Cognitive functioning after six months of follow-up in a sample of alcohol use disorder outpatients

Funcionamiento cognitivo después de seis meses de seguimiento en una muestra de pacientes ambulatorios con trastorno por uso de alcohol

Rocío Villa*, **, Ashkan Espandian***, Pilar A Sáiz*, **, ****, *****, Julia Rodríguez Revuelta*, **, ****, María Paz García-Portilla*, **, ****, *****, Julio Bobes*, **, ****, *****, Gerardo Flórez*****, ******.

* Mental Health Services of Principality of Asturias (SESPA), Spain.
** Institute of Health Research of Principality of Asturias (ISPA), Spain.
*** Psychiatry Service of the Bierzo Hospital. Mental Health Services of Castilla y León (SACYL), Spain.
**** Department of Psychiatry, University of Oviedo, Spain.
***** Biomedical Research Center in Mental Health Network (CIBERSAM), Spain.
****** Addictive Behavior Unit, Ourense University Hospital Complex, Spain.

Abstract

Until now, no follow-up studies had simultaneously evaluated executive functions, other non-executive functions related cognitive functions, and impulsivity in a large enough sample of moderate to severe alcohol use disorder (AUD) patients. The main objective of the present study was to compare neuropsychological performance and its relation to alcohol use in patients with AUD and healthy controls, and to determine the evolution of cognitive impairment and alcohol use over time. For this purpose, a 6-month follow-up study was designed to compare a sample of 100 outpatients with AUD (DSM-5 criteria) with 100 matched healthy controls. The patient group was recruited from three different health centres in Spain located in Orense, Gijón and Barcelona. The assessment consisted of a systematic battery of cognitive tests to evaluate the following functions: attention, anterograde memory, processing speed, verbal fluency, executive function, and implicit attitude toward alcoholic beverages. We also compared clinical variables associated with alcohol use, such as alcohol craving and impulsivity. After 6 months, anterograde memory, working memory, and resistance to interference improved remarkably in AUD patients, although not enough to match the normal population. With regard to clinical variables, there was a small but significant cognitive improvement related to a reduction in alcohol use and impulsivity. Executive dysfunction and other non-executive functions related cognitive functions impairment can be considered prognostic factors in outpatients with moderate to severe AUD.

Keywords: Alcohol use disorder; cognitive impairment; executive function; impulsivity; follow-up study.

Resumen

Hasta la fecha, ningún estudio de seguimiento había evaluado simultáneamente la función ejecutiva, otras funciones no ejecutivas relacionadas con funciones cognitivas y la impulsividad en una muestra suficientemente grande de pacientes con trastorno por uso de alcohol (TUA) entre moderado y grave. Este estudio tuvo como objetivo principal comparar el desempeño neuropsicológico y su relación con el uso de alcohol en pacientes con TUA y en controles sanos, y determinar la evolución del deterioro cognitivo y el uso de alcohol a largo plazo. Con este fin, se diseñó un estudio de seguimiento de seis meses para comparar una muestra de 100 pacientes ambulatorios con TUA (criterios del DSM-5) emparejados con 100 controles sanos. Los pacientes se reclutaron de tres centros sanitarios diferentes de España, Orense, Gijón y Barcelona. La evaluación consistió en una batería sistematizada de pruebas cognitivas para evaluar las siguientes funciones: atención, memoria anterógrada, velocidad de procesamiento, fluidez verbal, función ejecutiva y actitud implícita hacia bebidas alcohólicas. También se compararon variables clínicas asociadas al consumo de alcohol, como el *craving* y la impulsividad. Después de seis meses, la memoria anterógrada, memoria de trabajo y resistencia a la interferencia mejoraron notablemente en los pacientes con TUA, aunque no llegaron a igualar la población general. Respecto de las variables clínicas, hubo una pequeña pero significativa mejoría cognitiva relacionada con una reducción del consumo de alcohol y de la impulsividad. La disfunción ejecutiva y otras funciones no ejecutivas relacionadas con el deterioro cognitivo pueden considerarse factores pronósticos en pacientes ambulatorios con TUA entre moderado y grave.

Palabras clave: Trastorno por uso de alcohol; deterioro cognitivo; función ejecutiva; impulsividad; estudio de seguimiento.

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Send correspondence to:
Rocío Villa. Centro de Salud Mental I La Magdalena. C/ Valdés Salas nº 6, 33402 Avilés, Asturias, Spain.
Email: rociov2002@hotmail.com

It is commonly accepted that alcohol use disorder (AUD) is associated with cognitive deficits. AUD is often a long-term relapsing condition and tends to become a chronic disease (Breese, Shina & Heilig, 2011; Koob, Sanna & Bloom, 1998; Volkow & Li, 2005).

Even moderate levels of alcohol use are associated with adverse brain outcomes including hippocampal atrophy. This is one of the reasons why the recommended alcohol use limits are being lowered (Topiwala et al., 2017). Reducing global use in the population, delaying the onset of alcohol use, and insistence on treatment of those who already present alcohol abuse problems are fundamental actions (Florez, Espandian, Villa & Saiz, 2019).

Executive functions is an umbrella term encompassing a set of high-level control mechanisms mediating the ability to successfully regulate thoughts and behaviours in order to fulfil a goal (Dohle, Diel & Hofmann, 2018; Miyake & Friedman, 2012), adapt to novel everyday life situations, and manage social interactions (Cristofori, Cohen-Zimerman & Grafman, 2019).

AUD is associated with cognitive impairments, particularly in executive functions (Stephan et al., 2017). These deficits constitute an important factor in AUD, increasing relapse risk (Brion et al., 2017). Among the most commonly reported cognitive sequelae in AUD are deficits in hippocampal-related functions (Bartels et al., 2006) and frontal cortex dysfunction (Nowakowska-Domagala, Jablkowska-Górecka, Mokros, Koprowicz & Pietras, 2017).

Many studies have evaluated the effect of periods of alcohol abstinence on executive functions, but the duration of these periods is not clearly established. Short-term abstinence is usually considered to be from the first few days of detoxification to several months, and long-term abstinence from several months to one year or more (Bartsch et al., 2007; Nowakowska-Domagala et al., 2017; Stavro, Pelletier & Potvin, 2013; Zahr & Pfefferbaum, 2017). Recovery from alcohol dependence contributes to functional improvement in memory, visuospatial abilities, and attention (Crews et al., 2005; Sullivan, Rosenbloom, Lim & Pfefferbaum, 2000).

Even short-term sobriety has been found to be beneficial (Bartsch et al., 2007). Long-term abstinence is also associated with cognitive recovery in patients with cognitive impairments related to alcohol use. Improvement in cognitive functions is achieved only after a period of several months of abstinence. After one year of abstinence, cognitive enhancement is more remarkable, but even in this case, certain residual cognitive impairments may persist (Bernardin, Maheut-Bosser & Paille, 2014). It has been demonstrated that after long-term abstinence (two years), there is a slow recovery process, which may continue beyond the two years (Bartels et al., 2006).

Two meta-analyses have studied cognitive deficits in alcoholism, in samples of short- and long-term sober alcoholics. Stavro *et al.* (2013) noted that alcoholic patients had similar levels of neuropsychological deficits in several cognitive domains after one month and after one year of sobriety. A more recent meta-analysis came to the conclusion that cognitive deficits and especially memory functioning among recently detoxified alcoholics persisted even in long-term abstinent alcoholics (Crowe, Cammisuli & Stranks, 2019). It is generally accepted that certain deficits, such as frontal cortex dysfunctions affecting verbal and working memory and executive functions (Nowakowska-Domagala et al., 2017), can persist even with prolonged sobriety (Le Berre, Fama & Sullivan, 2017; Romero-Martínez, Vitoria-Estruch & Moya-Albiol, 2020).

In addition to cognitive dysfunction, patients with AUD have greater impulsivity and inability to plan (Villa et al., 2021). Impulsivity is a heterogeneous concept encompassing a variety of behaviours which can be defined as a predisposition to perform quick, unplanned actions, without considering potential negative consequences of these actions (Herman & Duka, 2019).

