing a comparison between alcohol-related cognitive deficits and traumatic brain injury, Bates et al. (2002, 2006, and 2013) have suggested reframing the relationship

between alcohol-related cognitive deficits and treatment outcomes by adopting models which include mediation and moderation. In subjects with traumatic brain injuries psychosocial adaptation is often indirectly influenced by cognitive deficits, which moderate interpersonal and contextual factors and influence the behavioural outcomes. (Bates, Bowden, & Barry, 2002).

In alcohol dependent individuals, a mediation model would conceive cognitive deficits (predictors) as influencing treatment outcome through their impairing effects on intrapersonal and environmental factors. These dynamics also influence the treatment process, which in turn affects outcome (Bates, Buckman, & Nguyen, 2013). Cognitively impaired individuals are less likely to remember information related to treatment and to learn drink refusal skills and implement these prospectively (Teichner, 2002).

The moderation model considers cognitive impairment as a moderator affecting the strength or the direction of intrapersonal and environmental factors, which influence the change and the outcome. Moderation and mediation can occur at the same time and explanatory value of both models suggests their integration rather a mutual exclusion.

This review included a few studies in which potential interactions were assessed, although they did not always refer to mediation or moderation models. Walker et al.(1983) and Wolwer et al. (2001) focused on how treatment factors interact with neuropsychological abilities, whilst intrapersonal factors were considered by Sheehan (1989), Allsop et al.(2000) and Tapert et al.(2004). Allsop et al.'s(2000) was the only study which reported that cognitive functioning and post-treatment self-efficacy could provide prognostic information.

4.2 Methodological considerations

The investigation of neuropsychological predictors of treatment outcome has been carried out by studies adopting prospective designs. This reduces the applicability of domains assessment suggested by Higgins and Green (2011), which are more applicable to randomised controlled studies of treatments. Study designs impeded randomisation and concealment of allocation to treatment and similarly the blinding of participants and personnel. Three studies (Walker et al, 1983.; Moryama et al., Sussman et al., 1986) reported blinding of investigators, referring to the collection of follow up data by investigators who were unaware of the neuropsychological scores obtained by the subjects.

Most of the studies provided limited information about the treatments delivered, compliance by patients, the nature and the attendance of available aftercare support. Noel et al. (2002) examined subjects attending an outpatient treatment, whilst the remaining studies examined participants attending inpatient detoxification programmes. Wolwer et al. (2001) compared three treatment strategies but reported no interactions with neuropsychological functioning and personality disorders. Similarly, Allsop et al. (2000) allocated the participants to three treatment groups but no differences in outcome were reported between the three groups.

A general limitation for most of the studies was the small sample size; five studies (Bowden-Jones et al., 2005; Loeber et al., 2010; Moriyama et al, 2002; Noel et al., 2002; Wicks et al., 2001) reported that approximately 20 participants attended follow-up assessments. Small sample sizes increase the risk of type II error and limit the generalizability of the findings. Drop-out rates and limited participations at follow up assessments varied among the studies; some studies – especially the ones with small samples – reported 100% of attendance, while others reported several

subjects not completing the treatment or the study (for instance, 33% of subjects dropped out for Wicks et al., 29% for Alterman et al. and 37% for Pitel et al.).

The neuropsychological areas considered by the reviewed studies were assessed through the administration of 64 measures, grouped into unique batteries by the authors. Such a variety should be taken into account when generalising the results, as different measures might or not correlate with each other, even when measuring the same construct. It is possible that combining more than one measure for one area (e.g. memory) might reduce the information provided by the single measures. Additionally, the tests have been validated in different ways and with different population, which did not include individuals with alcohol dependence. Sussman et al. (1986) concluded that memory impairment could predict relapse using a test which was designed specifically for the study – developed by showing product pictures to eight alcoholics and eight staff members – and not previously validated for the studied population.

Other authors administered batteries ranging from two to 19 tests, with the possibility of tiredness effects partially influencing the results. Although most of the test administrations occurred in the first weeks of the detoxification programmes, it is possible to speculate that small differences in the length of early abstinence affected the results. Wicks et al. (2001) administered the test battery during the first week of detoxification, while participants were completing a medical treatment, which is likely to have heavily influenced their scores. Furthermore, independently from the number of tests, neuropsychological batteries can only provide partial information on the functioning levels of the subjects in real life; whether given by one test, as for Gregson and Taylor (1977) or by adding up more measures (Eckardt et al., 1988, Parsons et al., 1990; Wolwer et al., 2001), measures of general abilities can account

for only a limited amount of the variance in everyday life (Chatytor and Schmitter-Edgecombe, 2003).

A variety of treatment outcomes has been considered: six studies defined relapse as any post-treatment alcohol intake, whilst six other studies adopted less strict criteria and distinguished abstainers from relapsers on the base of the amount of alcohol intake following treatment; five studies did not provide clear definitions of treatment outcomes, although three studies referred to the number of post-treatment drinking days as a dependent variable. In general little attention was given to holistic measures of wellbeing at follow ups. These inconsistencies impact on the generalisability of the results, as the same post-treatment drinking behaviours would be classified as abstinence or relapse by different studies.

Furthermore, most of the studies relied on self-report measures to gather post treatment information on the alcohol intake of participants. Although some of these measures are considered valid and reliable (Del Boca and Darkes, 2003), they are susceptible to desirability or memory biases, with participants often under-reporting amount and frequency of alcohol intake. Some studies supported the self-reports with reports from family members or other services involved in after-care, and only two studies (Loeber et al., 2010; Tapert et al., 2004) included biological measures to confirm the validity of the reports.

Gender is another factor neglected by most of the studies; alcoholic women tend to be more vulnerable than alcoholic men to neurocognitive and motor functioning (Nolen-Hoeksema, 2004), yet women are more likely to achieve a positive treatment outcome (Adamson, Sellman & Frampton, 2009). Only seven studies out of 20 included mixed sample – with Durazzo’s study (2008) having three women in a sample of 70 participants – whilst three studies failed to report the

gender of the participants. Although the seven studies did not report differences due to the participants' gender, it is possible that studies have not investigated those neuropsychological areas in which women present more vulnerability.

4.3 Limitations of the review

The methodological limitations identified in the previous paragraph impact on the validity of this review. In addition, although sources beyond published papers such as dissertations, textbooks and conferences were considered, the final studies inserted in the review were all published in peer reviewed journals with the only exception of Sheehan's study (1989). The results could consequently reflect a publication bias. Furthermore, the review focused on alcohol dependence and excluded samples presenting with co-occurring substances disorders and diagnosed mental health difficulties. Given the high rates of co-morbidity, the results of this review are limited in their ecological validity and applicability to other populations.

4.4 Conclusions and implications

This review has confirmed that neuropsychological measures provide limited prognostic information for alcohol dependence. Although clinical experience attributes to difficulties in learning and recalling information, in shifting among different tasks, in controlling impulses an increased risk of relapse, studies have to date provided limited confirmation to such statements.

Chaytor and Schmitter-Edgecombe (2003) have pointed out that the majority of neuropsychological tests possess only moderate ecological validity and prediction of functioning in everyday life should always take into account how different cognitive domains compensate for each other. For example, patients with impaired

memory but intact executive skills could develop strategies to overcome the memory limitations. Neuropsychological tests usually focus on single abilities and neglect interactions and compensation, which presumably occur for the patients attempting to maintain post-treatment abstinence. In addition, patients with neurocognitive impairments might achieve positive treatment outcome through different processes operating for patients with unimpaired cognitive abilities (Bates et al., 2002). Whilst impaired abilities can hinder the therapeutic processes by affecting mediators such as self-efficacy and compliance, compensating behaviours can occur to determine positive outcome: Bates et al. (2002) reported that impaired patients attended more Alcoholics Anonymous (AA) and achieved same levels of abstinence of unimpaired patients even though the treatment compliance had been poorer.

Future research may shed light on the interactions between neuropsychological abilities and therapeutic processes by adopting designs based on moderation and mediation models. The literature of patient predictors of alcohol treatment outcome (Adamson, Sellman & Frampton, 2009) was recently reviewed: whereas neuropsychological abilities were reported as moderate predictors, strong predictive power was attributed to alcohol expectancies, motivation, treatment goals and alcohol-related self-efficacy. The latter was investigated by some studies here reviewed, which produced inconsistent results; however, the other variables could potentially clarify the role of neurocognitive factors in influencing treatment outcome.

Treatment modalities represent another important, yet insufficiently investigated factor which may mediate the influence of neuropsychological abilities on treatment outcomes. Wolwer et al.(2001) and the project MATCH (Donovan et al, 2001) did not report interactions between treatment modalities and neurocognitive

conditions, while a more promising direction is offered by psychological intervention integrating or preceding cognitive remediation. These interventions have focused on various neurocognitive skills, both to increment the treatment efficacy and increase the long term likelihood of abstinence thanks to improved memory, executive functions and psychological wellbeing (Bates et al., 2013).

Several methodological limitations were identified by this review and if taken into account by future researchers, more reliable results could be achieved. A more balanced attention to gender differences, a more careful use of statistical analyses, well defined treatment outcomes, reliable methods of recording post-treatment drinking behaviours - including biological samples- both for frequency and amount, homogeneous history of alcohol dependence, comprehensive and reliable neuropsychological measures are all elements that could overcome the inconsistencies so far reported.

References

- Abbott, M. W., & Gregson, R. A. (1981). Cognitive dysfunction in the prediction of relapse in alcoholics. *Journal of Studies on Alcohol and Drugs*, 42(03), 230.
- Adamson S.J, Sellman, J.D., & Frampton, C.M.A, (2009). Patient predictors of alcohol treatment outcome: A systematic review. *Journal of Substance Abuse Treatment*, 36, 75-86.
- Allsop, S., Saunders, B., & Phillips, M. (2000). The process of relapse in severely dependent male problem drinkers. *Addiction*, 95(1), 95-106.
- Alterman, A. I., Kushner, H., & Holahan, J. M. (1990). Cognitive functioning and treatment outcome in alcoholics. *The Journal of Nervous and Mental Disease*, 178(8), 494-499.
- American Psychiatric Association (1980). *Diagnostic and statistical manual of mental disorders, third edition (DSM-III)*. Washington, D.C.: American Psychiatric Press.
- American Psychiatric Association (1987). *Diagnostic and statistical manual of mental disorders, third edition, revised (DSM-R-III)*. Washington, D.C.: American Psychiatric Press.
- American Psychiatric Association (1994). . *Diagnostic and statistical manual of mental disorders, fourth edition (DSM-IV)*. Washington, D.C.: American Psychiatric Press.
- Annis, H.M. (1982). *Situational Confidence Questionnaire*. Toronto: Addiction Research Foundation of Ontario.
- Axelrod, B. N., Ryan, J. J., & Ward, L. C. (2001). Evaluation of seven-subtest short forms of the Wechsler Adult Intelligence Scale-III in a referred sample. *Archives of Clinical Neuropsychology*, 16(1), 1-8.

- Bates, M. E., Bowden, S. C., & Barry, D. (2002). Neurocognitive impairment associated with alcohol use disorders: implications for treatment. *Experimental and clinical psychopharmacology*, *10*(3), 193.
- Bates, M.E., Buckman, J.F., & Nguyen, T.T. (2013). A Role for cognitive rehabilitation in increasing the effectiveness of treatment for alcohol use disorders. *Neuropsychology Review*, *23*, 27-47.
- Bates, M.E., Pawlak, A.T., Tonigan, J.S., & Buckman, J.F. (2006). Cognitive impairment influences drinking outcome by altering therapeutic mechanisms of change. *Psychology of Addictive Behaviors*, *20*, 241-253.
- Beatty, W.W., Hames, K.A., Blanco, C.R., Nixon, S.J., & Tivis, L.J. (1996). Visuospatial perception, construction and memory in alcoholism. *Journal of Studies on Alcohol*, *57*, 136-143.
- Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, *50*(1), 7-15.
- Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral cortex*, *10*(3), 295-307.
- Beck, A.T., Ward, C.H., Mendelson, M., Mock. J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of general psychiatry*, *4*(6), 561-571.
- Belleville, S., Rouleau, N., & Caza, N. (1998). Effect of normal aging on the manipulation of information in working memory. *Memory & Cognition*, *26*(3), 572-583.
- Benedict, R. H. (1997). *Brief visuospatial memory test--revised: professional manual*. Odessa, FL: Psychological Assessment Resources.

- Benton, A. L., Hamsher, K., & Sivan, A. B. (1983). *Multilingual aphasia examination: manual of instructions*. Iowa City, IA: AJA Associates.
- Benton, A. L., Varney, N. R., & Hamsher, K. D. (1978). Visuospatial judgment: A clinical test. *Archives of Neurology*, 35(6), 364.
- Berg, E. A. (1948). A simple objective technique for measuring flexibility in thinking. *The Journal of general psychology*, 39(1), 15-22.
- Bowden-Jones, H., McPhillips, M., Rogers, R., Hutton, S., & Joyce, E. (2005). Risk-taking on tests sensitive to ventromedial prefrontal cortex dysfunction predicts early relapse in alcohol dependency: A Pilot study. *The Journal of Neuropsychiatry and Clinical Neurosciences*, 17, 417-420.
- Brickenkamp, R. (1981). *Test d2 Aufmerksamkeits-Belastungs-Test Verlag für Psychologie*. Göttingen, Toronto, and Zürich: Hogrefe.
- Burgess, P. W. (1997). Theory and methodology in executive function research. In P. Rabbitt (Ed.), *Methodology of frontal and executive function* (pp. 81 – 116). Hove, UK: Psychology Press.
- Buschke, H. (1973). Selective reminding for analysis of memory and learning. *Journal of Verbal Learning and Verbal Behavior*, 12(5), 543-550.
- Cardebat, D., Doyon, B., Puel, M., Goulet, P., & Joanette, Y. (1989). Formal and semantic lexical evocation in normal subjects. Performance and dynamics of production as a function of sex, age and educational level. *Acta Neurologica Belgica*, 90(4), 207-217.
- Chaytor, N., & Schmitter-Edgecombe, M. (2003). The ecological validity of neuropsychological tests: A review of the literature on everyday cognitive skills. *Neuropsychology Review*, 13(4), 181-197.

- Choices, N.H.S. (2011). *What's your poison: a sober analysis of alcohol and health in the media*. Retrieved from:
<http://www.nhs.uk/news/2011/10October/Pages/alcohol-special-report.aspx>
- Coyette, F., Thomas-Antérion, C., Sellal, F., Poitrenaud, J., Gély-Nargeot, M. C., Van der Linden, A. C. J., & Deweer, B. (2004). *L'évaluation des troubles de la mémoire: Présentation de quatre tests de mémoire épisodique (avec leur étalonnage)*. Marseille, France: Solal.
- Davison, L. A. (1974). *Current status of clinical neuropsychology*. New York: Winston & Sons.
- Dawson, L. K., & Grant, I. (2000). Alcoholics' initial organizational and problem-solving skills predict learning and memory performance on the Rey–Osterrieth Complex Figure. *Journal of the International Neuropsychological Society*, 6(01), 12-19.
- DeFilippis, N. A., McCampbell, E., & Rogers, P. (1979). Brief report development of a booklet form of the category test: Normative and validity data. *Journal of Clinical and Experimental Neuropsychology*, 1(4), 339-342.
- Del Boca, F.K. & Darkes, J. (2003). The validity of self-reports of alcohol consumption: state of the science and challenges for research. *Addiction*, 98, 1-12.
- Delis, D. C., Kramer, J. H., Kaplan, E., & Ober, B. A. (2000). *California Verbal Learning Test*. San Antonio, TX: The Psychological Corporation.
- Donovan, D. M., & O'Leary, M. R. (1978). The drinking-related locus of control scale; reliability, factor structure and validity. *Journal of Studies on Alcohol and Drugs*, 39(05), 759.

