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1 ***Cognitive barriers to readiness to change in alcohol-dependent patients***

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15

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22 otherwise.

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1 **Abstract**

2

3 **Background**

4 Patients' personal investment and readiness to change have proved to be a prerequisite for the
5 successful treatment of alcohol addiction. The aim of this study was to determine the
6 contribution of cognitive functions to the motivation process to abandon maladjusted
7 behaviour in favour of a healthier lifestyle.

8 **Methods**

9 An adapted version of the 'readiness to change' questionnaire was completed by 31 alcohol-
10 dependent patients after detoxification and at alcohol treatment entry. This tool is designed to
11 assess the three main stages of motivation to change regarding alcohol consumption:
12 precontemplation (substance abuse and no intention to stop drinking), contemplation (strong
13 intention to change habits but ambivalent behaviour) and action (cessation of excessive
14 alcohol consumption and behavioural changes for healthier habits) stages. Patients and 37
15 healthy controls also underwent an extensive neuropsychological battery including episodic
16 memory, metamemory, executive functions and decision-making assessment.

17 **Results**

18 When alcohol-dependent patients were considered as a group, the mean score on the action
19 subscale was significantly higher than the precontemplation and contemplation ones.
20 Nevertheless, when the stage of change reached by each patient was considered individually,
21 we found that some alcohol-dependent patients were still in the earlier precontemplation and
22 contemplation stages. Stepwise regression analysis revealed links between impaired memory
23 and executive functions and low motivation, and between good decision-making skills and
24 high motivation.

25

1 **Conclusions**

2 Our results suggest that a set of complementary cognitive abilities is needed to achieve
3 awareness and resolve ambivalence towards alcohol addiction, which is essential for
4 activating the desire to change problematic behaviour.

5 **Keywords:** Alcohol dependence; Motivation; Episodic memory; Metamemory; Executive
6 functions; Decision-making

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1 **1. Introduction**

2 The psychological treatment of excessive alcohol consumption requires the initiation
3 and development of intrinsic motivation to change addictive behaviour. This can be achieved
4 through motivational interviewing, a client-centered and directive therapeutic style that helps
5 patients to explore and resolve their ambivalence to enhance their desire to change their
6 behaviour (Hettema et al., 2005; Miller and Rose, 2009). High motivation is the key to
7 patients' engagement in clinical treatment (DiClemente et al., 1999). Prochaska and
8 DiClemente's 'stages of change' (Prochaska and DiClemente, 1983; DiClemente, 2007)
9 model comprises different stages of motivation, including 'precontemplation' (substance
10 abuse and no intention of stopping drinking), 'contemplation' (strong intention of changing
11 addictive habits but ambivalent attitude) and 'action' (cessation of excessive alcohol
12 consumption and adoption of previously envisaged healthier lifestyle). To progress through
13 the different stages and adopt permanent and sustainable healthier behavioural changes,
14 patients must implement processes of change, which are covert and overt activities and
15 experiences in which individuals engage in order to attempt to modify risky behaviour such as
16 consciousness raising (increasing information about unhealthy drinking behaviour) and
17 dramatic relief (experiencing and expressing feelings about drinking behaviour). It is well
18 known to clinicians that alcohol-dependent patients who seek treatment can be at different
19 levels of motivation, some of them being ready to change behaviour and others being still
20 ambivalent and resistant to modify their unhealthy habits (e.g., Carney and Kivlahan, 1995;
21 DiClemente and Hughes, 1990; Edens and Willoughby, 2000). This heterogeneity in
22 motivational level at treatment entry could be explained by personal and contextual factors
23 including demographic variables, perceived stress, perceived severity of alcohol dependence
24 and reported drinking consequences, psychiatric comorbidity, environmental quality of life
25 and positive treatment outcome expectancies (DiClemente et al., 2009); In addition to these

1 previous findings, the contribution of cognitive functions to motivation to change should be
2 also investigated.