Impairment in cognitive abilities may lead to loss of self-control. Impulsivity is a symptom that reflects this lack of executive control, and it is a risk factor for alcohol addiction (Mujica-Parodi, Carlson, Cha & Rubin, 2014). People whose cognitive function is lower are more predisposed to lose control with alcohol. Acute alcohol use interferes with executive functions, and chronic abuse damages brain structures responsible for such executive functions, in both cases resulting in reduced cognitive control and increased risk of losing control (Draper, Karmel, Gibson, Peut & Anderson, 2011).

Until now, no follow-up studies had simultaneously evaluated executive functions, additional cognitive functions, and impulsivity in a large enough sample of moderate to severe alcohol use disorder patients. The aim of the study was two-fold (investigation of the evolution of EF, impulsivity and other cognitive functions throughout treatment AND investigation of the relationship between cognitive variables and clinical measures). So, the main objective of this study was to determine whether executive dysfunction and cognitive impairment in patients with moderate to severe alcohol use disorders can be considered a prognostic factor in outpatient treatment. Our hypothesis was that after 6 months of follow-up, although there would be at least partial recovery from these deficits, they will have become a prognostic factor. So, the patients who presented the strongest cognitive impairment would be the ones with the least improvement in their alcohol use.

Methods

Subjects

Two different groups of participants were recruited: 1) an alcohol use disorder (AUD) group (DSM-5 criteria for moderate to severe AUD) (n=100) and 2) a control

group of healthy volunteers (n=100). The drop-out rate between baseline and follow-up evaluation was 11 patients (n=111 at baseline), who did not attend the evaluation, refused to perform it or did not show commitment during treatment and therefore maintained the same level of consumption. The AUD group was recruited from three different health centres: The Addictive Behavior Unit of the Psychiatry Service at the Hospital of Orense, the La Calzada Mental Health Center in Gijón, and the Institute of Neuropsychiatry and Addictions at Parc de Salut Mar in Barcelona. The control group was matched to the AUD group for demographic criteria, sex, age, and years of education. The main study characteristics and the inclusion/exclusion criteria have been thoroughly described elsewhere (Villa et al., 2021).

All participants were fully informed about the nature and characteristics of the study and provided written informed consent to participate. They were all given a 50-euro gift card for their participation in the study.

The study was approved by the local ethics committees in Orense, Asturias and Barcelona, and was conducted in compliance with the ethical principles of the Declaration of Helsinki (World Medical Association General Assembly, 2013).

Procedure

The study was designed as a prospective longitudinal 6-month follow-up study of moderate to severe alcohol use disorder outpatients. These patients may or may not have achieved abstinence. This was confirmed by self-report and by blood analysis (MCV, GOT, GPT, and GGT).

Assessment

All participants were assessed by well-trained qualified clinicians using the following tools: 1) An ad-hoc questionnaire was used to gather sociodemographic variables including sex, age, marital status, living situation, education level, and employment situation; clinical characteristics including age of onset of alcohol and tobacco use, alcohol and tobacco use during the last month, inclusion and exclusion criteria, age of onset of AUD (patients), and family history of alcoholism; 2) Levels of biomarkers related to alcohol use (GOT, GPT, GGT, and MCV) were measured in serum; 3) Clinical assessment: 17-item Hamilton Depression Rating Scale (HDRS-17; Hamilton, 1960), Barratt Impulsiveness Scale Version 11 (BIS-11; Patton, Stanford & Barratt, 1995); and Obsessive Compulsive Drinking Scale (OCDS; Anton, Moak & Latham, 1995); 4) Neuropsychological variables: Two Wechsler adult intelligence scale (WAIS-IV; Wechsler, 2008) subtests, Symbol Search and Arithmetic were used to assess information processing speed and abstract reasoning; the d2 Test of Attention (Steinborn, Langner, Flehmig & Huestegge, 2018) was used to assess attention; the California Verbal Learning Test (CVLT; Elwood, 1995); and two WAIS-IV subtests, Digit Symbol Coding and Retained Digit (Hagen et al., 2016) were used to measure memory; the FAS Verbal Fluency Test and Category Fluency Test (animals; del Ser Quijano et al., 2004); the Stroop Test (SCWT; Scarpina & Tagini, 2017), the Wisconsin Card Sorting Test (WCST; Nyhus & Barcelo, 2009), the Iowa Gambling Test (IGT; Steingroever, Wetzels, Horstmann, Neumann & Wagenmakers, 2013) were used to examinate executive function; and lastly, an

Table 1. *Battery of neuropsychological tests.*

Neuropsychological test	Main function evaluated	Characteristics
Symbol search (from WAIS-IV)	Processing speed	Measures the ability to quickly identify the presence of figures in a series. Nonverbal.
Arithmetic (from WAIS-IV)	Abstract reasoning	Measures the mental solving of arithmetic problems given a time limit. Verbal.
Attention Test D2	Sustained attention / inhibition of response **(Attention)**	Measures the ability to focus on relevant visual stimuli and ignore irrelevant ones. Nonverbal.
California Verbal Learning Test (CVLT)	Immediate recall, delayed recall, and identification **(Memory)**	Measures the ability to remember lists of words over several attempts, with and without interference. Verbal.
Digit Symbol (from WAIS-IV)	Working memory **(Memory)**	Measures speed in converting numbers into symbols according to an established sequence. Nonverbal.
Digit Span (from WAIS-IV)	Short-term memory **(Memory)**	Measures the ability to remember and follow a sequence of numbers. Verbal.
FAS and semantic category of animals	Verbal fluency **(Executive function)**	Measures the ability to generate word lists by categories. Verbal.
Stroop Test (SCWT)	Divided attention and interference resistance **(Executive function)**	Measures the ability for color recognition. Nonverbal.
Wisconsin Card Sorting Test (WCST)	Abstract reasoning and cognitive flexibility **(Executive function)**	Measures the ability to select cards based on categories. Nonverbal.
Iowa Gambling Test (IGT)	Decision-making and cognitive flexibility **(Executive function)**	Measures the ability to select stimuli based on short- and long-term rewards. Nonverbal.
Implicit Association Test (IAT)	Implicit attitude to a stimulus **(Automatic processing)**	Measures speed of matching words based on implicit attitudes related to alcohol. Nonverbal.

Table 2. *Evolution of parameters related to alcohol consumption and impulsivity at 6-month follow-up.*

	Baseline (SD)	6 months (SD)	*p*
SDU	9.27 (5.90)	2.14 (4.30)	‹ .001
GOT	39.63 (25.99)	29.54 (21.67)	.002
GPT	37.92 (20.56)	28.41 (12.65)	‹ .001
GGT	135.10 (174.30)	82.00 (135.60)	.001
MCV	94.83 (6.43)	91.13 (7.75)	‹ .001
BIS11 Cognitive	17.77 (7.98)	16.00 (5.56)	.013
BIS11 Motor	16.27 (6.94)	15.82 (5.99)	.531
BIS11 Non-planning	19.58 (8.52)	18.66 (7.29)	.022
BIS11-TOTAL	53.85 (19.86)	50.54 (15.80)	.044
OCDS Obsessive	6.25 (4.80)	2.95 (3.85)	‹ .001
OCDS Compulsive	10.54 (4.44)	3.85 (4.33)	‹ .001
OCDS TOTAL	16.77 (8.08)	6.90 (7.87)	‹ .001

Note. SD: standard deviation; SDU: standard drink unit; BIS: Barratt Impulsiveness Scale; OCDS: Obsessive Compulsive Drinking Scale; GOT: glutamate oxalacetate transaminase; GPT: glutamate pyruvate transaminase; GGT: gamma-glutamyl transferase; MCV: mean corpuscular volume.

alcohol Implicit Association Test (IAT; Ostafin, Marlatt & Greenwald, 2008) was used to assess automatic processing. The cognitive battery used to obtain neuropsychological variables is summarized in Table 1.

The instruments described above were administered at baseline and at 6 months follow-up.

The patients had no symptoms of intoxication prior to the evaluation, as determined by experienced clinicians.

Once detoxification was completed, treatment with 1-3 mg of lorazepam or equivalent doses of other benzodiazepines was allowed. Approved pharmacological treatments for alcohol dishabituation were also allowed.