- Dunn, L. M., & Dunn, L. M. (1965). *Peabody picture vocabulary test*. Circle Pines, MN: American Guidance Service.
- Dunn, L. M., & Markwardt, F. C. (1970). *Peabody individual achievement test*. Circle Pines, MN: American Guidance Service.
- Durazzo, T. C., Gazdzinski, S., Yeh, P. H., & Meyerhoff, D. J. (2008). Combined neuroimaging, neurocognitive and psychiatric factors to predict alcohol consumption following treatment for alcohol dependence. *Alcohol and Alcoholism, 43*(6), 683-691.
- Eckardt, M. J., Parker, E. S., Noble, E. P., Feldman, D. J., & Gottschalk, L. A. (1978). Relationship between neuropsychological performance and alcohol consumption in alcoholics. *Biological Psychiatry, 13*, 551-564.
- Eckardt, M. J., Parker, E. S., Noble, E. P., Pautler, C.P., & Gottschalk, L. A. (1979). Changes in neuropsychological performance during treatment for alcoholism. *Biological Psychiatry, 14*, 943-954.
- Eckardt, M. J., Rawlings, R. R., Graubard, B. I., Faden, V., Martin, P. R., & Gottschalk, L. A. (1988). Neuropsychological performance and treatment outcome in male alcoholics. *Alcoholism: Clinical and Experimental Research, 12*(1), 88-93.
- Evans, J.J., Chua, S.E., McKenna, P.J., & Wilson, B.A. (1997). Assessment of the dysexecutive syndrome in schizophrenia. *Psychological Medicine, 27*, 635-646).
- Folkman, S., & Lazarus, R.S. (1988). *Manual for the ways of coping questionnaire*. Palo Alto: Consulting Psychologists Press.

- Fowler, K. S., Saling, M. M., Conway, E. L., Semple, J. M., & Louis, W. J. (2002). Paired associate performance in the early detection of DAT. *Journal of the International Neuropsychological Society*, 8(01), 58-71.
- Golden, C. J., & Freshwater, S. M. (1978). *Stroop color and word test*. Chicago, IL: Stoelting Company.
- Golden, C. J., Hammeke, T. A., & Purisch, A. D. (1978). Diagnostic validity of a standardized neuropsychological battery derived from Luria's neuropsychological tests. *Journal of Consulting and Clinical Psychology*, 46(6), 1258.
- Goldman, M. S. (1990). Experience-dependent neuropsychological recovery and the treatment of chronic alcoholism. *Neuropsychology Review*, 1, 75–101.
- Goldman, M. S. (1995). Recovery of cognitive functioning in alcoholics - the relationship to treatment. *Alcohol Health and Research World*, 19(2), 148–154.
- Goldman, M.S., (1983). Cognitive Impairment in chronic alcoholics. Some cause for optimism. *American Psychologist*, 38, 1045-1054.
- Graham, F. K., & Kendall, B. S. (1960). Memory-for-designs test: Revised general manual. *Perceptual and Motor Skills*, 11(2), 147-188.
- Grant, D. A., & Berg, E. (1948). A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card-sorting problem. *Journal of Experimental Psychology*, 38(4), 404.
- Gregson, R. A. M., & Taylor, G. M. (1977). Prediction of relapse in men alcoholics. *Journal of Studies on Alcohol and Drugs*, 38(09), 1749.
- Grober, E., & Buschke, H. (1987). Genuine memory deficits in dementia. *Developmental Neuropsychology*, 3(1), 13-36.

- Grober, E., Buschke, H., Crystal, H., Bang, S., & Dresner, R. (1988). Screening for dementia by memory testing. *Neurology*, 38(6), 900-903.
- Heaton, R. K. (1993). *Wisconsin card sorting test: computer version 2*. Odessa: Psychological Assessment Resources.
- Higgins, J. P. T., & Green, S. (2011). *Cochrane handbook for systematic reviews of interventions*, version 5.1.0. Oxford: Cochrane Collaboration.
- Horn, W. (1983). *Leistungsprüfsystem (LPS). 2., erweiterte und verbesserte Auflage*. Göttingen: Hogrefe.
- Jones-Gotman, M., & Milner, B. (1977). Design fluency: The invention of nonsense drawings after focal cortical lesions. *Neuropsychologia*, 15(4), 653-674.
- Kapur, N., & Butters, N. (1977). Visuo-perceptive deficits in long-term alcoholics and alcoholics with Korsakoff's psychosis. *Journal of Studies on Alcohol and Drugs*, 38(11), 2025-2035.
- Kimura, D. (1963). Right temporal lobe damage, *Archives of Neurology*, 8, 264–271.
- Knight, R. G., & Longmore, B. E. (1994). *Clinical neuropsychology of alcoholism*. Hove: Lawrence Erlbaum.
- Krabbendam, L., Visser, P. J., Derix, M. M., Verhey, F., Hofman, P., Verhoeven, W., Tuinier, S., & Jolles, J. (2000). Normal cognitive performance in patients with chronic alcoholism in contrast to patients with Korsakoff's syndrome. *The Journal of Neuropsychiatry and Clinical Neurosciences*, 12(1), 44-50.
- Lafayette Instrument (1989). *Instruction manual for the 32025 Grooved pegboard test*. Lafayette, USA: Lafayette Instrument.
- Lehrl, S. (1977). *Mehrfachwahl-Wortschatz-Test (MWT-B)*. Straube: Erlangen.
- Lehrl, S., Gallwitz, A., & Blaha, L. (1992). *Kurztest Für Allgemeine Basisgrößen der Informationsverarbeitung, KAI*. Aufl. Vless: Ebersberg.

- Levine, M. (1966). Hypothesis behavior by humans during discrimination learning. *Journal of Experimental Psychology*, 71(3), 331.
- Lezak, M.D. (1980). *Neuropsychological assessment*. New York: Oxford University Press.
- Loeber, R., & Hay, D. (1997). Key issues in the development of aggression and violence from childhood to early adulthood. *Annual Review of Psychology*, 48(1), 371-410.
- Loeber, S., Duka, T., Márquez, H. W., Nakovics, H., Heinz, A., Mann, K., & Flor, H. (2010). Effects of repeated withdrawal from alcohol on recovery of cognitive impairment under abstinence and rate of relapse. *Alcohol and Alcoholism*, 45(6), 541-547.
- Lyvers, M. (2000). "Loss of control" in alcoholism and drug addiction: a neuroscientific interpretation. *Experimental and Clinical Psychopharmacology*, 8(2), 225.
- Macciocchi, S. N., Ranseen, J. D., & Schmitt, F. A. (1989). The relationship between neuropsychological impairment in alcoholics and treatment outcome at one year. *Archives of Clinical Neuropsychology*, 4(4), 365-370.
- McManus, S., Meltzer, H., Brugha, T., Bebbington, P., Jenkins, R. (2009). *Adult Psychiatric Morbidity in England, 2007: results of a household survey* London: National Centre for Social Research.
- Milner, B. (1971). Inter-hemispheric differences in the localization of psychological processes in man. *British Medical Bulletin*, 27(3), 272-277.
- Moriyama, Y., Mimura, M., Kato, M., Yoshino, A., Hara, T., Kashima, H., Kato, A., & Watanabe, A. (2002). Executive dysfunction and clinical outcome in

- chronic alcoholics. *Alcoholism: Clinical and Experimental Research*, 26(8), 1239-1244.
- Morrison, F. (2011). Neuropsychological impairment and relapse following inpatient detoxification in severe alcohol dependence. *International Journal of Mental Health and Addiction*, 9(2), 151-161.
- Nelson, H. E., & Willison, J. R. (1991). *The revised national adult reading test—test manual*. Windsor: NFER-Nelson.
- Noël, X., Sferrazza, R., Van der Linden, M., Paternot, J., Verhas, M., Hanak, C., Pelc, I., & Verbanck, P. (2002). Contribution of frontal cerebral blood flow measured by 99mTc-Bicisate SPECT and executive function deficits to predicting treatment outcome in alcohol-dependent patients. *Alcohol and Alcoholism*, 37(4), 347-354.
- Nolen-Hoeksema, S., (2004). Gender differences in risk factors and consequences for alcohol use and problems. *Clinical Psychology Review*, 24, 981–1010
- Owen, A.M., Downes, J.J., Sahakian, B.J., Polkey, C.E., & Robbins, T.W. (1990). Planning and spatial working memory following frontal lobe lesions in man. *Neuropsychologia*, 28, 1021-1034.
- Parsons, O. A. (1998). Neurocognitive deficits in alcoholics and social drinkers: a continuum?. *Alcoholism: Clinical and Experimental Research*, 22(4), 954-961.
- Parsons, O. A., Schaeffer, K. W., & Glenn, S. W. (1990). Does neuropsychological test performance predict resumption of drinking in posttreatment alcoholics?. *Addictive Behaviors*, 15(3), 297-307.
- Pitel, A. L., Beaunieux, H., Witkowski, T., Vabret, F., Guillery-Girard, B., Quinette, P., Desgranges, B., & Eustache, F. (2007). Genuine episodic memory deficits

and executive dysfunctions in alcoholic subjects early in abstinence.

Alcoholism: Clinical and Experimental Research, 31(7), 1169-1178.

Pitel, A. L., Rivier, J., Beaunieux, H., Vabret, F., Desgranges, B., & Eustache, F.

(2009). Changes in the episodic memory and executive functions of abstinent and relapsed alcoholics over a 6-month period. *Alcoholism: Clinical and Experimental Research*, 33(3), 490-498.

Quinette, P., Guillery, B., Desgranges, B., de la Sayette, V., Viader, F., & Eustache,

F. (2003). Working memory and executive functions in transient global amnesia. *Brain*, 126(9), 1917-1934.

Quinette, P., Guillery-Girard, B., Noël, A., de la Sayette, V., Viader, F., Desgranges,

B., & Eustache, F. (2006). The relationship between working memory and episodic memory disorders in transient global amnesia. *Neuropsychologia*, 44(12), 2508-2519.

Ratti, M. T., Bo, P., Giardini, A., & Soragna, D. (2002). Chronic alcoholism and the

frontal lobe: which executive functions are impaired?. *Acta Neurologica Scandinavica*, 105(4), 276-281.

Raven, J. C. (1960). *Guide to the standard progressive matrices: sets A, B, C, D and*

E. London: HK Lewis.

Reitan, R. M. (1972). Verbal problem solving as related to cerebral damage.

Perceptual and Motor Skills, 34(2), 515-524.

Reitan, R.M. (1958). Validity of the trail making test as an indicator of organic brain

damage. *Perceptual and Motor Skills*, 1958, 8, 271-276.

Reitan, R.M., Wolfson D. (1993). *The Halstead-Reitan neuropsychological test*

battery: theory and clinical interpretation. Tucson, AZ: Neuropsychological Press.

- Rennick, P. M. (1979). *Color-naming and visual search tests for repeatable cognitive-perceptual motor battery*. Grosse Point Park, MI: Axon Publishing.
- Rey, A. (1964). *L'examen clinique en psychologie*. Paris: Universitaires de France.
- Rogers, R. D., Everitt, B. J., Baldacchino, A., Blackshaw, A. J., Swainson, R., Wynne, K., Baker, N.B., Hunter, J., Carthy, T., Booker, E., London, M., Deakin, F., J., Sahakina, B.J., & Robbins, T. W. (1999). Dissociable deficits in the decision-making cognition of chronic amphetamine abusers, opiate abusers, patients with focal damage to prefrontal cortex, and tryptophan-depleted normal volunteers: evidence for monoaminergic mechanisms. *Neuropsychopharmacology*, 20(4), 322-339.
- Rosvold, H. E., Mirsky, A. F., Sarason, I., Bransome, E. D., & Beck, L. H. (1956). A continuous performance test of brain damage. *Journal of Consulting Psychology*, 20(5), 343.
- Rourke, S. B., & Grant, I. (1999). The interactive effects of age and length of abstinence on the recovery of neuropsychological functioning in chronic male alcoholics: a 2-year follow-up study. *Journal of the International Neuropsychological Society*, 5(3), 234-246.
- Russell, E. W. (1975). A multiple scoring method for the assessment of complex memory functions. *Journal of Consulting and Clinical Psychology*, 43(6), 800.
- Sabia, S., Elbaz, A., Britton, A., Bell, S., Dugravot, A., Shipley, M., Kivimaki, M., & Singh-Manoux, A. (2014). Alcohol consumption and cognitive decline in early old age. *Neurology*, 82, 4, 332-339.
- Saxton, J., Munro, C. A., Butters, M. A., Schramke, C., & McNeil, M. A. (2000). Alcohol, dementia, and Alzheimer's disease: comparison of

- neuropsychological profiles. *Journal of Geriatric Psychiatry and Neurology*, 13(3), 141-149.
- Schaeffer, K. W., & Parsons, O. A. (1987). Learning impairment in alcoholics using an ecologically relevant test. *The Journal of Nervous and Mental Disease*, 175(4), 213-218.
- Schuckit, M. A. (2009) Alcohol-use disorders. *The Lancet*, 373, 492-501.
- Sheehan, T. (1989). *Expectancies and intellectual functioning as predictors of relapse in male alcoholics*. Ph.D. Dissertation, The Fielding Institute.
- Shipley, W. C. (1940). A self-administering scale for measuring intellectual impairment and deterioration. *The Journal of Psychology*, 9(2), 371-377.
- Sivan, A. B. (1992). *Benton visual retention test*. San Antonio, TX: Psychological Corporation.
- Smith, A. (1973). *Digit symbol modalities test*. Western Psychological Services, New York: Western Psychological Services.
- Stavro, K., Pelletier, J., & Potvin, S. (2013). Widespread and sustained cognitive deficits in alcoholism: a meta-analysis. *Addiction biology*, 18(2), 203-213.
- Stollmann, F. (1990). *Recurring-words-test: Entwicklung eines sprachlichen Gedächtnis-tests und einer Parallellform in Analogie zum Recurring Figures Test von Kimura*. Un-veröffentlichte Dissertation, Universität Aachen.
- Sussman, S., Rychtarik, R. G., Mueser, K., Glynn, S., & Prue, D. M. (1986). Ecological relevance of memory tests and the prediction of relapse in alcoholics. *Journal of Studies on Alcohol and Drugs*, 47(04), 305.
- Tapert, S. F., Ozyurt, S. S., Myers, M. G., & Brown, S. A. (2004). Neurocognitive ability in adults coping with alcohol and drug relapse temptations. *The American Journal of Drug and Alcohol Abuse*, 30(2), 445-460.

- Teichner, G., Horner, M.D., Roitzsch, J.C., Herron, J., & Thevos, A. (2002). Substance abuse treatment outcomes for cognitively impaired and intact outpatients. *Addictive Behaviours*, 27 (5), 751-763.
- Uekermann, J., Daum, I., Schlebusch, P., Wiebel, B., & Trenckmann, U. (2003). Depression and cognitive functioning in alcoholism. *Addiction*, 98(11), 1521-1529.
- Walker, R. D., Donovan, D. M., Kivlahan, D. R., & O'Leary, M. R. (1983). Length of stay, neuropsychological performance, and aftercare: Influences on alcohol-treatment outcome. *Journal of Consulting and Clinical Psychology*, 51(6), 900-911.
- Wechsler D. (1981). *Manual for the Wechsler adult intelligence scale revised*. San Antonio, TX: Psychological Corporation.
- Wechsler, D. (1945). *Wechsler memory scale*. New York: Psychological Corporation.
- Wechsler, D. (1997). *WAIS-III: Wechsler adult intelligence scale*. San Antonio, TX: Psychological Corporation.
- Weinstein, C. S., & Shaffer, H. J. (1993). Neurocognitive aspects of substance abuse treatment: A psychotherapist's primer. *Psychotherapy*, 30, 317-333.
- Wetzel, L., & Boll, T. J. (1987). *Short category test, booklet format*. Los Angeles, CA: Western Psychological Services.
- Wicks, S., Hammar, J., Heilig, M., & Wisen, O. (2001). Factors affecting the short-term prognosis of alcohol dependent patients undergoing inpatient detoxification. *Substance Abuse*, 22(4), 235-245.