3 Even though efficient cognitive functioning would appear to promote abstinence, the
4 results in the literature are heterogenous. Some investigations have reported that poor
5 cognitive functioning may be predictive of difficulty in maintaining long-term abstinence
6 from alcohol (Abbott and Gregson, 1981; Allsop et al., 2000; Glenn and Parsons, 1991;
7 Gregson and Taylor, 1977; Miller, 1991; Noel et al. 2002; Parsons, 1994; Parsons et al., 1990;
8 Rourke and Grant, 1999), while others have failed to find any such link (Donovan et al., 1984;
9 Jin et al., 1998; Macciocchi et al., 1989; Moriyama et al., 2002; Pitel et al., 2009). However,
10 cognitive impairments could indirectly influence clinical outcomes (abstinence or relapse) by
11 affecting the influence of readiness to change, as several studies have highlighted a strong
12 relationship between motivation to change and drinking outcome (Penberthy et al., 2007;
13 Project MATCH Research Group, 1997, 1998). While several studies have investigated a
14 potential association between cognitive functioning and treatment outcome (abstinence or
15 relapse), few researchers have considered the relationships between cognitive functioning and
16 motivation to change. Intellectual functioning, memory and executive skills have predicted
17 greater motivation to change substance use including alcohol use among people with severe
18 co-occurring mental disorders (Blume et al., 1999) and among college students with drinking
19 problems (Blume et al., 2000). In addition, Severtson et al. (2010) demonstrated an
20 association between executive functioning and motivation to enter treatment among regular
21 users of heroin and/or cocaine. Although episodic memory (Fama et al., 2004; Pitel et al.,
22 2007), executive functions (Sullivan et al., 2000; Moselhy et al., 2001; Pitel et al., 2007),
23 metamemory (Le Berre et al., 2010) and decision-making (Goudriaan et al., 2005; Noel et al.,
24 2007) are all known to be impaired in alcohol-dependent patients, only one study (Blume et
25 al., 2005) examined the relationships between episodic memory, executive functions and the

1 readiness to change drinking behaviour, as assessed by the ‘readiness to change’
2 questionnaire (RTC, Rollnick et al., 1992), in alcohol-dependent patients who met either the
3 criteria for alcohol abuse or dependence but were not in treatment. This preliminary study
4 revealed links between motivation stages and verbal memory scores but did not show a
5 relationship with executive abilities, in accordance with another study conducted within the
6 same clinical population (Blume et al., 2009), Further studies are now required to determine
7 the specific memory components (learning, encoding, retrieval or recollection) which might
8 be associated with readiness to change .in alcohol-dependent patients at treatment entry.

9 The aim of the present study was therefore to define the cognitive factors that might, at
10 least partially, predict the motivational evolution to change drinking behaviour. To this end,
11 we measured motivation with the RTC and assessed a range of neuropsychological functions,
12 including episodic memory and executive functions and higher level cognitive functions such
13 as metamemory and decision making.

14

15 **2. Materials and Methods**

16 **2.1. Participants**

17 Two groups of participants were included in this study: 31 chronic alcohol-dependent
18 patients (mean age: 43.9 ± 7 years; range: 31-56) and 37 controls (mean age: 45.5 ± 6.1 years;
19 range: 31-60) matched for age and education. There were 25 men in the control group and 26
20 men in the alcohol-dependent group. Alcohol-dependent patients were early in abstinence
21 from alcohol (mean days of sobriety before inclusion: 12.64 ± 7.16 ; range: 7-40).

22 Age, education level and Mini Mental State Examination (MMSE, Folstein et al.,
23 1975), depression level and anxiety level scores are summarized in Table 1.

24 Performances on the MMSE were significantly poorer in the chronic alcohol-
25 dependent patients than in the controls. The depression level, measured with the self-

1 administered Beck Depression Inventory (BDI, Beck et al., 1961), was higher in the alcohol-
2 dependent group than in the control group. Similarly, anxiety, measured with the State-Trait
3 Anxiety Inventory (STAI, Spielberger et al., 1983), was higher in the alcohol-dependent
4 group. Demographic and clinical data for patients and controls are summarized in Table 1.