No remediation cognitive intervention was carried out in addition to the detoxification treatment.

Statistical analysis

The continuous variables of the two groups in the study were compared using Student's t-test, while the analysis of differences between the two groups in the distribution of categorical variables was carried out with a chi-square test. The criterion for statistical significance in all tests was $p<0.05$, set as the maximum acceptable value for the probability of making a type I error. Bonferroni corrections were conducted for multiple comparisons.

Results

Variables related to drinking and impulsivity

Six months after starting outpatient treatment, patients showed significant differences from baseline, with a decrease in the number of SDUs (standard drink units) (t=2.14, $p<0.001$), decrease in the analytical variables related to alcohol use: GOT (t= 29.54, $p=0.002$), GPT (t=28.41, $p<0.001$), GGT (t=82.00, $p=0.001$), and MCV (t=91.13, $p<0.001$), and lower pathological alcohol use scores as measured by OCDS - Obsessive (t=2.95, $p<0.001$), OCDS - Impulsive (t=3.85, $p<0.001$), and OCDS - Total (t=6.90, $p<0.001$). There were also significant differences with respect to impulsivity as measured using the BIS, which showed a decrease in all subscales, BIS - Cognitive (t=16.00, $p=0.013$), BIS - Non-planning (t=18.66, $p=0.022$), and BIS - Total (t=50.54, $p=0.044$), except for the BIS - Motor (t=15.82, $p=0.531$) (Table 2).

Cognitive variables

Table 3 shows the results yielded by the different cognitive tests in each group (controls and patients) at the 6-month follow-up, with respect to neuropsychological variables. All tests yielded significant results, which indicated better cognitive function in the control group, with the exception of the IGT and IAT, for which no significant between-group differences were found.

Table 4 presents the same cognitive tests, but comparing the results between patients at baseline and 6-month follow-up. The results reflected statistically significant differences on the following tests: California Verbal Learning Test (CVLT), Digit Symbol Coding and Retained Digits, and the Stroop Test (SCWT), which means an improvement in anterograde memory, divided attention, and interference resistance after 6 months of outpatient treatment: CVLT-A1 first attempt (t=6.86, $p<0.001$), CVLT-A5 fifth attempt (t=11.93, $p=0.001$), CVLT-AToT total attempts (t=48.66, $p<0.001$), CVLT-Free immediate (t=10.396, $p=0.002$), CVLT-Free delayed (t=11.08, $p=0.001$), CVLT - Guided (t=12.31, $p<0.001$), Digit Symbol correct (t=49.24, $p=0.004$), Digit Symbol standard score (t=8.22, $p<0.001$), Digits cumulative (t= 6.99, $p=0.041$), Digits total (t= 22.21, $p=0.020$), SCWT proportion correct (t=0.92, $p=0.001$), SCWT mean RTCC (t=2412, $p=0.004$, SCWT mean RTCCO (t=2550, $p=0.035$),

Table 3. *Comparison of neuropsychological tests between controls and patients at 6-month follow-up assessment (The cases column at baseline has been retrieved from Villa et al. (2021).*

	Controls (SD) N=100	Cases 6 months (SD) N=100	*P*	Cases (SD) at baseline N=111
Processing speed				
SYMBOL SEARCH Correct	30.78 (8.33)	24.31 (7.91)	‹ .001	23.95 (7.45)
SYMBOL SEARCH Error	0.95 (1.30)	1.30 (1.54)	.086	1.54 (1.88)
SYMBOL SEARCH Raw Score	29.57 (9.31)	22.71 (8.44)	‹ .001	22 (7.69)
SYMBOL SEARCH Standard score	10.46 (3.12)	8.41 (3.05)	‹ .001	8.10 (2.83)
Abstract reasoning				
ARITHMETICS Raw score	13.79 (3.93)	11.68 (3.12)	‹ .001	11.32 (321)
ARITHMETICS Standard score	10.70 (3.53)	8.90 (3.02)	‹ .001	8.43 (3.06)
Attention				
D2	163.70 (43.2)	113.69 (43.20)	‹ .001	113 (44.50)
Memory				
CVLT-A1 first attempt	6.91 (2.75)	6.86 (2.35)	.893	5.77 (1.92)
CVLT-A5 fifth attempt	13.38 (2.51)	11.93 (2.68)	‹ .001	11.26 (2.93)
CVLT-AToT total attempts	53.20 (9.80)	48.66 (12.15)	.004	45.80 (11.60)
CVLT- Free immediate	12.31 (2.82)	10.40 (3.31)	‹ .001	9.77 (3.32)
CVLT- Free delayed	12.98 (2.90)	11.08 (3.20)	‹ .001	10.32 (3.35)
CVLT- Guided	13.64 (2.70)	12.31 (2.74)	.001	11.42 (2.38)
CVLT- Recognition	15.34 (1.08)	14.73 (1.70)	.003	14.20 (2.12)
DIGIT SYMBOL Correct	63.10 (19.10)	49.24 (17.48)	‹ .001	46.40 (15.80)
DIGIT SYMBOL Standard score	10.26 (3.26)	8.22 (3.22)	‹ .001	7.34 (2.86)
DIGITS Direct	9.33 (2.10)	8.34 (2.26)	.001	8.11 (2.21)
DIGITS Reverse	8.07 (2.18)	6.92 (1.89)	‹ .001	6.71 (2.01)
DIGITS Cumulative	8.19 (2.33)	6.99 (2.25)	‹ .001	6.64 (2.27)
DIGITS Total	25.54 (5.39)	22.21 (5.50)	‹ .001	21.42 (5.57)
Executive Function				
FAS Direct score correct	36.50 (11.70)	28.82 (11.73)	‹ .001	27.30 (11.30)
FAS Perseveration errors	0.81 (1.28)	0.98 (1.28)	.348	0.78 (1.53)
FAS Intrusion errors	0.23 (0.63)	0.55 (1.04)	.010	0.64 (1.03)
FAS Derivation errors	0.48 (1.14)	0.49 (0.80)	.970	0.58 (0.95)
ANIMALS Direct Score	21.56 (6.23)	18.01 (6.09)	‹ .001	17.14 (4.77)
SCWT prop correct	0.95 (0.07)	0.92 (0.11)	.032	0.89 (0.12)
SCWT mean RTCC	1972 (1288)	2412 (1465)	.025	2654 (1610)
SCWT mean RTCI	1874 (1170)	2860 (2186)	‹ .001	3033 (2635)
SCWT mean RTCCO	2349 (1921)	2550 (1516)	.412	3179 (2958)
SCWT PROPCC	1776 (188)	750 (1012)	‹ .001	1459 (1822)
SCWT PROPCI	0.99 (0.09)	0.87 (0.19)	‹ .001	0.85 (0.26)
SCWT PROPCCO	0.88 (0.18)	0.92 (0.15)	.320	0.85 (0.26)
SCWT mean RT	49 (351)	1709 (1993)	‹ .001	1181 (1633)
WCST Completed categories	4.59 (1.98)	3.31 (2.16)	‹ .001	3.08 (2.04)
WCST Correct	70.70 (11.30)	69.78 (12.54)	.562	67.20 (13.40)
WCST Error	36.10 (23.30)	47.09 (22.50)	.001	54 (21.00)
WCST SUMPE	6.77 (3.08)	5.99 (4.26)	.132	7.30 (11.00)
WCST PE	30.2 (21.20)	19.60 (18.25)	‹ .001	17 (18.20)
WCST PR	9.48 (4.41)	7.40 (5.15)	.002	9.30 (13.60)
WCST SFMS	0.90 (1.22)	1.39 (1.35)	.009	1.03 (1.28)
WCST TRIAL FIRST	22.60 (26.70)	30.02 (29.87)	.071	30.30 (34.30)
WSCT CI	18.40 (16.80)	22.86 (16.85)	.080	22.60 (19.40)
WCST FI		32.14 (19.68)	.012	33.20 (20.10)
WSCT NI	28.50 (22.90)	27.79 (26.54)	.875	31.60 (26.30)
WSCT C2	15.8 (15.30)	12.9 (18.90)	.229	32 (176)
WSCT DIFFC1F1	-1315 (13095)	-9.28 (26.00)	.321	-9.50 (30.30)
WSCT DIFFF1N1	-1.70 (28.30)	4.81 (34.83)	.169	1.50 (36.40)
WSCT DIFFN1C2	12.20 (24.70)	14.83 (31.11)	.488	16.70 (29.10)
WSCT DIFFC2F2	-0.20 (21.40)	0.94 (22.21)	.728	1.70 (22.80)
WSCT DIFFF2N2	3.30 (22.30)	5.27 (22.09)	.544	1836 (822)
IGT Total	2039 (964)	1841 (1013)	.156	46.50 (15.50)
IGT CA	49.90 (16.10)	48.09 (18.14)	.467	53.50 (15.50)
IGT CDA	50.10 (16.10)	51.91 (18.14)	.467	9.72 (4.60)
IGT NET 5 AD	10.56 (4.85)	10.01 (5.10)	.434	10.28 (4.60)
IGT NET 5 DIS	9.44 (4.85)	10.05 (5.06)	.385	30.30 (34.30)
Automatic processing				
IAT	-0.57 (0.52)	-0.48 (0.52)	.152	-0.48 (0.48)