- Willner, A. E. (1970). Towards development of more sensitive clinical tests of abstraction: The analogy test. In *Proceedings of the 78th Annual Convention of the American Psychological Association*, 5, 553-554.
- Wilson, B. A., Alderman, N., Burgess, P. W., & Emslie, J. J. (1996). *Manual of the behavioural assessment of the dysexecutive syndrome*. Bury St. Edmunds, UK: Thames Valley Test Company.
- Woelwer, W., Kiesow, S., Streit, M., & Gaebel, W. (1999). Störungen der visuomotorischen integration bei schizophrenen. In Brauning, P., *Motorische Störungen bei schizophrenen psychosen* (pp 116-125). Stuttgart, New York: Scattauer.
- Wölwer, W., Burtscheidt, W., Redner, C., Schwarz, R., & Gaebel, W. (2001). Out-patient behaviour therapy in alcoholism: impact of personality disorders and cognitive impairments. *Acta Psychiatrica Scandinavica*, 103(1), 30-37.
- World Health Organization (2009a). *Global health risks. Mortality and burden of disease attributable to selected major risks*. Geneva
- Zigmond, A.S., & Snaith, R.P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica*, 67 (6), 361–370.
- Zimmermann, P., North, P., & Fimm, B. (1993). Diagnosis of attentional deficits: theoretical considerations and presentation of a test battery. In Stachowiak, F. (Ed), *Developments in the assessment and rehabilitation of brain damaged patients* (pp 3-30). Tübingen: Narr Verlag.

Part 2: Empirical Paper

Approach and avoidance tendencies with alcohol- related stimuli in young heavy drinkers

Abstract

Aims Drinking behaviours are regulated by motivational tendencies – fast and automatic responses to alcohol related cues - and by a reflective system which can inhibit impulsive actions. While heavy drinkers tend to display an approach tendency, an avoidance tendency has been promoted by the Cognitive Bias Modification, a training that has reduced relapse rate in individuals treated for alcohol dependence. This study investigates motivational tendencies in a group of young heavy drinkers and matched controls.

Methods Participants were selected on the basis of their scores on the Alcohol Use Disorders Identification Test (AUDIT) and 23 heavy drinkers were compared with 20 social drinkers on a Relevant-Stimulus Response Compatibility (R-SRC) task. The R-SRC is a measure of automatic motivational tendencies and it requires to move a manikin away or towards alcohol related and neutral pictures on a computer screen. Neuropsychological tests and the Attentional Control Scale (ACS) were also administered.

Results Heavy drinkers and controls differed in their responses on the R-SRC task, with heavy drinkers being faster in approaching alcohol related images. There were minimal differences in working memory and attention between the two groups, while heavy drinkers reported lower scores than social drinkers on the ACS.

Conclusions Heavy drinkers showed an approach tendency towards alcohol-related cues. This might reflect motivational tendencies towards alcohol although these could have also been influenced by social desirability effects. Group differences in ACS scores might reflect heavy drinkers' awareness of alcohol-related cognitive

decline. Motivational tendencies and drinking patterns might increase the risk of alcohol dependence.

1. Introduction

1.1 Alcohol disorders

Alcohol appears to fuel the social life of a large proportion of young people in Europe. Up to 87% of 14-15 years old students reported having consumed alcohol in their lifetime and 57% reported alcohol consumption in the month prior to the survey (Hibell et al., 2012). Across the European countries, young people differ considerably in the average amount of alcohol consumed. The United Kingdom ranks among the highest levels of alcohol consumed (Hibell et al., 2012), where young drinkers between eleven and fifteen years old have almost doubled their alcohol intake over the last twenty years (Fuller, 2012). Yet, the taste of alcohol turns bittersweet when the health risks associated with its consumption are made explicit. In young people up to 24 years old, alcohol is the principal risk factor for disability, when adjusted for life years (Gore, 2011). Young¹ and older people present with different drinking patterns: while older drinkers consume more often and more regularly, younger drinkers are more prone to binge drinking (Office for National Statistics, 2013).

Although researches have not reached consensus on the definition of binge drinking or clinical cut-offs (Courtney & Polich, 2009), binges are usually considered to be single episodes of alcohol consumption that lead to intoxication. Key factors are the amount of alcohol consumed at once and the speed of drinking, with five drinks in a row constituting a binge; there is similar uncertainty about the duration of these drinking patterns in distinguishing dependence from binge drinking (Courtney & Polich, 2009). A variety of health and behavioural risks are associated with binge drinking, such as increased risk of regretted and unprotected sex (Hibell

¹Between 16-24 years old

et al., 2009, 2012), alcohol poisoning (Rehm et al., 2003), self-harm and suicide (McCloud, Barnaby, Omu, Drummond & Aboud, 2004), and accidental death (Thunstrom, 1988). Other risks are related to influence on neural development: binge drinkers are more vulnerable to the toxic effects of alcohol and have different cerebral activation patterns and neuropsychological responses, when compared to light drinkers or abstainers (Mota et al., 2013). Binge drinking students have been found to display impaired performances on neuropsychological measures testing verbal working and declarative memory, sustained attention, inhibitory control and cognitive interference (García-Moreno, Exposito, Sanhueza & Angulo, 2008; Goudriaan, Frekin & Sher, 2007; Hartley, Elsabagh & File, 2004; Heffernan, Clark, Bartholomew, Ling & Stephens, 2010; Johnson et al., 2008, all cited in Mota et al., 2013).

1.2 Motivational tendencies

Alcohol use is socially and culturally promoted within Western society, yet on the individual level, cognitive processes are involved in the promotion — or avoidance — of drinking behaviours. Motivational models have recently focused on approach avoidance tendencies, which are automatic motivational responses, unconscious and fast. They can be measured in experimental conditions by presenting stimuli for less than 1000ms (Krieglmeyer, De Houwer & Deutsch, 2013). Approach avoidance tendencies are considered independent of the valence of the stimuli and can be compared to the survival needs of approaching rewards and avoid punishments. Individuals might present both approach and avoidance inclinations to drinking alcohol, and potential conflicts might occur outside the person's awareness (Cox, Fadardi & Klingers, 2006, in Barkby, Dickson, Roper & Field, 2012).

Different paradigms have been used to investigate automatic cognitive processes, in heavy drinkers and help-seeking dependent drinkers. Studies using the Implicit Association Test (Greenwald, McGhee, & Schwartz, 1998) found that heavy drinking students were prone to associate words related to alcohol with words related to approach behaviours rather than avoidance; this association was also positively correlated with measures of drinking behaviours such as number of binge episodes (Ostafin and Palfai, 2006; Palfai and Ostafin, 2003).

The Relevant-Stimulus Response Compatibility task (R-SRC; Bradley, Field, Mogg & De Houwer, 2004; Mogg et al., 2003) is another measure of automatic motivational tendencies. The R-SRC requires moving a manikin towards or away from neutral or alcohol-related pictures on a computer screen and it is considered *relevant* as the instructions explicitly refer to the content of the pictures (Field et al., 2008), where participants have to acknowledge whether each picture's content is neutral or alcohol related. The R-SRC task was adopted to demonstrate that heavy drinking students are faster to approach than to avoid alcohol-related pictures (Field, Kiernan, Eastwood & Child, 2008); this tendency was correlated with weekly alcohol intake and was not found in light drinkers. A similar approach tendency was found when heavy drinking students were tested with the *irrelevant* Approach Avoidance Task (AAT; Rinck & Becker, 2007), where they pulled or pushed a joystick according to the shape (landscape versus portrait) of pictures with alcohol-related and neutral content presented on a computer screen (Wiers, Rinck, Dictus, & van den Wildenberg, 2009). Specifically, *irrelevance* refers to instructions that are not associated with the content of the images, which increases the likelihood of relatively automatic responses (De Houwer, 2003).

Wiers et al. used the AAT paradigm with hazardous drinkers (2010) and dependent drinkers (2011) to re-train automatic approach tendencies by associating the majority of pictures requesting avoidance (by pulling the joystick) with alcohol-related pictures. Both clinical and non-clinical participants reduced alcohol intake at follow up. The same procedures were formalised as Cognitive Bias Modification (CBM), which was confirmed as equally successful when applied to in-patients treated for alcohol dependence (Eberl, Wiers, Pawelczack, Rinck, Becker & Lindenmeyer, 2012). CBM training preceded a cognitive behavioural treatment and, when compared to a sham-treatment and no treatment condition, significantly reduced the number of participants who relapsed after treatment completion (Eberl et al., 2012).

While CBM has been used to promote avoidance, Spruyt et al. (2013) questioned the nature of this intervention on the basis of their findings: at the completion of an inpatient treatment, alcoholics “naturally” displayed an avoidance tendency on the R-SRC whilst social drinkers displayed an approach tendency. Additionally, at six months follow up, it was found that the strength of the avoidance was related to the likelihood of relapse. The authors suggested that the avoidance tendency might have been the result of attending a standard inpatient treatment for alcohol dependence that promoted the acquisition of a new, motivational tendency. It was argued that abstinent drinkers might experience more self-control dilemmas when exposed to alcohol-related cues, or that avoidance might prevent the emotional processing of the dependence. Attentional Control was another factor that determined the efficacy of the avoidant strategy, as indexed by the Attentional Control Scale (ACS; Derryberry, 2002; Derryberry & Reed, 2002).

Conceived as a component of executive functioning, attentional control refers to people's ability to flexibly control their attention over perception, thoughts and different tasks. It is therefore possible that when abstinent, individuals possess sufficient control, an avoidance strategy seems sustainable, but when control is low, avoidant abstainers seem more vulnerable to alcohol-related cues and are more likely to relapse (Spruyt et al., 2013). This argument appears to be in line with the recent conceptualisation of addictive behaviours as resulting from the interaction between two semi-independent systems: a fast, *impulsive* system which evaluates the stimuli in terms of motivational valence and a slower, *reflective*, inhibitory system which regulates impulses and emotions (Wiers et al., 2007; Wiers & Stacy, 2006). Impairment in the second system, whose functions overlap with executive functions, could make drinkers more vulnerable to automatic cognitive processes (Peeters, Wiers, Monshouwer, Schoot, Janseen, & Vollebergh, 2012; Thush, Wiers, Ames, Grenard, Sussman, & Stacy, 2008). Such vulnerability is increased by the fact that drinking alcohol in itself has a negative impact on executive functions (Nixon, 2013; Noel et al, 2001).

1.3 The Present Study

The majority of previous studies on motivational tendencies have focused on clinical populations of dependent drinkers seeking help or on 'heavy drinking' students. The two populations differ radically in drinking patterns and amount of alcohol consumption. In studies of 'heavy drinkers' a score of eight on the *Alcohol Use Disorders Identification Test (AUDIT)*; Saunders, Aasland, Babor & Grant, 1993) was sufficient to label participants as heavy drinkers (Ostafin & Palfai, 2006).

We aimed to assess approach/avoidance tendencies in a population of drinkers who are not seeking help, yet present markedly dysfunctional drinking patterns as evidenced by very high scores on AUDIT and more frequent binge drinking. We hypothesised that a non-clinical sample, as assessed with an R-SRC task, would present an approach rather than avoidance tendency towards alcohol cues. In order to investigate whether heavy drinking influenced participants' neuropsychological functioning, we administered a battery of measures on pre-morbid intelligence, working memory and executive functions (attention, processing speed and cognitive flexibility). In addition, we administered the ACS and hypothesised that heavy drinkers would have lower scores on the ACS and that their performance in neuropsychological tests would correlate with both their attentional control abilities and their drinking patterns (AUDIT and binge drinking scores). We also explored whether neuropsychological performance and attentional control influenced performance on the R-SRC task in terms of motivational tendencies and accuracy of responses.

2. Method

This study was part of a joint project with another UCL Clinical Psychology Doctorate student, Bradley Platt. Contributions of each trainee are outlined in Appendix A.

2.1 Participants

Both heavy drinkers and controls were recruited from students and staff at the University College London (UCL). Recruitment of heavy drinkers was extended to an association campaigning for real ale. All UCL staff and students received an email notification via the university notification system, where they were provided

information about the study and invited to complete an online survey. A similar email was sent to the ale association members through their monthly online program after contacting the association director for permission. The survey comprised questions investigating participants' demographics and whether they met eligibility criteria, the AUDIT, the HADS (*see following paragraph for details*) and questions related to drug use. Over 400 participants from the UCL pool and over ten members of the ale association completed the survey.

The allocation of participants to the heavy drinker and control groups was based on AUDIT scores: respondents who scored fifteen and above were considered heavy drinkers, and those below eight were controls. Participants were excluded if they were not fluent in English; or if they had a diagnosis of dependence on alcohol/illicit drugs, a history of brain injury, past or current psychotic experiences, a diagnosis of learning disabilities, reading problems and use of antipsychotic medication.

On the basis of these criteria, 20 heavy drinkers and 20 controls were recruited from UCL, with three additional heavy drinkers from the Campaigning for Real Ale society. Data of two participants, one in each group, were excluded from the analysis due to errors in the screening process.

2.2 Measures

1. Relevant Stimulus Response Compatibility (R-SRC) task (Bradley, Field, Mogg & De Houwer, 2004; Mogg et al., 2003). Pictorial stimuli for the task consisted of a 16 alcohol related-pictures (e.g. a man drinking beer) and 16 neutral pictures that did not contain alcohol. Half the pictures were the same as those used by Spruyt et al. (2013), while the remaining ones were substituted with pictures

portraying contents more familiar to British participants (e.g. a pub instead of a café as the site of alcohol consumption). Alcohol-related and unrelated pictures were matched closely in perceptual features (brightness, complexity) and content (e.g. a man drinking water versus a man drinking beer). The height of these pictures varied between 246 and 250 pixels, and their width between 182 and 343 pixels. Affect 4.0 (Spruyt et al., 2010) was used to program the R-SRC task. The task included two blocks of 64 trials, where all pictures appeared in the centre of the computer screen and were presented twice in each block. For each picture, the manikin - 79 pixels high and 51 pixels wide - was presented once above the picture and once below it. Participants had to press arrow keys to move the manikin up or down. Instructions for the compatible block were to move the manikin towards alcohol-related pictures and away from alcohol-unrelated pictures. For the incompatible block, the instructions were to move the manikin away from alcohol-related pictures and to move it towards alcohol-unrelated pictures. Eight practice trials were presented before each block. When the response was incorrect (e.g. if the manikin was moved towards alcohol in the incompatible block) a bleep was emitted.



Figure 1

Two examples of alcohol related pictures used in the R-SRC task



Fig 2

Two examples of alcohol unrelated pictures used in the R-SRC task

2. *Attentional Control Scale (ACS)*. The ACS (Derryberry, 2002; Derryberry & Reed, 2002) is a self-report scale consisting of 20 items. It measures the individual's ability to focus perceptual attention, switch attention between tasks, and flexibly control thought (Derryberry, 2002). Each item was scored on a 4-point scale and the total scores were proportional to the individual attentional control.

3. *Spot the Word Test (STWT)*; Baddeley, Emslie & Nimmo-Smith, 1993) is a measure of pre-morbid intelligence. It consists of 60 letter-string pairs containing a real word and an invented, yet plausible one. Participants are instructed to identify the real word. The test is highly correlated with other measures of pre-morbid intelligence; for instance, a convergent validity of 0.83 was reported with the National Adult Reading Test.

4. *Trail Making Test (TMT)* (Army Individual Test Battery, 1944) consists of subtests A and B. In part A participants have to join up in ascending order 25 numbered circles dispersed randomly on a paper sheet. In part B the circles contain both letters and numbers, and the participants have to join those alternating numbers and letters in ascending order (e.g. 1-A-2-B etc.). The test produces two scores of

completion time and number of errors, although a third score – Trail B-Trail A– is reported here, as it provides an index of cognitive flexibility.

5. *Story Recall* (Wilson, Cockburn & Baddeley, 2003) assesses verbal memory span. Participants listen to a short prose and are instructed to repeat as much as possible right after listening (immediate recall) and twenty minutes later (delayed recall). Scores of one or half point are given according to the accuracy of recall for each component of the text.