5 *Insert Table 1*

6 Alcohol-dependent participants were recruited by clinicians on the basis of the DSM-
7 IV criteria for alcohol dependence (American Psychiatric Association, 1994) while they were
8 receiving treatment for alcohol dependence as in-patients at Caen University Hospital.
9 Patients had no history of other types of substance dependence (except tobacco), and they had
10 already completed detoxification when they were included in the study. They were
11 interviewed to constitute a review of their alcohol use history and typical use patterns prior to
12 treatment including the length of alcohol-dependence and their usual daily alcohol intake over
13 the six months prior to treatment (Table 1). None of the participants was taking psychotropic
14 medication, displayed psychiatric problems or had any history of pathology (head injury,
15 coma, epilepsy, Wernicke's encephalopathy, cirrhosis or depression) that might have affected
16 their cognitive functions. Control participants were interviewed to confirm they did not drink
17 more than 21 (men) or 14 (women) weekly standard drinks and no more than four at a time
18 (World Health Organization criteria). Prior to inclusion, all the participants filled in a health
19 questionnaire including questions about alcohol and drug consumption. None of the controls
20 had a history of drug abuse. All the participants gave their informed consent to the study,
21 which was approved by the local ethics committee.

22

23

1 **2.2. Materials and procedure**

2 **2.2.1. ‘Readiness to change’ (RTC) questionnaire**

3 We used an adapted version of the RTC (Rollnick et al., 1992) self-report questionnaire to
4 assess motivation and readiness to change alcohol abuse behaviour. Based on the stages of
5 change model (Prochaska and DiClemente, 1983), it is made up of 12 questions divided into
6 three subscales, each corresponding to a stage of change (4 questions per subscale). These
7 three subscales correspond to the precontemplation stage (“It’s a waste of time thinking about
8 my drinking”), the contemplation stage (“I enjoy my drinking but sometimes I drink too
9 much”) and the action stage (“Anyone can talk about wanting to do something about their
10 drinking but I am actually doing something about it”). Patients were asked to rate their
11 agreement with statements about their alcohol consumption on a 5-point Likert-type scale
12 ranging from ‘strongly disagree’ (-2) to ‘strongly agree’ (+2). We took the patients’ scores on
13 each subscale (ranging from -8 to 8) as our variables. The subscale with the highest score
14 indicated which motivational stage the patient had reached at the time of the testing. When
15 two or more subscale scores were equal, we considered that the scale farthest along the
16 continuum of change (precontemplation-contemplation-action) represented the patient’s stage
17 of change. The interpretation of the motivation measures must be done as follow. A higher
18 score on action subscale than on precontemplation and contemplation subscales refers to high
19 level of motivation. Inversely, a higher score on precontemplation and contemplation
20 subscales than on action subscale refers to low level of motivation

21 **2.2.2. Neuropsychological assessments** (a description of each task is provided in the online Table SM1)

22 **Episodic memory**

23 We assessed episodic memory with the Free and Cued Selective Reminding Test
24 (FCSRT) (Grober and Buschke, 1987; Grober et al., 1988) for verbal learning abilities. The
25 state of consciousness associated with memories, together with encoding and retrieval skills,

1 was measured with the Spondee test (Pitel et al., 2007), which includes the Remember-Know
2 paradigm (Gardiner et al., 2002).

3 **Metamemory**

4 We assessed metamemory with the “Feeling-of-Knowing” (FOK) task (Pinon et al.,
5 2005; Le Berre et al., 2010). After learning 20 cue-target pairs and prior to a recognition task,
6 participants were asked to say whether they thought they would recognize the target
7 afterwards. An episodic FOK accuracy measure was then calculated (Goodman-Kruskal
8 gamma, Nelson, 1984) to assess the agreement between predicted and actual recognition
9 performance.

10 **Executive functions and decision-making**

11 We assessed executive functions with a verbal fluency task (Cardebat et al., 1990;
12 adapted version by the Groupe de Réflexion pour l’Evaluation des Fonctions EXécutives
13 (GREFEX), Godefroy O, 2001) for spontaneous flexibility abilities and strategic search in
14 memory, the Trail-Making Test (Reitan, 1958; adapted GREFEX version) Part B for reactive
15 flexibility, the Stroop test (Stroop, 1935; adapted GREFEX version) for inhibition, the
16 Hayling test (Burgess and Shallice, 1996; French adapted version by Meulemans et al., 2001)
17 for semantic inhibition, the Modified Card Sorting Test (MCST) (Nelson, 1976; adapted
18 GREFEX version) for cognitive flexibility, working memory, problem-solving and set-
19 shifting abilities, and the Iowa Gambling Task (Bechara et al., 1994) for decision-making.
20 These are well-established tests and detailed descriptions of them are widely available (Lezak
21 et al., 2004).