Note. SD: Standard deviation; SCWT: prop correct: Proportion of correct total responses; mean RTCC: Mean response time for congruent correct responses; mean RTCI: Mean response time for incongruent correct responses; mean RTCCO: Mean response time for correct responses; PROPCC: Proportion of congruent correct responses; PROPCI: Proportion of incongruent correct responses; PROPCCO: Proportion of correct responses; mean RT: Mean response time for total correct responses; IGT: Total: Total score achieved; CA: Correct responses; CDA: Incorrect responses; NET 5 AD: Correct responses in the last 20 trials; NET 5 DIS: Incorrect responses in the last 20 trials; WCST: SUMPE: Sum of all incorrect attempts with errors; PE: Percentage of perseverative errors; PR: Perseveration percentage on the tests; SFMS: Total number of occasions in which an incorrect card is selected; TRIAL FIRST: Number of trials needed to complete the first category after at least 5 correct; CI: Percentage of errors in the first color category; NI: percentage of errors in the first number category; FI: Percentage of errors in the first form category; C2: Percentage of error rate in the second color category; DIFF: Difference in error percentages between adjacent categories.

Table 4. *Comparison of neuropsychological tests between patients at baseline and at 6-month follow-up assessment.*

	Baseline (DS) N = 111	6 months (DS) N = 100	*P*
	Processing speed		
SYMBOL SEARCH Correct	23.73 (7.52)	24.31 (7.91)	.369
SYMBOL SEARCH Error	1.48 (1.91)	1.30 (1.54)	.439
SYMBOL SEARCH Raw Score	21.91 (7.57)	22.71 (8.44)	.333
SYMBOL SEARCH Standard score	8.19 (2.86)	8.41 (3.05)	.446
	Abstract reasoning		
ARITHMETICS Raw score	11.28 (3.10)	11.68 (3.12)	.102
ARITHMETICS Standard score	8.44 (2.30)	8.90 (3.02)	.069
	Attention		
D2	111.95 (43.60)	113.69 (43.20)	0.665
	Memory		
CVLT-A1 first attempt	5.74 (1.94)	6.86 (2.35)	‹ .001
CVLT-A5 fifth attempt	11.07 (2.84)	11.93 (2.68)	.001
CVLT-AToT total attempts	45.09 (11.49)	48.66 (12.15)	‹ .001
CVLT- Free immediate	9.55 (3.26)	10.40 (3.31)	.002
CVLT- Free delayed	10.16 (3.29)	11.08 (3.20)	.001
CVLT- Guided	11.31 (2.79)	12.31 (2.74)	‹ .001
CVLT- Recognition	14.20 (2.09)	14.73 (1.70)	.005
DIGIT SYMBOL Correct	46.09 (15.54)	49.24 (17.48)	.004
DIGIT SYMBOL Standard score	7.42 (2.83)	8.22 (3.22)	‹ .001
DIGITS Direct	8.09 (2.14)	8.34 (2.26)	.168
DIGITS Reverse	6.68 (1.89)	6.92 (1.89)	.137
DIGITS Cumulative	6.55 (2.21)	6.99 (2.25)	.041
DIGITS Total	21.30 (5.37)	22.21 (5.50)	.020
	Executive Function		
FAS Direct score correct	27.38 (11.04)	28.82 (11.73)	.119
FASPerseveration errors	0.85 (1.59)	0.98 (1.28)	.452
FAS Intrusion errors	0.67 (1.06)	0.55 (1.04)	.369
FAS Derivation errors	0.58 (0.97)	0.49 (0.80)	.397
ANIMALS Direct Score	17.30 (4.70)	18.01 (6.09)	.174
SCWT prop correct	0.88 (0.12)	0.92 (0.11)	.001
SCWT mean RTCC	2671 (1634)	2412 (1465)	.049
SCWT mean RTCI	3102 (2730)	2860 (2186)	.359
SCWT mean RTCCO	3194 (3046)	2550 (1516)	.035
SCWT PROPCC	1384 (1852)	750 (1012)	.002
SCWT_PROPCI	0.83 (0.26)	0.87 (0.19)	.108
SCWT_PROPCCO	0.86 (0.22)	0.92 (0.15)	.011
SCWT mean RT	1298 (1668)	1709 (1993)	.041
WCST Completed categories	3.00 (1.99)	3.31 (2.16)	.116
WCST Correct	66.79 (13.57)	69.78 (12.54)	.061
WCST Error	55.30 (20.44)	47.09 (22.50)	‹ .001
WCST SUMPE	7.14 (11.28)	5.99 (4.26)	308
WCST PE	15.82 (17.58)	19.60 (18.25)	.083
WCST PR	9.11 (14.03)	7.40 (5.15)	.242
WCST SFMS	1.03 (1.29)	1.39 (1.35)	.070
WCST TRIAL FIRST	31.33 (35.37)	30.02 (29.87)	.716
WSCT CI	23.56 (19.37)	22.86 (16.85)	.759
WCST FI	33.02 (20.27)	32.14 (19.68)	.699
WSCT NI	32.15 (26.76)	27.79 (26.54)	.180
WSCT C2	33.50 (184.70)	12.90 (18.90)	.268
WSCT DIFFC1F1	-8.26 (30.72)	-9.28 (26.00)	.770
WSCT DIFFF1N1	0.83 (36.75)	4.81 (34.83)	.365
WSCT DIFFN1C2	17.15 (30.04)	14.83 (31.11)	.469
WSCT DIFFC2F2	1.83 (23.66)	0.94 (22.21)	.774
WSCT DIFFF2N2	8.91 (19.6)	5.27 (22.9)	.224
IGT Total	1845 (819)	1841 (1013)	.975
IGT CA	46.49 (15.63)	48.09 (18.14)	.411
IGT CDA	53.51 (15.63)	51.91 (18.14)	.411
IGT NET 5 AD	9.79 (4.66)	10.01 (5.10)	.724
IGT NET 5 DIS	10.21 (4.66)	10.050 (5.06)	.796
	Automatic processing		
IAT	-0.50 (0.47)	-0.48 (0.52)	.671

Note. SD: Standard deviation; SCWT: prop correct: Proportion of correct total responses; mean RTCC: Mean response time for congruent correct responses; mean RTCI: Mean response time for incongruent correct responses; mean RTCCO: Mean response time for correct responses; PROPCC: Proportion of congruent correct responses; PROPCI: Proportion of incongruent correct responses; PROPCCO: Proportion of correct responses; mean RT: Mean response time for total correct responses; IGT: Total: Total score achieved; CA: Correct responses; CDA: Incorrect responses; NET 5 AD: Correct responses in the last 20 trials; NET 5 DIS: Incorrect responses in the last 20 trials; WCST: SUMPE: Sum of all incorrect attempts with errors; PE: Percentage of perseverative errors; PR: Perseveration percentage on the tests; SFMS: Total number of occasions in which an incorrect card is selected; TRIAL FIRST: Number of trials needed to complete the first category after at least 5 correct; CI: Percentage of errors in the first color category; NI: percentage of errors in the first number category; FI: Percentage of errors in the first form category; C2: Percentage of error rate in the second color category; DIFF: Difference in error percentages between adjacent categories.