6. *Single Digit Cancellation Task (SDCT)* is a measure of sustained attention and processing speed (White & Lintzeris, 2010). Participants are presented with a block of 400 digits, and are instructed to identify and cross out all the number 4s while ignoring the other numbers. Both completion time and omissions are included in the scoring.

7. *Digit Span Test (DS)* is a measure of short-term memory (Richardson, 2007). Participants are presented with increasingly longer lists of digits and asked to repeat them; in the “forward” condition, digits are repeated following the order in which they are presented, and in “backwards” condition, the digits are repeated in a reverse order. The test is a component of the WAIS-IV edition (Wechsler, 2008).

8. *Verbal and Category Fluency* tasks are components of the Controlled Oral Word Association Task (Benton, Hamsher & Sivan, 1983). Participants are given one minute for each condition, to generate words beginning with a letter or within a precise category. To accomplish the tasks it is necessary to exert executive control over cognitive processes such as selective attention, mental set, internal response generation and self-monitoring (Patterson, 2011), hence it requires abilities that fall under the umbrella of executive functions.

9. *Hospital Anxiety and Depression Scale (HADS)*. The brief self-assessment scale (Zigmond & Snaith, 1983) comprises of fourteen questions focused on symptoms of depression and anxiety in the week prior to completion. The instrument possesses good specificity and sensitivity both in primary care, psychiatric and general populations (Bjelland, Dahl, Haug & Neckelmann, 2002).

10. *Alcohol Use Questionnaire (AUQ)*. The self-report measure (Mehrabian & Russell, 1978) investigates participants' habitual use of alcohol. Rather than asking for precise amounts of alcohol consumption, it elicits an estimation of the quantity consumed in the previous six months. AUQ scores take into account the number of alcoholic drinks per week, the hourly speed of drinking, the number of episodes of intoxication in the previous six months and the percentage of drinking episodes leading to intoxication. Total scores on the AUQ are calculated through an equation: $\text{Item 3} + \text{Item 6} + \text{Item 9} + (4 \times \text{Item 10}) + \text{Item 11} + (0.2 \times \text{Item 12})$.

The questionnaire also provides a *Binge Score*, based on the relationship between drinking patterns and alcohol intake. An equation which combines answers given in items 10 (speed of drinking), 11 (number of intoxications in the previous six months), and 12 (the percentage of intoxications over all drinking episodes) provides an indication of drinking patterns (Townshend & Duka, 2002). The AUQ possesses good reliability ($r= 0.73$) in measuring habitual drinking (Townshend & Duka, 2002).

11. *Alcohol Use Disorders Identification Test (AUDIT)*. The self-report questionnaire (Saunders, Aasland, Babor & Grant, 1993) consists of ten items investigating alcohol use, potential symptoms of alcohol dependence and alcohol-related problems. The AUDIT provides cut-off scores to distinguish different levels of risk linked to the alcohol consumption: hazardous drinking, harmful drinking and

potential intervention in alcohol dependence. Alcohol use problems in a student population should be detected by scores above a cut-off of eleven (Fleming, Barry & MacDonald, 1991).

In addition to standardised measures, five questions were added to the self-administered AUDIT to record each participant's use of tobacco, illicit drugs and benzodiazepines, as well as frequency of use.

2.3 Procedure

This study was approved by the Graduate School Ethics Committee of University College London and all participants provided written informed consent. Participants agreed to abstain from alcohol and illicit substances for the 24 hours prior to the testing; such abstinence was tested and confirmed by using a breathalyser, which provided negative results for all. Individualised test administration took place on UCL premises and lasted between two and three hours, with tests administered in a consistent sequence. Participants completed the R-SRC task, Immediate Story Recall, Digit Span, Spot the Word, Trail Making Test A & B, SDCT, Verbal and Category Fluency, Delayed Story Recall, ACS and AUQ. Participants were paid £12/18 – according to the length of testing – to compensate for their participation time.

2.4 Power Analysis

Power analysis was informed by the work of Griffith and colleagues (2012) on prospective memory, which was investigated on the same population by another trainee. Sample size was calculated using G*Power (Faul, Erdfelder, Lang and Buchner, 2007) on the basis of effect sizes identified as large ($g = 0.80$); alpha was

specified at 5% and desired power at 80%. The required sample size is estimated at 32. However, previous studies have reported for the R-SRC task effect sizes identified as small to moderate. Consequently, unless the effect size in the current study is larger, it might not be detected in the current sample.

2.5 Data Analysis

Scores on survey, questionnaires and neuropsychological tests were manually entered in a SPSS 20.0 dataset. Data from the R-SCR were later merged on three copies of the dataset to compute analyses with outliers to assess accuracy, and without outliers to assess R-SRC scores. Differences between groups in demographic characteristics, drinking measures and neuropsychological performance were calculated using t-tests. Chi-square test was employed to compare the groups' frequency of drugs use.

T-tests were used to assess group differences on each task, while a one-tailed t-test was used to compare the groups on the final R-SRC scores (approach-avoidance tendencies). One-sample t-tests were calculated separately for each group to ascertain whether participants showed R-SRC scores that were significantly different from zero (e.g. indicating approach or avoidance bias). A repeated measures analysis of variance (ANOVA) was employed to assess whether the block order for the compatible task (presented in the first or second block) impacted on the R-SRC scores between the groups. T-tests were then used to ascertain whether the two groups differed on R-SRC scores on the different blocks. Accuracy of responses on both blocks and on trials were analysed separately with repeated measures analysis of variance (ANOVA).

In addition, relationships between drinking measures (AUQ, AUDIT, Binge drinking and drinking days), ACS and neuropsychological variables which differed between groups were explored with within group Pearson's r correlations.

3. Results

3.1 Participants demographics and drug use

In total, 41 participants were tested. Heavy drinkers and controls did not differ in gender, age, Spot the Word scores or anxiety and depression (Table 1). Significant differences were identified in the intake of alcohol, with heavy drinkers scoring higher on the AUDIT and AUQ, and reporting more drinking days in an average week (Table 2). More heavy drinkers reported higher use of cigarettes, cocaine, MDMA, benzodiazepines and amphetamines than controls (Table 3).

Table 1

Descriptive statistics for gender, age, depression, anxiety and Spot the Word in the Heavy Drinker and Control Group

	Heavy Drinkers (n=22)		Control Group (n=19)	Difference
	Mean (SD)		Mean (SD)	
Number of M/F	14/8		12/7	$\chi^2 = 0.001, p = 0.950$
Age	25.13 (10.14)		26.89 (6.53)	$t(39) = -0.648, p = 0.521$
Spot the Word	43.70 (9.47)		45.36 (6.93)	$t(37) = -0.625, p = 0.536$
Anxiety (scores on HADS)	10.50 (2.32)		11.52 (2.89)	$t(39) = -1.259, p = 0.216$
Depression (scores on HADS)	8.27 (2.05)		8.52 (1.61)	$t(39) = -0.435, p = 0.666$

Table 2*Descriptive statistics for alcohol use in the Heavy Drinker and Control Group*

Alcohol Use:	Heavy Drinkers (n=22)	Control Group (n=19)	Difference
	Mean (SD)	Mean (SD)	
AUDIT scores	23.13 (4.25)	3.73 (1.91)	$t(30.03)= 19.25, p<0.001$
Drinking Days per week	4.63 (1.29)	1.42 (1.34)	$t(39)= 7.79, p<0.001$
AUQ scores	67.03 (29.87)	10.49 (6.19)	$t(20.88)= 8.52, p<0.001$
Binge scores	40.45 (21.99)	7.91 (4.90)	$t(22.19)= 6.60, p<0.001$

Table 3*Number of participants reporting use of other drugs in the Heavy Drinker and Control Group*

	Heavy Drinkers	Control Group	Difference
	Number of participants using drugs		
Benzodiazepines	5	0	$\chi^2 = 4.92, p=0.027$
Cannabis	13	1	$\chi^2 = 13.13, p< 0.0005$
Cigarettes	14	1	$\chi^2 = 14.97, p< 0.0005$
Cocaine	7	0	$\chi^2 = 7.29, p= 0.007$
MDMA	8	0	$\chi^2 = 8.58, p= 0.003$
Speed	3	0	$\chi^2 = 2.80, p= 0.095$

3.2 Neuropsychological measures (Table 4)

Heavy drinkers and controls significantly differed in only two of the tests administered. In the single digit cancellation task, heavy drinkers committed more errors; on the backwards digit span, they recalled fewer digits when compared to participants in the control group. The groups did not differ in their performance on Single Digit Cancellation Task-time, Forward Digit span, Letter and Category

Fluency, differences between Trails A and B, errors in Trails A and B or Prose Recall.

Table 4
Neuropsychological performance in the Heavy Drinkers and the Control Group

Neuropsychological Test	Heavy Drinkers (<i>n</i> =22)	Control Group (<i>n</i> =19)	Group Difference (Test Statistic)
	Mean (<i>SD</i>)	Mean (<i>SD</i>)	
SDCT -time	51.85 (10.57)	61.30 (26.50)	$t(37) = -1.47, p = 0.148$
SDCT-omissions	3.55 (4.63)	1.05 (1.58)	$t(37) = 2.22, p = 0.032^*$
Digit-Forwards	7.22 (1.15)	7.89 (1.14)	$t(39) = -1.85, p = 0.072$
Digit-Backwards	5.18 (1.53)	6.47 (1.12)	$t(39) = -3.03, p = 0.004^*$
Letter fluency	17.27 (3.78)	19.21 (5.58)	$t(39) = -1.31, p = 0.196$
Category fluency	25.09 (4.70)	24.73 (6.17)	$t(39) = 0.208, p = 0.836$
Trails B-A	24.68 (19.76)	20.02 (15.16)	$t(38) = 0.208, p = 0.836$
Trail A- errors	0.09 (0.29)	0.05 (0.23)	$t(38) = 0.413, p = 0.682$
Trail B- errors	0.68 (1.58)	0.055 (0.23)	$t(38) = 1.657, p = 0.106$
Recall Prose	7.47 (2.81)	7.16 (3.38)	$t(38) = 0.821, p = 0.417$

* t-tests are significant at the 0.05 level (2-tailed), not corrected for multiple comparisons

On the ACS, the control group had significantly higher scores ($M=57.58, SD=8.39$) than the heavy drinkers ($M=51.54, SD=8.52$), $t(37) = -2.209, p = 0.033$.

3.3 R-SRC Task

Prior to calculating individual R-SRC scores, all outliers and errors were excluded, using criteria based on previous research conducted with this task (Spruyt et al., 2013). First, response latencies above 5000ms (~ 0%) were removed. Next, response latencies deviating more than 2.5 *SD* from the participant's mean were removed from each response condition (compatible and incompatible) separately (3%). Finally, response latencies to all error trials in which the first

response was incorrect (error trials 5.5%) were removed. Individual R-SRC scores were calculated for each participant by subtracting their mean response latency in the compatible block from the mean response latency in the incompatible block. Positive R-SRC scores therefore reflect a behavioural tendency to approach alcohol cues, whereas negative scores are indicative of avoidance. In the administration of the task we aimed to counterbalance the order of the blocks – compatible and incompatible – across the participants, although the balance between block orders was not achieved (see frequencies in Table 5).

Normality checks were performed on the distribution of R-SRC scores. Skewness scores approached significance ($z=2.58$); however a Kolmogorov-Smirnov test demonstrated that the R-SRC scores were normally distributed [$D(41) = 0.155$, $p = 0.015$], and parametric tests could be performed without transforming the data (Field, 2009).

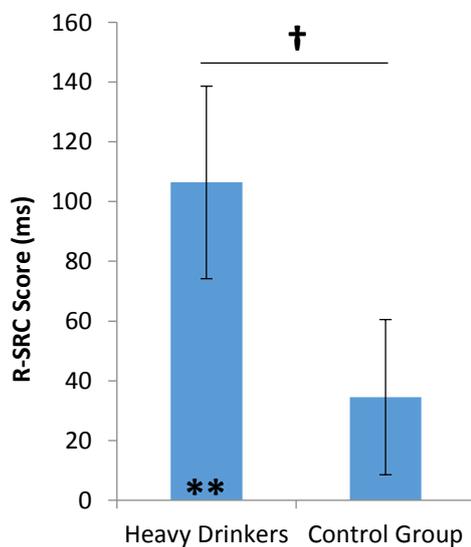


Figure 3

Mean (SD) R-SRC scores in milliseconds for each group.

*** signifies R-SRC scores significantly different from 0, $p < 0.05$*

† signifies difference between group means, $p < 0.05$

As seen in Figure 3, R-SRC means were positive for both the groups and the heavy drinkers' mean was higher. A one-tailed t-test supported our hypothesis, $t(39)=1.70$, $p=0.048$. However, no significant differences were found when the groups were compared with t-tests in the response latencies of both tasks separately. When instructed to approach alcohol-related images, both heavy drinkers and controls displayed similar responses [$t(39)=-0.354$, $p=0.726$]; when instructed to move away from alcohol, the two groups did not differ [$t(39)=1.257$, $p=0.216$].

A factorial repeated-measures ANOVA showed a main effect of task [$F(1, 39)=11.11$, $p=0.002$, $\eta^2=0.222$], with shorter latency in approaching alcohol-related images ($M=751.88$, $SD=98.94$) than in avoiding them for both groups ($M=824.97$, $SD=155.60$). There was no main effect of group [$F(1,39)=0.51$, $p=0.48$], but there was a marginal interaction between task and group [$F(1,39)=2.89$, $p=0.097$, $\eta^2=0.069$].

Differences in response latencies were compared separately for each group using a one-sample t-test. Whereas response latencies did not differ from zero in the control group [$t(18)=1.33$, $p=0.200$], heavy drinkers were faster in approaching alcohol than in moving away from it [$t(21)=3.30$, $p=0.003$]. Block order also appeared to influence the response latencies. Table 5 reports the R-SRC scores obtained by each group in both conditions according to the presentation order of the compatible task.

Table 5

R-SRC scores (Incompatible - compatible) scored by each group according to the order in which the compatible task was presented.

	R-SRC scores	
	Compatible task as first block	Compatible task as second block
Heavy Drinkers	$N=8, M=158.61, SD=130.70$	$N=14, M=76.58, SD=158.35$
Control Group	$N=5, M=39.83, SD=43.91$	$N=14, M=32.60, SD=130.79$

When the incompatible task was presented in the first block (Table 5), both groups scored similarly [$t(26)= 0.801, p= 0.430$] but heavy drinkers were much slower in moving away from alcohol if these instructions were given in the second block [$t(11)= 2.36, p= 0.042$ with equal variance not assumed].

Table 6

Number of correct and incorrect responses grouped by compatible and incompatible task

	Correct responses in each task	
	Compatible	Incompatible
Heavy Drinkers ($n=22$)	59.86 (2.60)	59.77 (2.75)
Control Group ($n=19$)	61.26 (3.39)	61.26 (2.78)

When the number of correct answers - including the ones with latency outliers - were compared across the two groups (Table 6), a trend approaching significance was found. In the incompatible block, the control group tended to score higher than the heavy drinkers [$t(39)= -1.71, p=.094$, two-tailed]. No significant difference was found [$t(39)= -1.49, p=0.144$] in the compatible block.

Table 7*Number of correct and incorrect responses in practice trials for both groups*

	Number of Responses in first practice block		Number of Responses in second practice block	
	Correct	Incorrect	Correct	Incorrect
Heavy Drinkers	6.41 (1.36)	1.59 (1.36)	7.09 (1.34)	0.91 (1.34)
Control Group	6.89 (1.96)	1.11 (1.96)	7.42 (1.01)	0.58 (1.01)

In order to investigate whether a practice effect was present, the number of incorrect responses in practice trials - including outliers - were compared between the two groups (Table 7). A factorial repeated-measures ANOVA showed only a marginal effect of order [$F(1,39) = 3.78, p = 0.059, \eta=0.088$], with both groups tending to make fewer errors in the second block ($M = 0.76, SD = 1.20$) than in the first block ($M = 1.37, SD = 1.67$). No group [$F(1,39) = 3.78, p = 0., \eta=0.088$], or interaction [$F(1,39) = 1.49, p = 0.23,$] effects were observed.