22 **2.3. Statistical analysis**

23 We analysed the data in four steps. First, we conducted a group analysis to describe
24 the motivational features of the alcohol-dependent group as a whole, applying a paired-
25 samples *t*-test to the three RTC subscale scores. In addition, we analysed individual

1 motivation profiles to find out which stage of change each patient was, according to the RTC
2 subscale with the highest score. Second, we investigated the effects of alcohol-dependence on
3 episodic memory, metamemory, executive functions and decision-making skills, using an
4 unpaired two-sample *t*-test. Third, in order to identify the potential effect of confounding
5 factors (age, education, drinking history MMSE score and anxiety or depression levels), we
6 calculated Pearson's correlation coefficients in the alcohol-dependent group between these
7 factors and each motivation subscale score. Factors identified as being significantly correlated
8 ($p < .05$) with motivational data were included as covariates in a subsequent stepwise
9 regression analysis. Fourth, a stepwise regression analysis was carried out in the alcohol-
10 dependent group to examine the best cognitive predictors of each RTC subscale score among
11 episodic memory, metamemory, executive and decision-making scores. A probability level of
12 .05 was adopted for all analyses.

13

14 **3. Results**

15 **3.1. Readiness to change**

16 *Group analysis:* The mean score on the action stage subscale was higher than the mean scores
17 on both the precontemplation, $t(30) = -11.01, p < 0.001$, and contemplation stage subscales,
18 $t(30) = -4.18, p < 0.001$ (Table 2).

19 *Insert Table 2*

20 *Individual analyses:* 21 alcohol-dependent patients scored highest on the action subscale, nine
21 on the contemplation subscale and one on the precontemplation subscale.

22 **3.2. Effects of alcohol-dependence on episodic memory, metamemory, executive** 23 **functions and decision-making faculties**

24 Results revealed that alcohol-dependent patients performed more poorly than controls
25 on all the verbal episodic memory tasks (learning, encoding, retrieval and recollection), as

1 well as on the metamemory measure, the executive tasks (reactive flexibility, inhibition,
2 cognitive flexibility, working memory, problem-solving and set-shifting) and the decision-
3 making measure. Data are summarized in Table 3.

4 *Insert Table 3*

5 **3.3. Confounding variables**

6 As age, education, MMSE scores, psychiatric scores and drinking variables did not
7 correlate with the precontemplation and contemplation subscale scores in the alcohol-
8 dependent group, these variables were not included in the stepwise regression analyses for
9 these stages. Only alcohol intake was entered as a covariate in the stepwise regression
10 analysis conducted with the action stage score, as this drinking variable was significantly
11 correlated with it ($r = -0.40$, $p = 0.03$). Detailed results of the correlations are provided in
12 Table 4.

13 *Insert Table 4*

14 **3.4. Cognitive predictors of readiness to change**

15 *Precontemplation subscale:* The only cognitive predictor for the precontemplation
16 subscale score was the level of consciousness associated with recollection (mean percentage
17 of 'Remember' answers), which accounted for 20% of the variance. A lower state of
18 consciousness significantly predicted higher precontemplation subscale scores ($r = -0.44$, $p =$
19 0.01) (Fig. 1A and Table 5).

20 *Contemplation subscale:* In the first step, 23% of the variance in contemplation
21 subscale score was account for by the time spent on the Stroop interference task. The second
22 cognitive predictor making a significant contribution to contemplation subscale score was the
23 number of errors for the Modified Card Sorting Test (MCST) (accounting for 15% of the
24 variance). Higher Stroop Color-Word time score and higher MCST number of errors scores

1 significantly predicted higher contemplation subscale scores ($r = 0.48, p = 0.006$] and [$r =$
2 $0.46, p = 0.01$] respectively) (Figure 1B and Table 5).

3 *Action subscale:* The only cognitive predictor for the action subscale score was the
4 decision-making measure, which accounted for 19% of the variance. Higher decision-making
5 scores significantly predicted higher action subscale scores ($r = 0.43, p = 0.01$) (Fig. 1C and
6 Table 5).