Table 5. *Influence of baseline cognitive variables and impulsivity on severity of use at 6-month follow-up.*

Impulsivity and cognitive variables	SDU ≤ 2 mean/mean *(p)*	GGT ≤ 50 mean/mean *(p)*	MCV ≤ 88 mean/mean *(p)*	OCDS OBSESSIVE ≤ 5 mean/mean *(p)*	OCDS COMPULSIVE ≤5 mean/mean *(p)*	OCDS TOTAL ≤ 10 mean/mean *(p)*
BIS-11						
BIS Cognitive	18.59/ 18.52 (.975)	19.58/ 16.8 (.112)	17.45/ 1916 (.280)	18.17/ 20.23 (.245)	18.07/ 19.91 (.322)	18.17/ 19.72 (.342)
BIS Motor	16.23/ 18 (.327)	16.73/ 16.35 (.783)	16.31/ 16.74 (.764)	15.95/ 19.18 **(.049)**	16.33/ 17.21 (.540)	15.82/ 18.79 **(.041)**
BIS Non-planning	18.95/ 22.65 (.071)	20.59/ 18.17 (.138)	19.87/ 19.64 (.895)	19.25/ 21.64 (.213)	18.87/ 21.72 (.083)	18.68/ 22.65 **(.020)**
BIS Total	54.02/ 59.17 (.320)	52.21/ 51.32 (.150)	53.95/ 55.68 (.659)	53.50/ 61.50 (.060)	53.37/ 59.15 (.167)	52.82/ 61.52 **(.030)**
Processing speed						
SYMBOL SEARCH Correct	23.57/ 25.39 (.309)	23.69/ 24.40 (.628)	22.89/ 24.49 (.297)	23.65/ 25.14 (.427)	23.15/ 25.82 (.088)	23.61/ 24.90 (.427)
SYMBOL SEARCH Error	1.54/ 1.52 (.947)	1.55/ 1.52 (.943)	1.47/ 1.57 (.769)	1.61/ 1.27 (.376)	1.70/ 1.15 (.087)	1.67/ 1.17 (.140)
SYMBOL SEARCH Raw Score	22.04/ 21.83 (.898)	22.17/ 21.70 (.75)	21.68/ 22.16 (.759)	22.07/ 21.72 (.845)	21.47/ 23.24 (.250)	21.96/ 22.10 (.928)
SYMBOL SEARCH Standard score	8.07/ 8.22 (.804)	8.00/ 8.27 (.612)	7.76/ 8.27 (.389)	7.94/ 8.73 (.251)	7.73/ 8.97 (.034)	7.88/ 8.72 (.179)
Abstract reasoning						
ARITHMETIC Raw score	10.91/ 12.91 **(.010)**	11.07/ 11.77 (.266)	7.58/ 9.10 **(‹ .001)**	11.10/ 12.23 (.139)	11.10/ 11.85 (.278)	11.08/ 12.00 (.225)
ARITHMETIC Standard score	8.08/ 9.74 **(.026)**	8.17/ 8.9 (.226)	7.15/ 9.10 **(‹ .001)**	8.32/ 8.86 (.453)	8.38/ 8.54 (.793)	8.34/ 8.65 (.662)
Attention						
D2	113.96/ 109.17 (.681)	110.48/117.40 (.437)	106.76/ 116.20 (.25)	108.44/ 131.32 **(.032)**	111.68/ 116.03 (.654)	111.67/ 116.65 (.636)
Memory						
CVLT-A1 first attempt	5.62/ 6.30 (.117)	5.75/ 5.80 (.889)	5.71/ 5.79 (.837)	5.62/ 6.36 (.090)	5.58/ 6.21 (.108)	5.56/ 6.34 (.068)
CVLT-A5 fifth attempt	11.34/ 10.96 (.604)	11.35/ 11.10 (.670)	11.45/ 11.16 (.623)	11.20/ 11.50 (.694)	11.10/ 11.63 (.373)	11.13/ 11.62 (.462)
CVLT-AToT total attempts	45.51/ 46.69 (.672)	45.58/ 46.07 (.828)	44.92/ 46.19 (.593)	45.28/ 47.68 (.428)	44.63/ 48.42 (.102)	44.94/ 48.07 (.240)
CVLT-Free immediate	9.76/ 9.83 (.926)	9.72/ 9.87 (.809)	9.58/ 9.88 (.673)	9.62/ 10.41 (.294)	9.55/ 10.30 (.240)	9.60/ 10.27 (.327)
CVLT-Free delayed	10.28/ 10.43 (.845)	10.22/ 10.47 (.715)	10.03/ 10.46 (.517)	10.12/ 11.09 (.201)	10.23/ 10.51 (.669)	10.13/ 10.83 (.315)
CVLT-Guided	11.28/ 11.96 (.229)	11.29/ 11.65 (.528)	11.34/ 11.46 (.829)	11.25/ 12.14 (.144)	11.18/ 12.00 (.117)	11.22/ 12.00 (.162)
CVLT-Recognition	14.12/ 14.48 (.407)	14.28/ 14.05 (.597)	14.39/ 14.09 (.483)	14.16/ 14.26 (.698)	14.28/ 14.00 (.536)	14.15/ 14.34 (.678)
DIGIT SYMBOL Correct	45.46/ 49.91 (.210)	46.01/ 47.05 (.745)	44.53/ 47.36 (.393)	44.46/ 54.18 **(.015)**	44.65/ 50.48 (.061)	44.47/ 51.79 **(.031)**
DIGIT SYMBOL Standard score	7.16/ 8.04 (.123)	7.20/ 7.60 (.462)	6.81/ 7.62 (.180)	7.01/ 8.68 **(.017)**	7.05/ 8.03 (.073)	7.05/ 8.17 (.063)
DIGITS Direct	7.77/ 9.39 **(.001)**	7.93/ 8.42 (.260)	7.50/ 8.48 **(.026)**	7.80/ 9.36 **(.003)**	7.69/ 9.09 **(‹ .001)**	7.76/ 9.10 **(.003)**
DIGITS Reverse	6.57/ 7.26 (.076)	6.62/6.87 (.498)	5.87/ 7.15 **(‹ .001)**	6.44/ 7.82 **(.002)**	6.51/ 7.18 (.082)	6.46/ 7.41 **(.017)**
DIGITS Cumulative	6.51/ 7.13 (.099)	6.79/ 6.37 (.349)	6.03/ 6.96 **(.026)**	6.47/ 7.32 (.106)	6.33/ 7.36 **(.011)**	6.41/ 7.27 (.063)
DIGITS Total	20.81/ 23.78 **(.003)**	21.31/ 21.62 (.774)	19.34/ 22.51 **(.001)**	20.66/ 24.5 **(.004)**	20.49/ 23.64 **(.002)**	20.58/ 23.79 **(.006)**
Executive function						
FAS Direct score correct	26.90/ 28.83 (.429)	27.15/ 27.55 (.859)	24.21/ 28.9 **(.027)**	26.74/ 29.54 (.277)	26.87/ 28.30 (.518)	26.51/ 29.52 (.207)
FAS Perseveration errors	0.78/ 0.78 (996)	0.82/ 0.72 (.735)	1.00/ 0.671 (.366)	0.74/ .095 (.550)	0.72/ 0.94 (.477)	0.74/ 0.90 (.62)
FAS Intrusion errors	0.62/0.69 (.754)	0.60/ 0.70 (.664)	0.84/ 0.53 (.138)	0.67/ 0.50 (.051)	0.60/ 0.73 (.578)	0.62/ 0.69 (.773)
FAS Derivation errors	0.56/ 0.65 (.640)	0.60/ 0.52 (.645)	0.63/ 0.55 (.685)	0.59/ 0.50 (.636)	0.64/ 0.42 (.205)	0.60/ 0.52 (.662)
ANIMALS Direct Score	17.10/ 17.26 (.894)	16.96/ 17.45 (.61)	16.89/ 17.26 (.695)	16.61/ 19.27 **(.024)**	16.78/ 17.97 (.24)	16.39/ 19.24 **(0.005)**
SCWT prop correct	0.88/0.91 (.341)	0.89/ 0.88 (.795)	0.85/ 0.91 **(.016)**	0.88/ 0.93 **(.009)**	0.87/ 0.92 **(.012)**	0.87/ 0.93 **(.002)**
SCWT mean RTCC	2781.26/ 2167.57 **(.009)**	2766.21/ 2455.09 (.300)	3016.60/ 2465.40 (.130)	2850.62/ 1859.08 **(‹ .001)**	2847.00/ 2198.16 **(.012)**	2880.03/ 2015.27 **(‹ .001)**
SCWT mean RTCI	3288.10/2055.28 **(.001)**	3317.72/ 2526.65 (.078)	3935.78/ 2562.53 **(.038)**	3297.83/ 1959.8 **(‹ .001)**	3394.66/ 2177.01 **(.003)**	3358.89/ 2110.20 **(.001)**
SCWT mean RTCCO	3179.60/ 3177.89 (.999)	3189.87/ 3160.39 (.964)	3342.79/ 3094.11 (.660)	3462.60/ 2032.94 **(‹ .001)**	3258.51/ 2991.89 (.705)	3535.98/ 2170.53 **(.001)**
SCWT PROPCC	1517.22/ 1237.57 (.382)	1519.33/ 1352.67 (.635)	1444.11/ 1467.17 (.954)	1554.60/ 1073.63 (.102)	1546.05/ 1254.16 (.347)	1590.93/ 1086.99 (.083)
SCWT PROPCI	0.84/ 0.87 (.569)	0.84/ 0.85 (.899)	0.75/0.89 **(.012)**	0.82/ 0.95 **(‹ .001)**	0.82/ 0.91 (.052)	0.82/ 0.93 **(.005)**
SCWT PROPCCO	0.84/ 0.87 (.716)	0.86/0.83 (.469)	0.85/ 0.85 (.963)	0.84/ 0.87 (.507)	0.84/ 0.88 (.254)	0.84/ 0.89 (.161)
SCWT mean RT	1263.03/ 866.84 (.201)	1234.17/ 1086.45 (.625)	1571.47/ 97765 (.103)	1279.69/ 781.45 (.105)	1304.87/ 888.01 (.17)	1273.14/ 920.22 (.259)
WCST Completed categories	3.02/ 3.17 (.734)	2.90/ 3.32 (.280)	2.92/ 3.12 (.626)	2.95/ 3.45 (.290)	3.01/ 3.15 (.739)	2.88/ 3.55 (.118)
WCST Correct	65.78/ 69.69 (.132)	65.13/ 69.20 (.122)	64.1/ 67.89 (.239)	65.22/ 72.14 **(.034)**	64.83/ 70.76 **(.031)**	64.83/ 71.59 **(.019)**
WCST Error	53.60/ 5317.00 (.920)	54.59/ 51.60 (.464)	54.08/ 53.22 (.847)	54.30/ 50.32 (.386)	54.37/ 51.48 (.483)	55.11/ 49 (.165)
WCST SUMPE	7.78/ 5.04 (.059)	6.55/ 8.40 (.418)	5.81/ 7.94 (.200)	7.32/ 6.77 (.713)	7.91/ 5.57 (.144)	7.46/ 6.52 (.537)
WCST PE	18/ 12.18 (.062)	15.47/ 19.15 (.330)	14.71/ 17.89 (.331)	16.75/ 16.97 (.951)	17.7/ 14.66 (.366)	16.57/ 17.46 (.798)
WCST PR	9.89/ 6.52 (.071)	7.58/ 12.05 (.139)	6.99/ 10.34 (.106)	8.48/ 12.08 (.321)	9.12/ 9.35 (.935)	8.57/ 10.94 (.426)
WCST SFMS	1.09/ 0.74 (.063)	0.98/ 1.07 (.742)	0.87/ 1.09 (.357)	0.99/ 1.14 (.69)	0.95/ 1.18 (.436)	1.00/ 1.07 (.819)
WCST TRIAL FIRST	30.40/ 28.43 (.765)	33.10/ 24.47 (.158)	29.55/ 30.22 (.921)	31.84/ 22.50 (.190)	30.82/ 28.03 (.669)	31.55/ 25.59 (.365)
WSCT CI	22.67/ 21.49 (.772)	24.45/ 18.83 (.111)	23.97/ 21.62 (.556)	23.78/ 16.93 (.137)	22.86/ 21.4 (.714)	23.31/ 19.92 (.425)
WCST FI	31.18/ 31.62 (.736)	33.17/ 32.31 (.823)	31.52/ 33.56 (.613)	33.94/ 28.50 (.220)	32.74/ 33.14(.923)	34.73/ 27.56 (.071)
WSCT NI	30.36/ 34.89 (.455)	28.89/ 35.58 (.191)	33.67/ 30.07 (.508)	30.24/ 35.61 (.374)	32.55/ 28.34 (.417)	29.79/ 35.58 (.278)
WSCT C2	35.03/ 17.76 (.429)	38.32/ 19.26 (.470)	61.32/ 15.91 (.356)	34.43/ 19.41 (.480)	37.39/ 17.41 (.410)	35.68/ 19.49 (.481)
WSCT DIFFC1F1	-9.44/ -9.08 (.948)	-8.72/ -10.5 (.743)	-5.80/ -11.22 (.398)	-9.88/ -7.27 (.706)	-9.89/ -8.14 (.77)	-11.42/ -3.55 (.216)
WSCT DIFFF1N1	3.05/ -4.32 (.426)	4.28/ -3.37 (.291)	-1.61/ 3.16 (.509)	3.43/ -6.16 (.26)	0.19/ 4.68 (.549)	4.94/ -8.14 (.076)
IGT Total	1758.52/ 2134.78 (.059)	1785.91/ 1926.25 (.381)	1675/ 1920.55 (.131)	1803.37/ 1970.45 (.401)	1766.03/ 2003.03 (.188)	1785.97/ 1979.31 (.296)
IGT CA	45.46/ 50.43 (.158)	46.73/ 46.07 (.829)	46.47/ 46.51 (.991)	46.11/ 48.04 (.574)	46.14/ 47.33 (.695)	46.04/ 47.79 (.582)
IGT CDA	54.53/ 49.56 (.158)	53.27/ 53.92 (.829)	53.53/ 53.49 (.992)	53.89/ 51.95 (.574)	53.86/ 52.67 (.695)	53.96/ 52.21 (.582)
IGT NET 5 AD	9.45/ 10.74 (.196)	9.75/ 9.67 (.937)	9.21/ 9.99 (.402)	9.67/ 9.91 (.813)	9.42/ 10.42 (.254)	9.45/ 10.48 (.258)
IGT NET 5 DIS	10.54/ 9.26 (.196)	10.25/ 10.32 (.937)	10.79/ 10.01 (.402)	10.32/ 10.09 (.813)	10.58/ 9.57 (.254)	10.55/ 9.52 (.258)