3.4 Correlations

Heavy drinkers and controls differed only on two neuropsychological variables and on the ACS scores. In order to ascertain whether these differences could be linked to their alcohol intake, we calculated a series of Pearson's correlations between the indices of alcohol intake, the scores on the ACS and the scores on Digit Backwards. Scores of SDCT omissions were not included as the values were too small to be relevant. According to our hypothesis, a correlation should be expected between the indexes of alcohol intake (AUDIT and AUQ scores, number of binges, number of drinking days) and the responses on the R-SRC task. Correlations were also carried out to explore whether neuropsychological performance was associated with the accuracy of the responses on the R-SRC task

and/or response latencies. All the correlations were calculated separately for each group. The α level was adjusted to $p = 0.01$ to reduce type I error rate.

Table 8

Pearson's r correlations between neuropsychological variables and alcohol intake in heavy drinkers

	ACS	Backwards Digit	Errors in incompatible block	Correct responses in incompatible block	Errors in compatible block	Correct responses in compatible block	R-SRC scores
AUDIT	- 0.482*	- 0.303	- 0.386	0.341	- 0.216	0.120	0.166
BINGE	- 0.361	- 0.184	0.194	0.206	- 0.149	- 0.041	- 0.005
AUQ	- 0.308	- 0.240	0.133	- 0.189	- 0.128	0.010	0.130
Drinking Days	0.235	- 0.037	0.268	- 0.200	- 0.013	0.064	- 0.580

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

For the heavy drinkers only a trend ($p < 0.05$) towards a negative correlation was found between the scores on the ACS and the scores of the AUDIT [$r(22) = -0.482, p < 0.05$]. Among the controls, no significant correlations were found among the variables considered. We omitted reporting the correlations between neuropsychological performance and responses in R-SRC task as none were significant in both groups.

Table 9

Pearson's r correlations between neuropsychological variables and alcohol intake in controls

	ACS	Backwards Digit	Errors in incompatible block	Correct responses in incompatible block	Errors in compatible block	Correct responses in compatible block	R-SRC scores
AUDIT	-0.288	-0.068	-0.118	0.183	- 0.011	0.082	0.125
BINGE	-0.207	0.100	0.168	- 0.131	0.290	-0.186	0.037
AUQ	-0.042	0.022	0.210	- 0.127	0.303	-0.189	0.083
Drinking Days	0.399	-0.139	0.105	0.018	0.159	-0.115	0.139

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

4. Discussion

The main aim of this study was to investigate whether approach tendencies towards alcohol-related stimuli in a group of heavy drinkers differed from a control group of light drinkers. Additionally, neuropsychological variables were assessed so that potential relationships between these variables, approach tendencies and drinking habits could be explored.

The heavy drinkers had average scores of over 20 on the AUDIT, which is the clinical cut-off score, following which further diagnostic evaluation for alcohol dependence is recommended (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). The AUDIT's cut-off scores can distinguish among three levels of risk linked to the alcohol consumption. Scores between 8 and 15 suggest hazardous drinking, scores between 15 and 19 are indicative of harmful drinking, and scores of 20 and above suggest the need for an intervention for alcohol dependence. Although our participants were not seeking help, sixteen of them reported that because of their

drinking someone had been injured within the last year, and twenty of them reported that someone (i.e. family members, friends or professionals) was concerned about their drinking or advised them to reduce it.

Results on the R-SRC tasks indicated that, as hypothesised, heavy drinkers were faster in the compatible block, where they had to approach alcohol-related images and to move away from neutral images, than in the incompatible block where the instructions were reversed. Conversely, light drinkers did not differ in their response latencies whether they approached or avoided images with alcohol-related content. As predicted, the groups differed in their response patterns, with heavy drinkers being approaching alcohol-related images more than light drinkers.

The order of the blocks, and hence instructions, affected the response latencies of heavy drinkers but not of controls. When the incompatible task was given in the second block, heavy drinkers' performance was slower than the light drinkers' ones, whilst the groups did not differ when the incompatible task was given first. It might be possible that once the heavy drinkers started the task with compatible instructions, they found it more difficult to switch to incompatible ones. Moreover, automatic approach tendencies, expressed in the first block accordingly to the instructions, elicited more hesitation when they had to be restrained in the incompatible block. The compatible block was likely to reinforce both an approach tendency and an attentional bias elicited by alcohol-related cues (Field & Cox, 2008). Additionally, heavy drinkers had lower scores on the attentional control scale, hence they might have experienced potential difficulties in re-allocating their attention commensurate with a different instruction.

Trend level findings were observed for a higher number of errors in the incompatible block in heavy drinkers compared to controls. Heavy drinkers were

more likely to approach alcohol as first response when they were instructed to do the opposite. These differences might be speculatively attributed to the dilemma faced by heavy drinkers regarding moving in a direction opposite to the one desired. The number of errors of both groups declined in the second block, suggesting a practice effect as participants became more familiar with the task. However, errors were too few to ascertain statistically whether the block order affected the correctness of the responses.

Interestingly, the difference in R-SRC scores between heavy drinkers and controls was not as strong as might have been predicted on the basis of previous studies of heavy drinking students (Field et al., 2008; Ostafin & Palfai, 2006; Palfai & Ostainf, 2003). Moreover, response latencies and number of correct and incorrect responses on the R-SRC task did not correlate with any of the measures of alcohol intake in either group. However, it should be noted that our sample of heavy drinkers was much more severe in indices of drinking problems (on the AUDIT, $M= 23.13$, $SD= 4.25$) than samples in previous studies (in Field et al., 2008 on the AUDIT, $M= 16.73$, $SD= 5.15$; in Wiers et al., 2008 on the AUDIT, Median= 13).

The lack of correlation between alcohol intake measures and R-SRC scores is surprising given the assumption that approach tendencies are developed through classical conditioning. According to the incentive-sensitization theory (Robinson & Berridge, 1993, cited in Field, 2008) repeated administrations of substances of abuse elicit dopamine release, and this sensitises the dopamine system to subsequent administrations of the drug. In this process, the substance acquires more salience and stronger motivational properties, driving the individual to repeatedly seek the substance and crave for it. Given the high levels of reported alcohol intake in this study, we expected that these would correlate with latencies on the R-SRC task.

The partial discrepancies in our results could be ascribed to the dilemma between approach and avoidance. Although not help-seeking, heavy drinkers might have been tempted to avoid alcohol-related stimuli, possibly because they were conscious of alcohol's negative impact on health and professional efficiency as well as for social desirability. In fact the R-SRC task, as *relevant* task, implies an overt reference to the content; in addition, participants were attending an experiment in which they were asked by clinical psychologists to quantify their alcohol consumption by filling in questionnaires. It is likely that the *relevance* of the R-SRC task and the experimental context can elicit social desirability biases. Furthermore, the average latency of our participants' responses to alcohol stimuli was 800ms; although each stimulus was present on the screen until the response was completed, participants took on average almost a second before beginning an approach or avoidance motion. In the attentional bias paradigm, stimulus exposures greater than 500ms (Field & Cox, 2008) are considered relatively long and as such they allow attention to shift and disengage from stimuli. This translates in our paradigm as a potentially increased hesitation between approach and avoidance, and it questions whether responses can be considered completely automatic. Similar reasons could be taken into account when comparing relevant and irrelevant tasks: these are considered *structurally* different and the majority of previous studies reporting approach tendencies and CBM have used the *irrelevant* Approach Avoidance Task.

R-SRC, IAT and AAT, despite being measures of automatic motivational tendencies, have been previously reported to not inter-correlate (Wiers, Gladwin, & Rinck, 2011). As a result, comparisons between different clinical groups might lead to inconsistent outcomes when different measures are employed. The same limitations apply to the clinical use of Cognitive Bias Modification (CBM), as

contradictory effects have been attributed to approach and avoidance tendencies. Wiers has promoted avoidance training as a component of treatment for alcohol dependence which has been proven to be effective in reducing relapse (Wiers et al., 2011), whereas Spruyt et al. (2013) have linked avoidance tendencies, alongside poor attentional control, to an increased risk of relapse. Additionally, studies applying CBM have induced an avoidance tendency in participants, yet have failed to find differences in approach tendencies between alcoholics and controls prior to treatment (Eberl et al., 2012; Wiers et al., 2011). In two studies conducted using the R-SRC task, different conclusions were reached. Whereas Spruyt et al. (2013) concluded that dependent drinkers develop an avoidance tendency as a coping mechanism through the process of pursuing abstinence, heavy drinkers not seeking help displayed predominantly approach tendencies (Fields et al., 2008). It should be noted however that these authors tested different populations and reached their conclusions through different analyses of the data.

In the present study, heavy drinkers and controls differed in their scores on the Attentional Control Scale (ACS), with controls scoring higher on abilities to address, sustain and shift their attention. Heavy drinkers' perception of cognitive difficulties — here specifically linked to attention — appeared to suggest a deficit that did not emerge in the neuropsychological measures. The two groups did not differ in neuropsychological performance except for two measures of errors on the Single Digit Cancellation Task, which assesses sustained attention, and scores on the Backwards Digit Span, which assesses working memory. Both measures are components of executive functions and they seem to associate with heavy drinkers' awareness of having reduced attentional control on the ACS. These results can partially explain why heavy drinkers committed more errors when the incompatible

instructions were given in the second block. Surprisingly, no differences were found in Trail Making A or B, the latter of which is considered a reliable and valid measure of the capacity to shift between tasks. Furthermore, none of the neuropsychological measures correlated with R-SRC scores, response latencies or with any of alcohol intake measures. We did not collect information on when the participants began drinking heavily. Heavy drinkers as young as twenty years old are likely to display a premature cognitive decline, especially in tasks related to executive functioning such as attention, cognitive control, planning and working memory (Sanhueza, Garcia-Moreno & Exposito, 2011). It is possible that the majority of the tests administered were not sensitive enough to detect changes that did not fall into a more marked clinical domain. It is also possible that the characteristics of our sample influenced these results. As students of a prestigious university, they were likely to perform at ceiling levels and henceforth a drop in their neuropsychological performance would have been less likely to be detected; additionally, education level has a buffering effect on cognitive decline. However, heavy drinkers did have lower scores on the ACS. As the academic success of our participants was linked to intact attention and concentration skills, they were likely to be sensitive to the decline of these skills even when it did not reach clinical levels.

A trend towards negative correlation was found between scores on Attentional Control Scale for heavy drinkers and scores on the AUDIT, suggesting that increased amount of drinking was associated with perceived difficulties in controlling attention. This result is coherent with the view that compromised attentional control, as part of executive cognitive functioning, represents a vulnerability towards the increased motivational properties of substance-related cues (Field et al., 2008). The

correlation does not suggest a causal relationship and impaired attentional control could also be a consequence of the heavy drinking.

4.1 Clinical implications and future research

This study sheds light on a population of young drinkers who reported problematic drinking but were not seeking help. They presented with an approach tendency toward alcohol-related stimuli, reported reduced attentional control and impaired working memory when compared to light drinkers. The combination of these features along with high levels of alcohol intake makes this population at risk of developing alcohol dependence. In order to minimise the risk, by drawing on the already available evidence, regular screenings based on the AUDIT might allow the identification of drinkers at risk who could benefit from Brief Interventions (BI: Patton, Deluca, Kaner, Newbury-Birch, Phillips, & Drummond, 2013). Potential interventions could also be aimed at modifying alcohol approach tendencies, for example by applying cognitive bias modification, and at strengthening attentional control.

Our results suggest the need for further investigation into the relationship between motivational tendencies and heavy drinking. In relation to our sample, it would be helpful to follow up the participants to explore how heavy drinking, alcohol-approach tendencies and attentional control might interact in determining pathways to different levels of drinking behaviours. Specifically, as our population reported problematic drinking but did not seek help, it would be interesting to explore whether participants would later require treatment and whether this would be accompanied by changes in approach tendency.

On a broader perspective, whereas recent studies have been addressing therapeutic applications of cognitive bias modification (Eberl et al., 2012; Wiers et al., 2011), no clarity or agreement has been achieved on how approach tendencies impact on alcohol consumption and how the latter can be reduced by inducing an avoidance tendency. Future research would benefit from comparing approach tendencies within the same sample through different measures – R-SRC task, AAT and IAT. Avoidance strategies resulting from treatment were associated with higher risk of relapse when patients also presented with poor attentional control (Spruyt et al., 2013), yet this variable was not measured in the studies applying CBM. This could provide additional information on who is actually benefitting from the training.

4.2 Strengths and limitations

This study has clear strengths in the recruitment process employed, as we succeeded in obtaining quite a unique population in terms of age and drinking behaviours and in matching this sample to controls equivalent in age, gender, pre-morbid intelligence, depression and anxiety levels.

At the same time, limitations of this study should be taken into account when assessing if our findings could be extended to other populations. Firstly, both heavy drinkers and controls were mainly young university students. Despite the high scores on the AUDIT and reports of high levels of alcohol consumed, it is likely that their drinking patterns differ from those of an older and/or more dependent population. Secondly, self-reports of alcohol consumption can be limited in terms of validity and reliability, as people generally under-report the amount of alcohol they drink (Ely, Hardy, Longford, & Wadsworth, 2001). Thirdly, our sample size was fairly small, and this could have reduced the power of the statistical analyses including the

correlational analyses. Increasing the number of participants might have strengthened our findings and would have allowed further investigations on the effects of task order on response latency and accuracy. Additionally, although more males drink heavily, female participants were also under-represented and it is possible that with a different ratio of male/female participants differences related to gender could have been explored. Fourthly, we did not allocate an equal number of participants to the conditions in which the R-SRC was administered (compatible task in the first block vs compatible task in the second block). This limited the possibility of exploring order effects. Lastly, our conclusions on the difference approach tendency presented by heavy drinkers and control on the R-SRC task were confirmed by a one-tailed t-test. The test was used on the basis of results congruent to our hypothesis but with a two-tailed t-test the difference between the groups would have not been significant.

4.3 Conclusions

In summary, this study provides further evidence that motivational tendencies are associated with drinking behaviours. Our findings suggest that heavy drinkers present an approach tendency towards alcohol-related cues. Future research could address issues of causation and further explore the relationships between motivational tendencies, neuropsychological variables and alcohol consumption in a prospective, longitudinal study.

References

- Army Individual Test Battery. (1944). *Manual of directions and scoring*.
Washington, US: War Department, Adjutant General's Office.
- Babor, T. F., Higgins-Biddle, J. C., Saunders, J. B., & Monteiro, M. G. (2001). The alcohol use disorders identification test. *Guidelines for use in primary care*. Department of Mental Health and Substance Dependence, World Health Organization.
- Baddeley, A., Emslie, H., & Nimmo-Smith, I. (1993). The Spot-the-Word Test: a robust estimate of verbal intelligence based on lexical decision. *British Journal of Clinical Psychology, 32*, 55-65.
- Barkby, H., Dickson, J. M., Roper, L., & Field, M. (2012). To Approach or avoid alcohol? Automatic and self-reported motivational tendencies in alcohol dependence. *Alcoholism: Clinical and Experimental Research, 36*(2), 361-368.
- Benton, A. L., Hamsher, K. D., & Sivan, A. B. (1983). *Multilingual aphasia examination* (2nd ed.). Iowa City, IA: AJA Associates.
- Bjelland, I., Dahl, A. A., Haug, T. T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale: an updated literature review. *Journal of Psychosomatic Research, 52*(2), 69-77.
- Bradley, B., Field, M., Mogg, F.K., De Hower, W. (2004). Attentional and evaluative biases for smoking cues in nicotine dependence: component processes of biases in visual orienting. *Behavioural Pharmacology, 15*(1), 29-36.
- Courtney, K. E., & Polich, J. (2009). Binge drinking in young adults: Data, definitions, and determinants. *Psychological Bulletin, 135*(1), 142.