7 *Insert Fig. 1 and Table 5*

8

9 **4. Discussion**

10 The main objective of our study was to improve our understanding of how cognitive
11 abilities are involved in the motivation to change addictive behaviour. More specifically, we
12 investigated the basic and higher-level cognitive functions that are known to be impaired in
13 alcohol-dependence to explain – at least in part - why some patients have difficulty shifting
14 from a low level of motivation to a high level of motivation. To this end, we focused our
15 attention on the effect of episodic memory, metamemory, executive function and decision-
16 making abilities on motivation in alcohol-dependent patients early in abstinence and at
17 clinical treatment entry.

18 Concerning readiness to change for the alcohol-dependent group as a whole, the mean
19 score on the action subscale was significantly higher than the precontemplation and
20 contemplation mean scores. This observation is not surprising, given that those patients were
21 at alcohol treatment entry. Nevertheless, when we adopted a more qualitative approach,
22 investigating the stage of change reached by each individual patient, we found that some
23 patients were still in the earlier precontemplation and contemplation stages. This finding is in
24 accordance with clinical observation that not every patient is highly motivated to change at
25 treatment entry (e.g., Carney and Kivlahan, 1995; DiClemente and Hughes, 1990; Edens and

1 Willoughby, 2000). Moreover, alcohol-dependent patients performed more poorly than
2 controls on the cognitive tasks, in agreement with previous studies showing episodic memory
3 impairment (Beatty et al., 1995; Fama et al., 2004; Goldstein et al., 2004; Pitel et al., 2007),
4 executive dysfunction (Fama et al., 2004; Noel et al., 2001; Pitel et al., 2007; Tedstone et
5 Coyle, 2004), metamemory decline (Le Berre et al., 2010) and decision-making deficit
6 (Goudriaan et al., 2005; Noel et al., 2007) in these patients. Our results also revealed a
7 relationship between verbal episodic memory impairment, more specifically a deficit of
8 conscious recollection (Pitel et al., 2007), and high precontemplation scores, as well as
9 relationships between weak executive performances and high contemplation scores, and
10 between good decision-making skills and high action scores.

11 These findings suggest that patients with higher episodic memory abilities would have
12 greater intention of changing their high-risk behaviour in the near future. More particularly,
13 our data showed an association with a specific episodic memory score: the ‘R answers’. This
14 measure refers to conscious recollection involving retrieval of a personal event and features
15 about its encoding context (Gardiner et al., 2002). We can assume that higher episodic
16 memory functioning promotes patients’ engagement in the ‘consciousness-raising’ process.
17 This hypothesis is supported by the findings of Blume et al. (2005) suggesting that intact
18 verbal memory performance favours awareness of difficulties arising from alcohol
19 consumption. ‘Consciousness-raising’ refers to an increase in the level of awareness about the
20 origins, consequences and treatment possibilities of inappropriate behaviour such as excessive
21 alcohol consumption. It is achieved when patients are able to access information about
22 alcohol-dependence to supplement their own knowledge about their disease.

23 Moreover, during the contemplation stage, patients need to complete a ‘decisional
24 balance’ (Janis and Mann, 1977) evaluating the perceived advantages and disadvantages of
25 consuming alcohol or quitting drinking. This ‘decisional balance’ enables them move on to

1 the next stages of change. Alcohol-dependent patients are ambivalent and oscillate between
2 their impulsive ‘limbic’ behaviour and more controlled behaviour subtended by frontal lobe
3 activity (Crews and Boettiger, 2009). Our study revealed that patients with lower motivation
4 to change also had lower executive functioning including deficits of inhibition, mental
5 flexibility, problem-solving and rule abstraction. These findings suggest that efficient
6 executive functioning is necessary to go through “decisional balance”.

7 Finally, our statistical analysis demonstrated a relationship between higher decision-
8 making abilities and higher action stage scores. This observation could imply that patients
9 early in abstinence who have problems making decisions (Noel et al., 2007) experience
10 greater difficulty resolving decisional balance and moving towards a strong desire for change.
11 They must hone their decision-making faculties in order to detect risks related to alcohol in
12 the everyday life situations. They also have to glean information about causes and outcomes
13 from past experiences and project themselves into the future. However, some patients who are
14 addicted to alcohol or other substances and who have decision-making disorders may have
15 difficulty anticipating the future. They prefer choices that bring an immediate benefit, even if
16 they are harmful in the long term (loss of work and family or social deterioration) (Bechara et
17 al., 2001; Bechara et al., 2002; Goudriaan et al., 2005; Noel et al., 2007).