Note. SDU = 0 patients who have consumed 0 standard drink unit per day in the last month; SDU ≤ 2 patients who have consumed 2 or less standard drink unit per day in the last month; patients with a GGT (gamma-glutamyl transferase) equal or lesser value than 50; patients with a MCV (mean corpuscular volume) equal or lesser value than 88; OCDS: Obsessive Compulsive Drinking Scale; OCDS OBSESSIVE ≤ 5 patients with a score less than or equal to 5 in the obsessive subscale of the OCDS; OCDS COMPULSIVE ≤5 patients with a score less than or equal to 5 in the compulsive subscale of the OCDS; OCDS TOTAL ≤ 10 patients with a score less than or equal to 10 in the total subscale of the OCDS. SCWT: prop correct: Proportion of correct total responses; mean RTCC: Mean response time for congruent correct responses; mean RTCI: Mean response time for incongruent correct responses; mean RTCCO: Mean response time for correct responses; PROPCC: Proportion of congruent correct responses; PROPCI: Proportion of incongruent correct responses; PROPCCO: Proportion of correct responses; mean RT: Mean response time for total correct responses; IGT: Total: Total score achieved; CA: Correct responses; CDA: Incorrect responses; NET 5 AD: Correct responses in the last 20 trials; NET 5 DIS: Incorrect responses in the last 20 trials; WCST: SUMPE: Sum of all incorrect attempts with errors; PE: Percentage of perseverative errors; PR: Perseveration percentage in the tests; SFMS: Total number of occasions in which an incorrect card is selected; TRIAL FIRST: Number of trials needed to complete the first category after at least 5 correct; CI: Percentage of errors in the first color category; NI: percentage of errors in the first number category; FI: Percentage of errors in the first form category; C2: Percentage of error rate in the second color category; DIFF: Difference in error percentages between adjacent categories.