- Cox, W.M., Fadardi, J.S., & Klinger, E. (2006). Motivational processes underlying implicit cognition in addiction. In Wiers, R.W., & Stacy, A.W. (Eds.), *Handbook of implicit cognition and addiction*, (pp 253–264). Thousand Oaks, CA: Sage.
- De Houwer, J. (2003). A structural analysis of indirect measures of attitudes. In Musch, J., & Klauer, K.C. (Eds.), *The psychology of evaluation: affective processes in cognition and emotion* (pp. 219–244). Mahwah, NJ: Psychology Press.
- Derryberry, D. (2002). Attention and voluntary self-control. *Self and Identity*, 1(2), 105-111.
- Derryberry, D., & Reed, M. A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology*, 111(2), 225.
- Eberl, C., Wiers, R. W., Pawelczack, S., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2013). Approach bias modification in alcohol dependence: Do clinical effects replicate and for whom does it work best?. *Developmental Cognitive Neuroscience*, 4, 38-51.
- Ely, M., Hardy, R., Longford, N. T., & Wadsworth, M. E. (2001). Methods of estimating individual levels of alcohol consumption in the general population. *UK Alcohol Education and Research Council (AERC) Final Report*.
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioural, and biomedical sciences. *Behaviour Research Methods*, 39(2), 175-191.

- Field, M., & Cox, W. M. (2008). Attentional bias in addictive behaviors: a review of its development, causes, and consequences. *Drug and Alcohol Dependence*, 97(1), 1-20.
- Field, M., Kiernan, A., Eastwood, B., & Child, R. (2008). Rapid approach responses to alcohol cues in heavy drinkers. *Journal of behavior therapy and experimental psychiatry*, 39(3), 209-218.
- Fleming, M. F., Barry, K. L., & MacDonald, R. (1991). The alcohol use disorders identification test (AUDIT) in a college sample. *Substance Use & Misuse*, 26(11), 1173-1185.
- Fuller, E. (2012). *Smoking, Drinking and Drug Use among Young People in England in 2011*. London: NHS Information Centre for Health and Social Care.
- García-Moreno, L.M., Expósito, J., Sanhueza, C., & Angulo, M.T., (2008). Actividad pre-frontal y alcoholismo de fin de semana en jóvenes. *Adicciones*, 20, 271–280.
- Gore, F.M., Bloem, P.J.N., Patton, G.C., Ferguson, J., Joseph, V., Coffey, C., Sawyer, S.M., & Mathers, C.D., (2011). Global burden of disease in young people aged 10–24 years: a systematic analysis. *The Lancet*, 377, 2093–2102.
- Goudriaan, A. E., Grekin, E. R., & Sher, K. J. (2007). Decision making and binge drinking: a longitudinal study. *Alcoholism: Clinical and Experimental Research*, 31(6), 928-938.
- Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of personality and social psychology*, 74(6), 1464.

- Grenard, J.L., Ames, S.L., Wiers, R.W., Thush, C., Sussman, S. & Stacy, A.W. (2008) Working memory moderates the predictive effects of drug-related associations. *Psychology of Addictive Behaviour*, 22, 426–432.
- Griffiths, A., Hill, Morgan, C., Rendell, P. G., Karimi, K., Wanagaratne, S., & Curran, H. V. (2012). Prospective memory and future event simulation in individuals with alcohol dependence. *Addiction*, 107, 1809-1816.
- Hartley, D. E., Elsabagh, S., & File, S. E. (2004). Binge drinking and sex: effects on mood and cognitive function in healthy young volunteers. *Pharmacology Biochemistry and Behavior*, 78(3), 611-619.
- Heffernan, T., Clark, R., Bartholomew, J., Ling, J., & Stephens, S. (2010). Does binge drinking in teenagers affect their everyday prospective memory? *Drug and Alcohol Dependence*, 109(1), 73-78.
- Hibell, B., Guttormsson, U., Ahlstrom, S., Balakireva, O., Bjarnason, T., Kokkevi, A., & Kraus, L. (2009). The 2007 ESPAD Report. *Substance Use among Students in 35 European Countries*. Stockholm: European Schools Survey Project on Alcohol and Other Drugs.
- Hibell, B., Guttormsson, U., Ahlström, S., Balakireva, O., Bjarnason, T., Kokkevi, A., & Kraus, L. (2012). The 2011 ESPAD report. *Substance use among students in 36 Countries*. Stockholm: European Schools Survey Project on Alcohol and Other Drugs.
- Houben, K., Nederkoorn, C., Wiers, R. W., & Jansen, A. (2011). Resisting temptation: decreasing alcohol-related affect and drinking behavior by training response inhibition. *Drug and Alcohol Dependence*, 116(1), 132-136.
- Johnson, C.A., Xiao, L., Palmer, P., Sun, P., Wang, Q., Wei, Y., Jia, Y., Grenard, J.L., Stacy, A.W., & Bechara, A., (2008). Affective decision-making deficits,

- linked to a dysfunctional ventromedial prefrontal cortex, revealed in 10th grade Chinese adolescent binge drinkers. *Neuropsychologia*, 46, 714–726.
- Krieglmeyer, R., De Houwer, J., & Deutsch, R. (2013). On the nature of automatically triggered approach–avoidance behavior. *Emotion Review*, 5(3), 280-284.
- McCloud, A., Barnaby, B., Omu, N., Drummond, C., & Aboud, A. (2004). Relationship between alcohol use disorders and suicidality in a psychiatric population. In-patient prevalence study. *The British Journal of Psychiatry*, 184(5), 439-445.
- Mehrabian, A., & Russell, J. A. (1978). A questionnaire measure of habitual alcohol use. *Psychological reports*, 43(3), 803-806.
- Mogg, K., Bradley, B. P., Field, M., & De Houwer, J. (2003). Eye movements to smoking-related pictures in smokers: relationship between attentional biases and implicit and explicit measures of stimulus valence. *Addiction*, 98(6), 825-836.
- Mota, N., Parada, M., Crego, A., Doallo, S., Caamaño-Isorna, F., Rodríguez Holguín, S., Cadaveira, F., & Corral, M. (2013). Binge drinking trajectory and neuropsychological functioning among university students: A longitudinal study. *Drug and Alcohol Dependence*, 133(1), 108-114.
- Nixon, S. J. (2013). Executive functioning among young people in relation to alcohol use. *Current Opinion in Psychiatry*, 26(4), 305-309.
- Noël, X., Paternot, J., Van der Linden, M., Sferrazza, R., Verhas, M., Hanak, C., Kornreich, C., Martin, P., De Mol, J., Pelc, I., & Verbanck, P. (2001). Correlation between inhibition, working memory and delimited frontal area

- blood flow measured by ^{99m}Tc -Bicisate Spect in alcohol-dependent patients. *Alcohol and Alcoholism*, 36(6), 556-563.
- Office for National Statistics (2013). *Drinking habits amongst adults, 2012*. Retrieved from http://www.ons.gov.uk/ons/dcp171778_338863.pdf.
- Ostafin, B. D., & Palfai, T. P. (2006). Compelled to consume: the Implicit Association Test and automatic alcohol motivation. *Psychology of Addictive Behaviors*, 20(3), 322.
- Palfai, T. P., & Ostafin, B. D. (2003). Alcohol-related motivational tendencies in hazardous drinkers: assessing implicit response tendencies using the modified-IAT. *Behaviour Research and Therapy*, 41(10), 1149-1162.
- Patterson, J. (2011). Verbal Fluency. In J. Patterson, B. Caplan, J. DeLuca, & J. S. Kreutzer (Eds.), *Encyclopedia of Clinical Neuropsychology*, (pp. 2603-2606). New York: Springer.
- Patton, R., Deluca, P., Kaner, E., Newbury-Birch, D., Phillips, T., & Drummond, C. (2013). Alcohol screening and brief intervention for adolescents: the how, what and where of reducing alcohol consumption and related harm among young people. *Alcohol and Alcoholism*, 49(2), 207-212.
- Peeters, M., Wiers, R. W., Monshouwer, K., Schoot, R., Janssen, T., & Vollebergh, W. A. (2012). Automatic processes in at-risk adolescents: the role of alcohol-approach tendencies and response inhibition in drinking behavior. *Addiction*, 107(11), 1939-1946.
- Rehm, J. U. R., Room, R., Monteiro, M., Gmel, G., Graham, K., Rehn, N., Sempos, C.T., & Jernigan, D. (2003). Alcohol as a risk factor for global burden of disease. *European Addiction Research*, 9(4), 157-164.

- Richardson, J. T. (2007). Measures of short-term memory: a historical review. *Cortex*, 43(5), 635-650.
- Rinck, M., & Becker, E. S. (2007). Approach and avoidance in fear of spiders. *Journal of Behavioral Therapy and Experimental Psychiatry*, 38(2), 105-120.
- Saunders, J. B., Aasland, O. G., Babor, T. F., & Grant, M. (1993). Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption-II. *Addiction*, 88(6), 791-804.
- Spruyt, A., Clarysse, J., Vansteenwegen, D., Baeyens, F., & Hermans, D. (2010). Affect 4.0: A free software package for implementing psychological and psychophysiological experiments. *Experimental Psychology*, 57(1), 36.
- Spruyt, A., De Houwer, J., Tibboel, H., Verschuere, B., Crombez, G., Verbanck, P., Hanak, C, Brever, D., & Noël, X. (2013). On the predictive validity of automatically activated approach/avoidance tendencies in abstaining alcohol-dependent patients. *Drug and Alcohol Dependence*, 127(1), 81-86.
- Thunström, M. (1988). The alcohol intoxicated child and its prognosis. *Acta Paediatrica*, 77(1), 3-9.
- Thush, C., Wiers, R.W., Ames, S.L., Grenard, J.L., Sussman, S. & Stacy, A.W. (2008). Interactions between implicit and explicit cognition and working memory capacity in the prediction of alcohol use in at-risk adolescents. *Drug and Alcohol Dependence*, 94, 116–124.
- Townshend, J.M. & Duka, T. (2002) Patterns of alcohol drinking in a population of young social drinkers: a comparison of questionnaire and diary measures. *Alcohol and Alcoholism*, 37 (2): 187-192.

- Wechsler, D. (2008). *Wechsler Adult Intelligence Scale—fourth edition (WAIS—IV)*. San Antonio, TX: NCS Pearson.
- White, J., & Lintzeris, N. (2010). Psychopharmacology. In P. G. Miller, J. Strang & P. M. Miller (Eds). *Addiction Research Methods*. Chichester: Wiley-Blackwell.
- Wiers, R. W., Gladwin, T. E., & Rinck, M. (2013). Should we train alcohol-dependent patients to avoid alcohol? *Frontiers in Psychiatry, 4*.
- Wiers, R. W., Reinout, W., Bartholow, B. D., van den Wildenberg, E., Thush, C., Engels, R. C., Sher, K. J., Grenard, J., Ames, S.L., & Stacy, A. W. (2007). Automatic and controlled processes and the development of addictive behaviors in adolescents: a review and a model. *Pharmacology Biochemistry and Behavior, 86*(2), 263-283.
- Wiers, R. W., Rinck, M., Dictus, M., & Van Den Wildenberg, E. (2009). Relatively strong automatic appetitive action-tendencies in male carriers of the OPRM1 G-allele. *Genes, Brain and Behavior, 8*(1), 101-106.
- Wiers, R.W., & Stacy, A.W. (2006a) *Handbook of implicit cognition and addiction*. Thousand Oaks, CA: Sage Publishers.
- Wilson, B. A., Cockburn, J. & Baddeley A. (2003). *The Rivermead Behavioural Memory Test—II*. Bury St Edmunds, UK: Thames Valley Test.
- Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica, 67*(6), 361-370.

Part 3: Critical Appraisal

1. Introduction

The empirical paper investigated motivational tendencies of heavy drinkers. The completion of the research was far from being linear, with issues in the recruitment process that eventually led to a major change in the design of the study. In this section I explore methodological issues that emerged in the recruitment, with a particular focus on the population initially investigated. I also present a brief summary of the concept of binge drinking and its effects on neuropsychological abilities; although a partial review, it sheds light on the characteristics of our sample in terms of drinking behaviours and cognitive functioning. Finally, I include reflections on the study carried out in terms of how it might inform future research.

2. Alcohol Treatment in community settings

The empirical study initially aimed to combine and replicate two studies that investigated alcohol dependent participants undergoing inpatient detoxification treatment. The first study focused on prospective memory (Griffiths et al., 2012), the ability to remember to perform intended actions in the future (Ellis & Freeman, cited in Kliegel, McDaniel & Einstein, 2008). Virtual Week (Rendell & Craik, 2000) was used as the main measure of prospective memory. The second study focused on approach avoidance tendencies (Spruyt et al., 2013), which were measured through the Relevant- Stimulus Response Compatibility task (R-SRC; Bradley, Field, Mogg & De Houwer, 2004; Mogg et al., 2003).

We assumed that inpatient detoxification treatment is generally reserved for drinkers with severe symptoms of alcohol dependence. Such drinking patterns are likely to be chronic and to be accompanied by health and social difficulties. The negative impact of severe alcohol dependence on neuropsychological performance

has been widely researched (Ambrose, Bowden, & Whelan, 2001; Kopera et al., 2012; Lawrence, Luty, Bogdan, Sahakian, & Clark, 2009; Noel et al., 2001; Oscar-Berman, Kirkley, Gansler, & Couture, 2004; Pitel et al., 2007; Ratti, Bo, Giardini, & Soragna, 2002; Zinn, Stein, & Swartzwelder, 2004). We expected that such detrimental cognitive effects would influence the findings of studies conducted with inpatient participants. Hence, we aimed to investigate both prospective memory and motivational tendencies in alcohol dependent drinkers attending a community-based treatment. We designed a study for which we sought and obtained ethical approval from the City Road and Hampstead NHS REC and we liaised with alcohol specialist services both in North and South London for the recruitment of participants. A series of difficulties emerged in the process, both in recruiting a sufficient number of participants and during their actual testing.

These difficulties forced the researchers to abandon the initial design, as in over six months of recruitment only thirteen participants were tested, whereas we aimed for a sample size of twenty participants to obtain sufficient statistical power. In order to complete our theses within the appropriate time-frame, we decided to opt to recruit young heavy drinkers. The new population would have been easier to recruit, yet would have added further knowledge on prospective memory and motivational tendencies of heavy drinkers.

In order to reflect on the obstacles we faced during our initial recruitment, it is helpful to explore here the context of community based treatments, as its provision is less obvious than what we had foreseen. The National Institute for Health and Clinical Excellence (NICE, 2011) recommends community based treatment as first choice for the majority of the service users and the choice of treatment providers and intensity of treatment should be based on the severity of alcohol dependence. Whilst mild dependence could be treated in primary care, moderate/severe dependence

should be treated with a “structured intensive community based intervention” (NICE, 2011).

Assessment and diagnosis of alcohol dependence are based on levels of problematic drinking and alcohol intake, measured with the Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor & Grant, 1993), the Severity of Alcohol Dependence Questionnaire (SADQ; Stockwell, Murphy, & Hodgson, 1983), the Leeds Dependence Questionnaire (LDQ; Raistrick, Bradshaw, Tober, Weiner, Allison, & Healey, 1994) and the Alcohol Problems Questionnaire (APQ; Williams & Drummond, 1994). Service users reporting more than fifteen units a day or scoring twenty or higher on the AUDIT would be identified as needing further assessment for moderate/severe dependence. Once dependence is established, service users should be offered a community based withdrawal programme or, in case of concerns, a residential detoxification.