18 To sum up, cognitive performance may predict the level of motivation of alcohol-
19 dependent patients at treatment entry and must be taken into account in clinical decisions.

20

21 *Clinical implications and limitations*

22 High cognitive functioning including efficient episodic memory, executive functions
23 and decision-making abilities seems essential to enhance readiness to change drinking
24 behaviour. The neuropsychological screening of possible cognitive impairments may prove to
25 be extremely useful at alcohol treatment entry and have to be taken into account to make

1 relevant clinical decisions and choose the most appropriate treatment according to the
2 patients' level of motivation. As a consequence of their cognitive deficits, some alcohol-
3 dependent patients may not be able to undergo the standard treatment in an addictology
4 department because of their low motivation. In alcohol-dependence, several studies have
5 shown that cognitive disorders are at least partly reversible with abstinence (Rourke and
6 Grant, 1999; Pitel et al., 2009). Therefore, once patients have physically completed
7 detoxification, it may be a good idea to favour the neuropsychological recovery of those who
8 display cognitive deficits by extending the period they spend without alcohol (e.g., in-patient
9 follow-up rehabilitation) before being admitted to the addictology department. It would also
10 be interesting to promote spontaneous neuropsychological recovery by using rehabilitation
11 techniques used with brain-injured patients.

12 One of the limitations of this study is that it was carried out with a very particular
13 sample of alcohol-dependent patients, as our aim was to explore readiness to change at a
14 specific point in the clinical course of alcohol dependence (i.e., at alcohol treatment entry,
15 early in abstinence). Although we are sure that cognitive performance was not influenced by
16 acute alcohol consumption, our findings cannot, nevertheless, be extended to the general
17 clinical population of alcohol-dependent patients. Therefore, other studies are needed to
18 provide information about the link between motivation and cognitive skills in patients with
19 alcohol abuse or dependence who are not receiving clinical treatment and who continue to
20 drink alcohol. Another limitation is that as the gender distribution of our alcohol-dependent
21 group reflected the gender distribution that prevails in most alcohol treatment departments in
22 France, our results are mainly representative of alcohol-dependent men. Moreover, although
23 the lack of motivation could partly be explained by cognitive impairment, the move towards
24 higher readiness to change relies on many processes of change which, in turn, rely not only on
25 higher-level cognitive functions but also on emotional and social skills including theory of

1 mind, empathy and self. Further studies are therefore needed to assess the possible
2 impairment of social cognition in alcohol-dependence and the latter's links – if any - with the
3 multidimensional phenomenon of motivation.

4

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4

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- 17

1 Figure Legend

2

3 Fig. 1. Scatterplot illustrating the relationship between (A) the Precontemplation subscale
4 score and the Recollection score (%); (B) the Contemplation subscale score and the inhibition
5 score (Stroop test Colour-Word time); and (C) the Action subscale score and the decision-
6 making measure in the alcohol-dependent group.

7

8

9

1 Table Legends

2 Table 1. Participants' main demographic and clinical features

3

4 Table 2. Patients' readiness to change

5

6 Table 3. Assessment of episodic memory, metamemory, executive functions and decision-
7 making in controls and alcohol-dependent patients

8

1 Table 1. Participants' main demographic and clinical features

	Controls (N = 37)	Alcohol-dependent patients (N = 31)	t	p value
Age	45.49 (6.07)	43.87 (6.97)	-1.02	0.31
Range	31-60	31-56		
Years of education	12.11 (3.56)	10.77 (2.14)	-1.82	0.07
Range	5-20	6-15		
MMSE	29.46 (0.77)	27.35 (1.68)	-6.81	0.001**
Beck Depression Inventory	1.54 (2.01)	7.68 (3.49)	/	0.001*
State-Trait Anxiety Inventory "State anxiety" (STAI Y-A)	29.22 (9.12)	33.84 (9.89)	/	0.05*
State-Trait Anxiety Inventory "Trait anxiety" (STAI Y-B)	33.22 (7.20)	50.77 (14.41)	/	0.001*
Days of sobriety before inclusion	/	12.64 (7.16)	/	/
Range	/	7-40	/	/
Years of alcohol-dependence	/	8.26 (8.26)	/	/
Range	/	0.5-33	/	/
Quantity per day (in units of alcohol)	/	21.95 (11.70)	/	/
Range	/	3.5-53.57	/	/