SCWT PROPCC (t=750, p=0.002), SCWT PROPCCO (t=0.92, p=0.011), and SCWT mean RT (t=1709, p=0.041).

Table 5 shows the comparison between cognitive performance at baseline versus treatment response after 6 months, measured with the OCDS, blood analysis (MCV and GGT), and alcohol use during the previous month (SDUs). Our results show that patients who had worse cognitive performance at baseline also had a worse response to treatment as indicated by the following significant findings: *OCDS Obsessive≤5:* BIS – Motor p=0.049; d2 p=0.032, Digit Symbol correct p=0.015; Digit Symbol standard score p=0.017; Digit Direct p = 0.003, Digit Reverse p=0.002; Digit Total p=0.004; Animals direct score p=0.024; SCWT proportion correct p=0.009; SCWT mean RTCC p<0.001; SCWT mean RTCI p<0.001; SCWT mean RTCCO p<0.001; SCWT PROPCI p<0.001, and WCST correct p=0.034. *OCDS Compulsive≤5:* Digit direct p<0.001; Digit cumulative p=0.011; Digit total p=0.002; SCWT proportion correct p=0.012; SCWT mean RTCC p=0.012; SCWT mean RTCI p=0.003, and WCST correct p=0.031. *OCDS Total≤10:* BIS - Motor p=0.041; BIS - Non-planning p=0.020; BIS Total p=0.030; Digit Symbol correct p=0.031; Digit direct p=0.003; Digit reverse p=0.017; Digit total p=0.006; Animals direct score p=0.005; SCWT proportion correct p=0.002; SCWT mean RTCC p<0.001; SCWT mean RTCI p=0.001; SCWT mean RTCCO p=0.001; SCWT PROPCI p=0.005; WCST correct p=0.019. *MCV≤88:* Arithmetic raw score p<0.001; Arithmetic standard score p<0.001; Digit direct p=0.026; Digit reverse p<0.001; Digit cumulative p=0.026; Digit total p=0.001; FAS direct score correct p=0.027; SCWT proportion correct p=0.016; SCWT mean RTCI p=0.038, and SCWT PROPCI p=0.012. *GGT≤50:* none. *SDU≤2:* Arithmetic raw score p=0.010; Arithmetic standard score p=0.026; Digit direct p=0.001; Digit total p=0.003; SCWT mean RTCC p=0.009, and SCWT mean RTCI p=0.001.

Table 6 shows the comparison between cognitive performance at 6 months versus treatment response after 6 months as measured with the OCDS, blood analysis (MCV, GGT), and alcohol use during the previous month (SDUs). Our results show that patients who had a better response to treatment had better cognitive performance at 6 months as indicated by the following significant findings: *OCDS Obsessive≤5:* BIS - Cognitive p=0.001; BIS - Motor p=0.007; BIS - Non-planning p=0.025; BIS Total p=0.001; Symbol Search error p=0.019; Symbol Search raw score p=0.042; Arithmetic raw score p=0.025; Digit reverse p=0.013; FAS direct score correct p=0.006; FAS intrusion errors p=0.028; SCWT proportion correct p=0.028; SCWT mean RTCC p=0.006; SCWT mean RTCI p=0.010; SCWT mean RTCCO p=0.016; SCWT PROPCI p=0.016; SCWT mean RT p=0 .009; WCST correct p=0.008; WCST error p=0.029, and WCST SUMPE p=0.036. *OCDS Compulsive≤5:* BIS - Cognitive p<0.001; BIS - Motor p=0.011; BIS - Non-planning p<0.001; BIS Total p<0.001; Symbol Search error p=0.045; Arithmetic raw score p=0.006; Arithmetic standard score p=0.014; CVLT-A5 fifth attempt p=0.013; Digit reverse p=0.016; Digit cumulative p=0.006; Digit total p=0.009; FAS direct score correct p=0 .001; FAS intrusion errors p=0.040; SCWT proportion correct p=0.003; SCWT mean RTCC p=0.025; SCWT mean RTCI p=0.003; SCWT mean RTCCO p=0.021; SCWT PROPCC p=0.045; SCWT PROPCI p<0.001; SCWT mean RT p=0.002; WCST correct p=0.031, and WCST error p=0.004. *OCDS Total≤10:* Symbol Search error p=0.005; Arithmetic raw score p=0.001; Arithmetic standard score p=0.018; FAS direct score correct p=0.013; SCWT proportion correct p=0.003; SCWT mean RTCC p=0.008; SCWT mean RTCI p=0.007; SCWT mean RTCCO p=0 .025; SCWT PROPCI p=0.001; SCWT mean RT p=0.005; WCST correct p=0.005, and WCST error p=0.011. *MCV≤88:* BIS - Cognitive p=0.003; BIS Total p=0.029; Symbol Search raw score p=0.012; Symbol Search standard score p=0.011; Arithmetic raw score p=0.010; Arithmetic standard score p=0.005; Digit reverse p<0.001; Digit cumulative p=0.006; Digit total p=0.002; SCWT mean RTCC p=0.017; SCWT mean RTCCO p=0.037; SCWT PROPCI p=0.022; SCWT mean RT p=0.012; WCST completed categories p=0.030, and WCST error p=0.048. *GGT≤50:* Arithmetic raw score p=0.048; Arithmetic standard score p=0.019; Digit reverse p=0.008; Digit cumulative p=0.029; Digit total p=0.025, and FAS derivation errors p=0.012. *SDU≤2:* BIS - Cognitive p=0.044; Arithmetic raw score p<0.001; Arithmetic standard score p<0.001; Digit direct p=0.046; Digit cumulative p=0.006; Digit total p=0.008; FAS direct score correct p=0.002, and WSCT DIFFC1F1 p=0.014.

Discussion

The present study used a systematized battery of verbal and non-verbal tests to compare the cognitive performance of a group of outpatients with AUD seeking cessation treatment after 6 months of follow-up to that of a group of healthy volunteers, matched for the main sociodemographic variables influencing cognitive capacity (age, sex, and completed years of schooling).

Data from this evaluation demonstrated statistically significant deficits in the patient group compared with healthy volunteers in almost all tests, with the exception of two: the IGT and IAT. These results are consistent with those already obtained in the previous study (Villa et al., 2021), which compared the same assessment in the same patients with controls, but at baseline. Based on these data, after 6 months of follow-up, cognitive functioning in the patients was still lower than in the healthy controls (Bernardin et al., 2014; Le Berre et al., 2017; Nowakowska-Domagala et al., 2017).