According to the guidelines, service users could be treated in the community even when they present with very poor social support, physical issues or psychiatric comorbidities. The community treatment implies contact with staff ranging from two up to seven days a week for one-to-three weeks, depending on the severity of the dependence and additional risk factors (NICE. 2011). Initially treatment consists of an assisted alcohol withdrawal, generally facilitated by the administration of benzodiazepines; the second part of the treatment can combine pharmacotherapy to reduce cravings – usually acamprosate or oral naltrexone – with psychological interventions, such as individual or group therapy, relapse prevention interventions and/or involvements of carers/family members. Such treatments should take place in residential settings when the service users are homeless. Recent reports from National Treatment Agency for Substance Misuse (2013) and from National Drug

Treatment monitoring System (NDTMS; 2013) indicated that in 2011-2012 the majority of patients presenting alcohol misuse (harmful drinking and dependence) were treated through psychosocial interventions (likely to include information giving and motivational interviews in primary care). However, pharmacological interventions (generally prescribed by community based alcohol services) and rehabilitations in inpatient settings were respectively received by 11% and 10% of the population presenting with alcohol misuse. These statistics show that, in spite of the NICE guidelines, individuals diagnosed with alcohol dependence are equally likely to receive community based treatments as inpatient ones.

During the recruitment process we were told that the inpatient treatments in some services outnumber those in the community. Residential rehabilitation, although more expensive and with limited evidence supporting its use (Raistrick, Heather, & Godfrey, 2006), seems to be preferred when service users present with health risks or are less likely to not comply with treatment in the community. Alcohol withdrawal is associated to a series of physical and psychological symptoms: anxiety, depression, fatigue, irritability, disturbed sleep, loss of appetite, nausea, vomiting, sweating and increased heart rate. These arise in the twelve hours following the last drinks and can continue for weeks once abstinence is achieved. However, the major risks related to the withdrawal phase are associated to the occurrence of seizures, delirium tremens and hallucinations. Withdrawal complications are more likely to be experienced by service users who have higher levels of dependence, present concomitant psychiatric or medical conditions such as sepsis, epilepsy, severe hepatic disease, head injury, pain and nutritional depletion (Myrick & Anton, 1997). When withdrawal is not properly managed, these seizures and delirium tremens can result in injuries and even death (Sarff & Gold, 2010).

The study design implied that in the services involved staff members would introduce the research project to potential participants and refer interested individuals to the research team. It was surprising to discover that not many people were actually completing a community based treatment, often because services tended to choose the safest option of inpatient detoxifications (Robert Hill, 2014, personal communication). It is possible to explain services' caution with a population of alcohol dependents that in London might differ from the general British population. In London, and especially in the south of the city, a large part of the service users treated appeared to belong to ethnic minorities, often presented with health issues and lived in isolation. These factors impacted on the number of outpatient detoxifications completed by the services but also on the eligibility of the service users to our study, as they did not meet our inclusion criteria. The most frequent reasons of exclusion were psychotic diagnoses (schizophrenia and bipolar) and lack of fluency in English. In north London we were told that service users attending outpatient detox were more "functional", with full time jobs and did not tend to engage in post-withdrawal therapeutic intervention, such as groups or relapse prevention; henceforth they were also less motivated to take time off to participate to our study. Furthermore, not all service users who met our inclusion criteria were willing to participate, and our monetary compensation did not suffice to increase their motivation.

The other recruitment related issue concerned the nature of our testing sessions. We utilised two computerised tests – the Virtual Week and the R-SRC task- as main measures, aware that they required a basic computer literacy. However, during the tests it became apparent that some service users had never used a computer and were not able to complete the tests. We decided to include a minimum

level of computer literacy among our inclusion criteria to reduce the occurrence of such difficulties. Furthermore, the testing session involved neuropsychological measures and questionnaires, which elicited anxiety in participants with limited literacy skills. These difficulties prolonged the testing sessions to over two hours, with additional fatigue effects. Given the neuropsychological impairments often experienced by alcoholics, it was likely that the performance on tests administered in a long session was influenced by a decline in attention, concentration and potential anxiety.

With hindsight, we should have considered these factors and simplified the testing regime. However, the study represented the final project of two theses and thus combined two studies. This maximised benefits from the joint recruitment, and testing. Unfortunately, it also led to testing sessions which were tiring for the participants tested and discouraging for potential participants who were unable to attend sessions longer than two hours.

Besides the characteristics of our study, recruitment of alcohol dependent participants undergoing outpatient treatment is likely to be difficult for any researcher. It might have been helpful to survey the frequency of outpatient detoxifications to predict whether a reasonable sample size was achievable in the planned time-frame. Additionally, piloting the testing with a few service users could have helped in obtaining a more user friendly design and more reliable data.

3. Binge Drinking

The empirical paper focused on automatic motivational tendencies in a sample of young adults. Participants reported drinking levels sufficiently high to raise concerns for alcohol dependence, although none of them were help-seeking.

Their average scores on the AUDIT were above twenty, which indicated problematic drinking. We found only a limited difference in neuropsychological performance between this group and the controls, mainly in the domain of executive functions. Given that the young students were well-functioning and attending a prestigious university, the large amount of alcohol consumed can appear surprising.

I propose here an overview of the recent literature on drinking behaviours of young people, with a focus on binge drinking, as it can be informative on our participants' drinking patterns. It also suggests potential direction for future research, which could combine the identification of potential drinking pathways and motivational tendencies.

Alcohol consumption appears overall to be stable over recent years, especially for drinkers aged 16-24; however, 23% of men and 18% of women in this age group report regular binge-drinking, here defined as consuming the double of daily safe limit in one occasion – eight units for men and six for women (Lifestyle Statistics, Health and Social Care Information Centre, 2013).

The definition of binge drinking has been somehow controversial and it has often been based on three factors: quantity, frequency and time-frame.

Quantity refers in general to the amount of alcohol consumed in a single drinking episode. One of the oldest definitions identified a binge as a drinking session in which at least five alcoholic drinks are consumed (Cahala, Cisin, & Crossley, 1969; cited in Courtney & Polich, 2009). Such amounts were later lowered for women to four drinks to take into account a different metabolic rate (Wechsler, Davenport, Dowdall, Moeykens, & Castillo, 1994; cited in Courtney & Polich, 2009) and the ratio 5/4 drinks for males/females has been largely accepted.

Frequency is another factor to consider as indicative of a behavioural drinking pattern. Townshend and Duka (2005) proposed to use the Alcohol Use Questionnaire (AUQ; Mehrabian & Russel, 1978; Townshend & Duka, 2002) to calculate a Binge Drinking score, on the base of number of hourly drinks, number of alcohol intoxications over the previous six months and percentage of intoxication over the overall drinking episodes in the same period.

The last factor to take into account is time-frame, which is the length of time to observe in order to distinguish binge drinking from alcohol dependence. Different studies have proposed time frames ranging from a week (Kokavec & Crowe, 1999; cited in Courtney & Polich, 2009) up to a year (Cranford, McCabe, & Boyd, 2006; cited in Courtney & Polich, 2009). A period of six months seems to be the best compromise between a time that allows variety in drinking behaviours and yet maintains some reliability in the recollection of drinking behaviours (Hartley, Elsabagh, & File, 2004; Townshend & Duka, 2002, 2005; Weissenborn & Duka, 2003).

Binge drinking - large amounts of alcohol consumption followed by periods of abstinence - is comparable to repeated withdrawal from alcohol (Townshend & Duka, 2005). Such patterns seem to take a toll on neuropsychological functioning. In comparisons to abstainers, binge drinkers presented with impaired executive functions and episodic memory (Hartley et al., 2004), spatial working memory and pattern recognition (Weissenborn & Duka, 2003).

Effects of binge drinking on cognitive performance have been compared to the changes that normally occur with aging, especially in relation to the domain of executive functions (Sanhueza, Garcia Moreno, & Exposito, 2011). At the same time, there is also evidence that these effects are reversible; when comparing binge

drinking students to non-drinkers, the first group obtained lower scores on measures of episodic working memory and response monitoring, yet the binge drinkers who gave up binge drinking performed returned to normal cognitive performance when re-tested two years later (Mota et al., 2013).

There is a growing body of evidence that associates binge drinking with neurophysiological changes and highlights the vulnerability of the brain in the age in which binge drinking typically occur. However, these studies mainly compare binge drinkers to non-drinkers and structural changes in the brain could be attributed to the global alcohol intake rather than to binge drinking patterns (Petit, Muraige, Kornreich, Verbanck, & Campanella, 2013). In fact chronic alcoholics and binge drinkers share similar structural and functional neurological activities, with binge drinkers performing on average slightly better than alcoholics (Kokavec & Crowe, 1999; Petit et al., 2013). Only a few studies have compared heavy drinkers with different drinking patterns (binge drinkers versus regular drinkers) in terms of how those impact on neurological abilities and have provided evidence of binge drinking having more harmful consequences (Campanella et al., 2013; Muraige, Joassin, Speth, Modave, Philippot, & Campanella, 2012).

Binge drinking appears a drinking pattern more common among adolescents and young adults than among older drinkers, however no clear relationship has been established between binge drinking and later development of alcohol dependence (Petit et al., 2013). Although a few epidemiological studies have linked binge drinking in youth to an increased risk of alcohol abuse and dependence in adult life (Chassin, Pitts, & Prost, 2002; Viner & Taylor, 2007; all cited in Petit et al., 2013), the mechanisms underlying the increased risk have not been identified. Given the early effects of binge drinking on neurological domains, it might be possible to

hypothesise the presence of neurobiological mechanisms playing a role in the increased risk of alcohol dependence. Impaired inhibitory control has been identified as risk factor for alcohol abuse (Lopez-Caneda, 2012). It is possible that, in line with the incentive-sensitization theory (Robinson & Berridge, 1993, cited in Field, 2008), binge drinking reinforces the salience of alcohol-related cues and increases the craving for alcohol; as inhibitory control is impaired by binge drinking patterns (Petit et al., 2013), young drinkers might find more difficult to resist the urges of drinking and henceforth increase frequency and amount of alcohol intake in a vicious circle.

Automatic motivational tendencies seem able to predict drinking behaviours in adolescents when inhibitory control is low, however the study did not report sufficient information on drinking patterns (Peeters, Wiers, Monshouwer, Schoot, Janseen, & Vollebergh, 2012).

These findings confirm the utility of exploring the interaction between motivational tendencies and neuropsychological functions. However, it is interesting that whereas binge drinking should be further investigated, no valid measures of the construct are available. Townshend & Duka (2005) studied mood and cognitions in a population of young heavy drinkers; to identify the binge drinkers, they calculate a Binge Score on the basis of AUQs and selected the 33% of the sample with a highest Binge Score as binge drinkers and the 33% of the sample with the lowest Binge Score as controls. Such procedure could have been applied to our study but it would have also changed the final sample as Binge Score do not correlate to weekly alcohol intake (Townshend & Duka, 2005) and we preferred the AUDIT scores as index of problematic drinking. We calculated the Binge Drinking Score on the basis of the AUQ scores, however we could not classify the participants as binge drinkers as a clinical cut-off is not available. It appears evident that a lack of consensus of what

identifies binge drinkers limits this review and, more broadly, research on binge drinking. Different studies adopt different definitions, impacting comparisons among studies and generalisability of findings.

4. Conclusions and Recommendations

The first part of this section describes how difficulties encountered in the recruitment of participants forced the research team to change the initial design of our study and to investigate another population. On the basis of our experience, future research investigating alcohol dependent individuals should take into account a variety of pragmatic difficulties that can occur in the recruitment. Local cultures in the service involved and characteristics of the local population, in our case North and South London, can significantly affect the recruitment. More pragmatic issues such as nature of tests, length of testing session, potential confounding variables such performance anxiety and fatigue should be also considered.

The second part of the section explores the concept of binge drinking. An increasing number of studies have focused on such drinking patterns, yet researchers appear to have neglected the lack of agreement on what constitutes binge drinking. Additionally, as it mainly represents a drinking modality of a sub-group of young people and it is considered a potential risk factor for future alcohol problems, research would benefit from exploring further differential effects among different drinking patterns. In line with our investigation of motivational tendency, future research should further explore the relationships between approach tendencies and executive functions in people with alcohol use disorders, as these could have important clinical implications.

References

- Ambrose, M. L., Bowden, S. C., & Whelan, G. (2001). Working memory impairments in alcohol-dependent participants without clinical amnesia. *Alcoholism, Clinical and Experimental Research*, 25(2), 185–191.
- Babor, T. F., Higgins-Biddle, J. C., Saunders, J. B., & Monteiro, M. G. (2001). The alcohol use disorders identification test. *Guidelines for use in primary care*. Department of Mental Health and Substance Dependence, World Health Organization.
- Cahalan, D., Cisin, I. H., & Crossley, H. M. (1969). *American drinking practices: A national study of drinking behavior and attitudes*. New Brunswick, NJ: Rutgers Center of Alcohol Studies.
- Campanella, S., Peigneux, P., Petit, G., Lallemand, F., Saeremans, M., Noël, X., Metens, T., Nouali, M., De Tiege, X., De Witte, P., Ward, R., & Verbanck, P. (2013). Increased cortical activity in binge drinkers during working memory task: a preliminary assessment through a functional magnetic resonance imaging study. *PLoS One*, 8(4), e62260. Retrieved from <http://www.plosone.org>
- Chassin, L., Pitts, S. C., & Prost, J. (2002). Binge drinking trajectories from adolescence to emerging adulthood in a high-risk sample: predictors and substance abuse outcomes. *Journal of Consulting and Clinical Psychology*, 70(1), 67-78.
- Courtney, K. E., & Polich, J. (2009). Binge drinking in young adults: Data, definitions, and determinants. *Psychological Bulletin*, 135(1), 142-156.

- Ellis, J.A. & Freeman, J.E. (2008). Ten Years On: Realising Delayed Intentions. In Kliegel, M., McDaniel, M.A. & Einstein, G.O. (Eds.), *Prospective memory: cognitive, neuroscience, developmental, and applied perspectives*. (pp. 1-27). New York: Lawrence Erlbaum Associates.
- Griffiths, A., Hill, Morgan, C., Rendell, P. G., Karimi, K., Wanagaratne, S., & Curran, H. V. (2012). Prospective memory and future event simulation in individuals with alcohol dependence. *Addiction*, 107, 1809-1816.
- Hartley, D. E., Elsabagh, S., & File, S. E. (2004). Binge drinking and sex: Effects on mood and cognitive function in healthy young volunteers. *Pharmacology, Biochemistry and Behavior*, 78, 611–619.
- Houben, K., & Wiers, R. W. (2009). Response inhibition moderates the relationship between implicit associations and drinking behavior. *Alcoholism: Clinical and Experimental Research*, 33(4), 626-633.
- Kokavec, A., & Crowe, S. F. (1999). A comparison of cognitive performance in binge versus regular chronic alcohol misusers. *Alcohol and Alcoholism*, 34, 601–608.
- Kopera, M., Wojnar, M., Brower, K., Glass, J., Nowosad, I., Gmaj, B., & Szelenberger, W. (2012). Cognitive functions in abstinent alcohol-dependent patients. *Alcohol*, 46(7), 665-671.
- Lawrence, A. J., Luty, J., Bogdan, N. A., Sahakian, B. J., & Clark, L. (2009). Problem gamblers share deficits in impulsive decision-making with alcohol-dependent individuals. *Addiction*, 104(6), 1006–1015.
- Lifestyle Statistics, Health and Social Care Information Centre (2013). *Statistics on Alcohol: England, 2013*. Retrieved from:
<http://www.hscic.gov.uk/catalogue/PUB10932/alc-eng-2013-rep.pdf>