2 Data are shown as means (standard deviation).

3 ** Significant difference between alcohol-dependent patients and controls ($p < 0.05$) for unpaired parametric
4 Student's paired *t*-test

5 * Significant difference between alcohol-dependent patients and controls ($p < 0.05$) for nonparametric

6 Kolmogorov-Smirnov test

7

1 Table 2. Patients' readiness to change

Precontemplation subscale score	-2.13 (3.40)
Range	-8-5
Contemplation subscale score	1.03 (5.28)
Range	-8-8
Action subscale score	5.35 (2.83)
Range	-4-8

2 Data are shown as means (standard deviation).

3

1 Table 3. Assessment of episodic memory, metamemory, executive functions and decision-
 2 making in controls and alcohol-dependent patients

	Tasks	Controls	Alcohol-dependent patients	<i>t</i>	<i>p</i> value
Verbal Episodic Memory					
Learning	sum of the three free recall scores, FCSRT	21.07 (4.98)	30.03 (5.01)	-4.29	0.001*
Encoding	recognition in the 'spontaneous' condition, Spondee test	0.86 (0.11)	0.77 (0.13)	-3.18	0.005*
Retrieval	free recall in the 'deep' condition, Spondee test	0.60 (0.16)	0.46 (0.18)	-3.08	0.005*
Recollection	R answers, Spondee test	0.77 (0.17)	0.66 (0.25)	-2.04	0.05*
Metamemory					
	FOK gamma correlation	0.25 (0.50)	-0.01 (0.54)	2.09	0.05*
Executive Functions					
Spontaneous flexibility	Verbal fluency	61.57 (12.28)	56.06 (14.95)	-1.67	0.10
	Stroop test Colour-Word time	98.27 (22.60)	115.13 (29.51)	2.66	0.01*
Inhibition	Stroop test Colour-Word errors	0.78 (1.16)	2.68 (3.65)	2.98	0.005*
	Hayling Part B time	64.76 (34.38)	76.39 (40.17)	1.29	0.20
	Hayling Part B penalties	6.67 (16.09)	7.77 (4.14)	0.40	0.71
Reactive flexibility	TMT B time	62.05 (20.50)	77.10 (34.51)	2.23	0.05*
	TMT B errors	0.24 (0.49)	3.77 (18.06)	1.19	0.24
Set-shifting	MCST time	268.24 (98.22)	357.81 (165.88)	2.76	0.01*
Problem-solving	MCST categories	5.73 (0.61)	4.93 (1.55)	-2.87	0.005*
Rule abstraction	MCST errors	5.51 (2.40)	11.06 (5.78)	2.94	0.005*
Decision-Making					
	Iowa Gambling Task	18.06 (26.33)	6.45 (17.81)	2.15	0.05*

3 Data are shown as means (standard deviation).

4 * Significant difference between alcohol-dependent patients and controls ($p < .05$) for unpaired parametric
 5 Student's *t*-test

6

- 1 Table 4. Correlations between age, years of education, MMSE, psychiatric data (BDI and
 2 STAI), drinking variables and ‘readiness to change’ subscales

	precontemplation subscale	contemplation subscale	action subscale
age	0.27	0.07	0.06
Years of education	-0.03	-0.16	0.01
MMSE	-0.06	-0.24	0.13
Beck Depression Inventory	0.27	0.02	-0.17
State-Trait Anxiety Inventory “State anxiety” (STAI Y-A)	0.17	0.03	0.04
State-Trait Anxiety Inventory “Trait anxiety” (STAI Y-B)	0.02	0.13	-0.24
Days of sobriety before inclusion	0.11	-0.15	0.09
Years of alcohol-dependence	0.02	0.03	-0.24
Quantity per day (in units of alcohol)	-0.14	-0.09	-0.40*

3 * p<0.05

4

1 Table 5. Cognitive predictors of ‘readiness to change’ subscale in alcohol-dependent patients

Dependent variable	Independent variable	β coefficient	Standard error of β	p value
precontemplation subscale	R answers	-0.44	0.17	0.013
contemplation subscale	Stroop test Colour-Word time	0.42	0.15	0.009
	MCST errors	0.39	0.15	0.015
action subscale	decision-making measure (Iowa Gambling Task)	0.43	0.17	0.015

2