- López-Caneda, E., Cadaveira, F., Crego, A., Gómez-Suárez, A., Corral, M., Parada, M., Caamano-Isorna, F., & Rodríguez Holguín, S. (2012). Hyperactivation of right inferior frontal cortex in young binge drinkers during response inhibition: a follow-up study. *Addiction, 107*(10), 1796-1808.
- MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. *Psychological Bulletin, 109*(2), 163-203.
- Maurage, P., Joassin, F., Speth, A., Modave, J., Philippot, P., & Campanella, S. (2012). Cerebral effects of binge drinking: respective influences of global alcohol intake and consumption pattern. *Clinical Neurophysiology, 123*(5), 892-901.
- Mehrabian, A., & Russell, J. A. (1978). A questionnaire measure of habitual alcohol use. *Psychological Reports, 43*, 803–806.
- Mota, N., Parada, M., Crego, A., Doallo, S., Caamaño-Isorna, F., Rodríguez Holguín, S., Cadaveira, F., & Corral, M. (2013). Binge drinking trajectory and neuropsychological functioning among university students: A longitudinal study. *Drug and Alcohol Dependence, 133*(1), 108-114.
- Myrick, H., & Anton, R. F. (1997). Treatment of alcohol withdrawal. *Alcohol Health and Research World, 22*(1), 38-43.
- National Drug Treatment monitoring System (2013). *Alcohol Statistics from the National Drug Treatment monitoring System (NDTMS)*. Retrieved from <https://www.ndtms.net/Publications/downloads/alcohol1213statsreport.pdf>
- National Treatment Agency for Substance Misuse (2013), Alcohol Treatment in England 2011-12. Retrieved from <http://www.nta.nhs.uk/uploads/alcoholcommentary2013final.pdf>

- NICE (2011). *Alcohol-use disorders: diagnosis, assessment and management of harmful drinking and alcohol dependence*. Retrieved from <http://www.nice.org.uk/CG115>
- Noël, X., Van der Linden, M., Schmidt, N., Sferrazza, R., Hanak, C., Le Bon, O., De Mol, O., Kornreich, C., Pelc, I., & Verbanck, P. (2001). Supervisory attentional system in nonamnestic alcoholic men. *Archives of General Psychiatry*, *58*(12), 1152-1158.
- Oscar-Berman, M., Kirkley, S. M., Gansler, D. A., & Couture, A. (2004). Comparisons of Korsakoff and non-Korsakoff alcoholics on neuropsychological tests of prefrontal brain functioning. *Alcoholism, Clinical and Experimental Research*, *28*(4), 667–675.
- Peeters, M., Wiers, R. W., Monshouwer, K., Schoot, R., Janssen, T., & Vollebergh, W. A. (2012). Automatic processes in at-risk adolescents: the role of alcohol-approach tendencies and response inhibition in drinking behavior. *Addiction*, *107*(11), 1939-1946.
- Petit, G., Maurage, P., Kornreich, C., Verbanck, P., & Campanella, S. (2013). Binge drinking in adolescents: a review of neurophysiological and neuroimaging research. *Alcohol and Alcoholism*, *49*, 198-206.
- Pitel, A. L., Witkowski, T., Vabret, F., Guillery-Girard, B., Desgranges, B., Eustache, F., & Beaunieux, H. (2007). Effect of episodic and working memory impairments on semantic and cognitive procedural learning at alcohol treatment entry. *Alcoholism: Clinical and Experimental Research*, *31*(2), 238-248.
- Raistrick, D., Bradshaw, J., Tober, G., Weiner, J., Allison, J., & Healey, C. (1994). Development of the Leeds Dependence Questionnaire (LDQ): a questionnaire

to measure alcohol and opiate dependence in the context of a treatment evaluation package. *Addiction*, 89(5), 563-572.

Raistrick, D., Heather, N., & Godfrey, C. (2006). *Review of the Effectiveness of Treatment for Alcohol Problems*. London: National Treatment Agency for Substance Misuse.

Ratti, M. T., Bo, P., Giardini, A., & Soragna, D. (2002). Chronic alcoholism and the frontal lobe: Which executive functions are impaired? *Acta Neurologica Scandinavica*, 105(4), 276–281.

Rendell, P. G., & Craik, F. I. (2000). Virtual week and actual week: Age-related differences in prospective memory. *Applied Cognitive Psychology*, 14(7), 43-62.

Robinson, T. E., & Berridge, K. C. (1993). The neural basis of drug craving: An incentive-sensitization theory of addiction. *Brain Research Reviews*, 18, 247–291.

Sanhueza, C., García-Moreno, L. M., & Expósito, J. (2011). Weekend alcoholism in youth and neurocognitive aging. *Psicothema*, 23(2), 209-214.

Sarff, M., & Gold, J. A. (2010). Alcohol withdrawal syndromes in the intensive care unit. *Critical Care Medicine*, 38(9), S494-S501.

Spruyt, A., De Houwer, J., Tibboel, H., Verschuere, B., Crombez, G., Verbanck, P., Crombez, G., Verbanck, P., Hanak, C., Brevers, D., & Noël, X. (2013). On the predictive validity of automatically activated approach/avoidance tendencies in abstaining alcohol-dependent patients. *Drug and Alcohol Dependence*, 127(1), 81-86.

- Stockwell, T., Murphy, D., & Hodgson, R. (1983). The severity of alcohol dependence questionnaire: its use, reliability and validity. *British Journal of Addiction*, 78(2), 145-155.
- Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18(6), 643-662.
- Townshend, J. M., & Duka, T. (2002). Patterns of alcohol drinking in a population of young social drinkers: A comparison of questionnaire and diary measures. *Alcohol and Alcoholism*, 37, 187–192.
- Townshend, J. M., & Duka, T. (2005). Binge drinking, cognitive performance and mood in a population of young social drinkers. *Alcoholism: Clinical and Experimental Research*, 29, 317–325.
- Viner, R. M., & Taylor, B. (2007). Adult outcomes of binge drinking in adolescence: findings from a UK national birth cohort. *Journal of Epidemiology and Community Health*, 61(10), 902-907.
- Wechsler, H., Davenport, A., Dowdall, G., Moeykens, B., & Castillo, S. (1994). Health and behavioral consequences of binge drinking in college: A national survey of students at 140 campuses. *Journal of the American Medical Association*, 272, 1672–1677.
- Weissenborn, R., & Duka, T. (2003). Acute alcohol effects on cognitive function in social drinkers: Their relationship to drinking habits. *Psychopharmacology*, 165, 306–312.
- Williams, B. T., & Drummond, D. C. (1994). The alcohol problems questionnaire: reliability and validity. *Drug and Alcohol Dependence*, 35(3), 239-243.

Zinn, S., Stein, R., & Swartzwelder, H. S. (2004). Executive functioning early in abstinence from alcohol. *Alcoholism, Clinical and Experimental Research*, 28(9), 1338–1346

Appendix A: Joint Project Information

This study was conducted as a joint research project with Bradley Platt, fellow UCL clinical psychology doctorate student.

Bradley's study investigated prospective memory, the ability to remember to perform intended actions in the future, and it used the Virtual Week as its main measure. The study also explored the effects of Future Event Simulation (FES), an imagery intervention, on the participants' prospective memory.

Both projects were supervised at UCL by Professor Val Curran and Dr Sunjeev Kamboj.

Joint work

The design of the empirical study.

Application for Ethical Approval.

Liaison with specialist alcohol services for recruitment.

Recruitment and testing of participants.

Independent Work

The literature review

Quantitative analysis and the write up of the empirical paper

Appendix B: Ethical Approval Letter



Professor Valerie Curran
Research Department of Clinical, Educational and Health Psychology
UCL

12 March 2014

Dear Professor Curran

Notification of Ethical Approval

Project ID: 5036/001: Prospective memory and cognitive bias in heavy drinkers

I am pleased to confirm that your study has been approved by the UCL Research Ethics Committee for the duration of the project i.e. until March 2015.

Approval is subject to the following conditions:

1. You must seek Chair's approval for proposed amendments to the research for which this approval has been given. Ethical approval is specific to this project and must not be treated as applicable to research of a similar nature. Each research project is reviewed separately and if there are significant changes to the research protocol you should seek confirmation of continued ethical approval by completing the 'Amendment Approval Request Form'.

The form identified above can be accessed by logging on to the ethics website homepage: <http://www.grad.ucl.ac.uk/ethics/> and clicking on the button marked 'Key Responsibilities of the Researcher Following Approval'.

2. It is your responsibility to report to the Committee any unanticipated problems or adverse events involving risks to participants or others. Both non-serious and serious adverse events must be reported.

Reporting Non-Serious Adverse Events

For non-serious adverse events you will need to inform Helen Dougal, Ethics Committee Administrator (ethics@ucl.ac.uk), within ten days of an adverse incident occurring and provide a full written report that should include any amendments to the participant information sheet and study protocol. The Chair or Vice-Chair of the Ethics Committee will confirm that the incident is non-serious and report to the Committee at the next meeting. The final view of the Committee will be communicated to you.

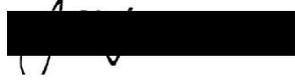
Reporting Serious Adverse Events

The Ethics Committee should be notified of all serious adverse events via the Ethics Committee Administrator immediately the incident occurs. Where the adverse incident is unexpected and serious, the Chair or Vice-Chair will decide whether the study should be terminated pending the opinion of an independent expert. The adverse event will be considered at the next Committee meeting and a decision will be made on the need to change the information leaflet and/or study protocol.

On completion of the research you must submit a brief report (a maximum of two sides of A4) of your findings/concluding comments to the Committee, which includes in particular issues relating to the ethical implications of the research.

With best wishes for the research.

Yours sincerely



Professor John Foreman
Chair of the UCL Research Ethics Committee

Cc:
Bradley Platt & Dr Sunjeev Kamboj, Applicants
Professor Peter Fonagy, Head of Department

UCL Research Ethics Committee, c/o The Graduate School, North Cloisters, Wilkins Building
University College London Gower Street London WC1E 6BT
Tel: +44 (0)20 7679 7844 Fax: +44 (0)20 7679 7043
ethics@ucl.ac.uk
www.ucl.ac.uk/gradschool

Appendix C: Information Sheets for Participants

PROSPECTIVE MEMORY AND COGNITIVE BIASES IN ALCOHOL DEPENDENCE

Participant Information Sheet

We would like to invite you to participate in this research study. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what it will involve. Please read the following information carefully and discuss it with others if you wish. If anything is unclear and you would like more information, please ask us. Your participation in this study is completely voluntary.

What is the purpose of the study?

Interventions for alcohol and drug use are effective at reducing people's alcohol and/or drug use during detoxification. Nevertheless, some people alcohol and/or drug use increases after they finish treatment. The reasons for relapse are not fully understood, but some researchers claim that it is related to people's thinking abilities. This study aims to examine the effects of alcohol and/or drug use on peoples' thinking abilities.

Why have you been chosen?

We are inviting people who have no history of being diagnosed with alcohol dependence or any substances other than nicotine, stroke or head trauma with loss of consciousness for more than 30 minutes, psychosis or learning disability. Unfortunately, you will not be able to participate if you have participated in one of the previous studies by our research group.

Do you have to take part?

No. It is up to you to decide whether or not to take part. In other words, your participation is voluntary. A decision to withdraw at any time will not affect the standard of your education. Even after agreeing to take part, you can withdraw yourself without giving any reason. You may withdraw your data from the project at any time up until it is transcribed for use in the final report.

What will happen to me if I take part?

If you do decide to take part, you will be given a copy of this information sheet to keep and will be asked to sign a consent form. Thereafter, a researcher will organise an appointment to meet with you.

At this appointment, you will be asked to complete a mixture of ten computer-based and paper-based tasks, and some questionnaires. This appointment will last approximately two hours, with one short break.

The tasks will assess your prospective (ability to remember something in the future) and episodic (ability to remember verbal information over short time interval) memory, attention and "executive function" (ability to initiate, plan and perform specific behaviours). The questionnaires will measure the severity of your alcohol use and any symptoms of depression and/or anxiety.

One of the computer-based tasks will assess your reactions towards alcohol related images. You will be shown different images on a laptop screen and will be instructed to respond to the images by pressing buttons on the keyboard.

To attend the appointment, you need to abstain from any alcohol, narcotic, benzodiazepine or illicit substance use for the previous 24 hours (you can ask the researchers for further clarification). You will be expected to give a breathalyzer reading on the day of testing.

After three months, we will contact you via phone and ask you about your drug and alcohol use over the past three months. Seeking to gain accurate records of data, these telephone interviews will be audio-recorded. If you like, you can attend an optional face to face interview.

Expenses and Payment

By taking part in this research, you will contribute to a better understanding about the treatment of alcohol dependence. As a thank you for your participation, you will be paid between £12 and £18 (£6 per hour) at the end of the testing session.

What are the risks of taking part in this research?

There are very minimal risks to taking part in this study. Both during and after your appointment, you may feel upset and experience urges to use alcohol or concerns about your cognitive abilities. Please share your concerns with the researcher, your healthcare worker or general practitioner, who will be able to help.

At any point, you are free to complain about the way you have been approached or treated by members of staff or researchers, and the nature of the research project. Please use the National Health Service or University College London complaint mechanisms about your concerns. For independent advice and support you can contact Camden and Islington Advice and Complaints Service (was PALS), which offers help, support, information and advice to patients and their relatives, friends and carers. Their contact details can be found at the end of this document.

In the unlikely event that you are harmed by taking part in this study, compensation may be available. If you suspect that the harm is the result of negligence on the part of the Sponsor (University College London), then you may be able to claim compensation. Please make the claim in writing to Professor Valerie Curran, who is the principal researcher for this study and is based at University College London. Professor Valerie Curran will then pass the claim to the University College London's insurers. You may have to bear the costs of the legal action initially, and you should consult a lawyer about this

Will my taking part in this study be confidential?

In compliance with the Data Protection Act 1998, the researchers will record, process and store confidential information in a fashion designed to avoid inadvertent disclosure. Nevertheless, the researchers will need to breach confidentiality when there appears sufficient evidence to raise serious concern about the healthcare, welfare or safety of you, children or vulnerable adults

Your GP will also be notified of your participation in this study with your consent.

What will happen to the results of the research?

The results of the study will be retained and written up as part of Doctoral research conducted at University College London (UCL). The UCL Records Office maintains archived records in a safe and secure off site location. Access to stored records is strictly controlled. The results could also be published in a journal. Any publication will uphold confidentiality and anonymity. If you provide consent, you will be sent a copy of the publication and a summary of the findings.

If you are interested in taking part in this research:

- Please contact the researcher Bradley Platt or Tommaso Italiano via telephone or email

Mr. Bradley Platt

Trainee Clinical Psychologist

Research Department of Clinical, Educational & Health Psychology

University College London, 1-19 Torrington Place, London WC1E 7HB

Email: [REDACTED], Phone: [REDACTED]

Mr. Tommaso Italiano

Trainee Clinical Psychologist

Research Department of Clinical, Educational & Health Psychology

University College London, 1-19 Torrington Place, London WC1E 7HB

Email: [REDACTED], Phone: [REDACTED]

Professor Valerie Curran

Research Department of Clinical, Educational & Health Psychology

University College London, 1-19 Torrington Place, London WC1E 7HB

Email: v.curran@ucl.ac.uk, Phone: 020 7679 1898, Fax : 020 7916 1989

Appendix D: Consent Form for Participants

INFORMED CONSENT FORM

Title of Project: Prospective memory and cognitive bias in heavy drinkers

This study has been approved by the UCL Research Ethics Committee:

Please tick each box once you have read it.

I confirm that I have read and understood the subject information sheet for the above study	
I have had the opportunity to ask questions about the study, which have been fully answered to my satisfaction	
I understand that if I decide at any time that I no longer wish to take part in this project, I can notify the researchers involved and withdraw immediately	
I understand that the interview at the end of the programme will be recorded	
I give permission for the researchers to process my personal information for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.	
I agree to take part in the above study.	
I confirm that I will have not used alcohol, narcotics, benzodiazepines and any illicit substances in the 24 hours prior to the testing session.	
I understand that I can withdraw my data from the project at any time up until it is transcribed for use in the final report or a scientific publication	
I agree to give a breathalyzer reading before completing the research tasks and questionnaires	
I agree to my telephone conversations to be audio-recorded for the purposes of data collection	
I understand that I must not take part in this study, if I have taken part in a previous study in the Clinical Psychopharmacology unit	
I understand that the information I have submitted will be published as a report and I will be sent a copy. Confidentiality and anonymity will be maintained and it will not be possible to identify me from any publications.	
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 be contacted in the future by UCL researchers who would like to invite me to participate in follow-up studies	

Participant Name	Signature	Date
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Researcher taking Consent	Signature	Date
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