When comparing the results of the cognitive evaluation of patients at baseline and after 6 months of follow-up, it

Table 6. *Influence of the severity of use on cognitive variables and impulsivity at 6-month follow-up.*

Impulsivity and cognitive variables	SDU ≤ 2 mean/mean *(p)*	GGT ≤ 50 mean/mean *(p)*	MCV ≤ 88 mean/mean *(p)*	OCDS OBSESSIVE ≤ 5 mean/mean *(p)*	OCDS COMPULSIVE ≤5 mean/mean *(p)*	OCDS TOTAL≤ 10 mean/ mean *(p)*
BIS-11						
BIS Cognitive	15.35/ 18.22 **(.044)**	15.72/ 16.43 (.525)	13.6/ 17.01 **(.003)**	15.02 /19.50 **(.001)**	14.48/ 19.12 **(< .001)**	14.71/ 19.21 **(< .001)**
BIS Motor	15.59/ 16.61 (.457)	15.53/ 16.26 (.543)	14.53/ 16.37 (.167)	15.15/ 18.23 **(.007)**	14.85/ 17.82 **(.011)**	14.93/ 18.03 **(.004)**
BIS Non-planning	17.93/ 21.13 (.053)	18.76/ 18.51 (.868)	17.47/ 19.17 (.248)	17.77/ 21.86 **(.025)**	16.93/ 22.24 **(< .001)**	17.24/ 22.21 **(.001)**
BIS Total	48.93/ 56 (.076)	50.08/ 51.28 (.714)	45.67/ 52.60 **(.029)**	47.95/ 59.86 **(.001)**	46.2/ 59.48 **(< .001)**	46.80/ 59.83 **(< .001)**
Processing speed						
SYMBOL SEARCH Correct	24.00/ 25.35 (.43)	23.66/ 25.33 (.295)	21.9/ 25.32 (.053)	23.62/ 26.77 (.119)	23.40/ 26.18 (.075)	23.54/ 26.21 (.118)
SYMBOL SEARCH Error	1.38/ 1.00 (.231)	1.34/ 1.23 (.734)	1.67/ 1.14 (.216)	1.44/ 0.77 **(.019)**	1.48/ 0.91 **(.045)**	1.51/ 0.76 **(.005)**
SYMBOL SEARCH Raw Score	22.23/ 24.35 (.231)	21.84/ 24.10 (.172)	19.23/ 24.18 **(.012)**	21.80/ 26 **(.042)**	21.91/ 24.36 (.166)	22.03/ 24.41 (.22)
SYMBOL SEARCH Standard score	8.24/ 8.96 (.267)	8.03/ 9.00 (.113)	7.23/ 8.90 **(.011)**	8.11/ 9.45 (.102)	8.04/ 9.15 (.083)	8.07/ 9.24 (.093)
Abstract reasoning						
ARITHMETIC Raw score	11.04/ 13.87 **(< .001)**	11.21/12.43 **(.048)**	10.50/ 12.18 **(.010)**	11.32/ 13 **(.025)**	11.06/ 12.97 **(.006)**	11.17/ 12.96 **(.010)**
ARITHMETIC Standard score	8.31/ 11.00 **(< .001)**	8.37/ 9.79 **(.019)**	7.70/ 9.44 **(.005)**	8.62/ 10 (.057)	8.37/ 10.06 **(.014)**	8.46/ 10.07 **(.018)**
Attention						
D2	112.18/ 118.83 (.498)	111.93/ 116.49 (.611)	111.83/ 114.48 (.783)	109.38/ 129.18 (.082)	108.06/ 125.30 (.055)	109.15/ 124.96 (.106)
Memory						
CVLT-A1 first attempt	6.77/ 7.17 (.524)	6.76/ 7.02 (.595)	6.77/ 6.90 (.789)	6.73/ 7.32 (.394)	6.79/ 7.00 (.701)	6.75/ 7.14 (.463)
CVLT-A5 fifth attempt	11.86/ 12.17 (.642)	11.79/ 12.15 (.508)	11.60/ 12.07 (.467)	11.73/ 12.64 (.157)	11.50/ 12.82 **(.013)**	11.65/ 1.62 (.090)
CVLT-AToT total attempts	48.15/ 50.39 (.477)	48.03/ 49.67 (.525)	47.47/ 49.17 (.536)	47.70/ 52.14 (.158)	47.07/ 51.94 (.057)	47.25/ 52.17 (.062)
CVLT-Free immediate	10.32/ 10.65 (.706)	10.5/ 10.23 (.709)	10.33/ 10.42 (.904)	10.24/ 10.95 (.349)	10.12/ 10.97 (.221)	10.32/ 10.59 (.716)
CVLT-Free delayed	11.11/ 10.96 (.862)	11.22/ 10.85 (.587)	11.27/ 11.00 (.689)	10.89/ 11.77 (.239)	10.84/ 11.57 (.302)	10.9/ 11.52 (.416)
CVLT-Guided	12.33/ 12.22 (.885)	12.39/ 12.18 (.734)	12.43/ 12.25 (.755)	12.19/ 12.73 (.369)	12.12/ 12.7 (.351)	12.25/ 12.45 (.766)
CVLT-Recognition	14.74/ 14.69 (.908)	14.87/ 14.51 (.35)	14.73/ 14.73 (.998)	14.71/ 14.82 (.792)	14.59/ 15.03 (.189)	14.62/ 15.00 (.292)
DIGIT SYMBOL Correct	48.74/ 50.91 (.601)	49.6/ 48.66 (.794)	48.70/ 49.46 (.850)	47.73/ 54.64 (.123)	48.51/ 50.73 (.52)	47.79/ 52.83 (.187)
DIGIT SYMBOL Standard score	8.10/ 8.61 (.506)	8.14/ 8.33 (.775)	7.90/ 8.35 (.548)	7.97/ 9.09 (.179)	8.15/ 8.36 (.738)	7.99/ 8.79 (.263)
DIGITS Direct	8.10/ 9.13 **(.046)**	8.10/ 8.72 (.185)	7.90/ 8.52 (.156)	8.18/ 8.91 (.260)	8.04/ 8.94 (.074)	8.18/ 8.72 (.307)
DIGITS Reverse	6.74/ 7.52 (.109)	6.52/ 7.56 **(.008)**	5.97/ 7.32 **(< .001)**	6.66/ 7.86 **(.013)**	6.60/ 7.57 **(.016)**	6.75/ 7.34 (.165)
DIGITS Cumulative	6.67/ 8.09 **(.006)**	6.60/ 7.61 **(.029)**	6.07/ 7.38 **(.006)**	6.86/ 7.45 (.259)	6.57/ 7.85 **(.006)**	6.80/ 7.44 (.195)
DIGITS Total	21.46/ 24.74 **(.008)**	21.21/ 23.79 **(.025)**	19.93/ 23.17 **(.002)**	21.63/ 24.27 (.064)	21.22/ 24.24 **(.009)**	21.67/ 23.55 (.121)
Executive function						
FAS Direct score correct	26.95/ 35.17 **(.002)**	28.1/ 29.97 (.433)	26.10/ 29.97 (.080)	27.34/ 34.14 **(.006)**	26.15/ 34.33 **(.001)**	27.08/ 33.14 **(.013)**
FAS Perseveration errors	0.95/ 1.09 (.669)	1.02/ 0.92 (.718)	0.87/ 1.03 (.539)	0.96/ 1.04 (.781)	0.97/ 1.00 (.917)	0.93/ 1.10 (.554)
FAS Intrusion errors	0.54/ 0.56 (.914)	0.66/ 0.36 (.132)	0.6/ 0.52 (.754)	0.63/ 0.23 **(.028)**	0.68/ 0.27 **(.040)**	0.60/ 0.41 (.389)
FAS Derivation errors	0.50/ 0.43 (.716)	0.63/ 0.26 **(.012)**	0.53/ 0.46 (.708)	0.54/ 0.27 (.078)	0.45/ 0.54 (.600)	0.49/ 0.48 (.984)
ANIMALS Direct Score	17.69/ 19.09 (.388)	17.47/ 18.87 (.259)	16.20/ 18.77 (.044)	17.86/ 18.54 (.643)	17.48/ 19.09 (.235)	17.51/ 19.24 (.224)
SCWT prop correct	0.91/ 0.94 (.290)	0.91/ 0.93 (.272)	0.88/ 0.93 (.09)	0.91/ 0.95 **(.028)**	0.90/ 0.95 **(.003)**	0.90/ 0.96 **(.003)**
SCWT mean RTCC	2457.02/ 2258.21 (.516)	2478.23/ 2306.07 (.555)	3084.08/ 2127.67 **(.017)**	2566.24/ 1856.99 **(.006)**	2599.58/ 2024.70 **(.025)**	2606.32/ 1928.69 **(.008)**
SCWT mean RTCI	3007.75/ 2358.03 (.108)	2965.73/ 2691.38 (.520)	3789.90/ 2466.79 (.033)	3069.78/ 2105.75 **(.010)**	3211.12/ 2135.85 **(.003)**	3147.22/ 2146.19 **(.007)**
SCWT mean RTCCO	2587.36/ 2421.61 (.613)	2544.4/ 2557.91 (.966)	3116.27/ 2310.18 **(.037)**	2690.01/ 2045.47 **(.016)**	2744.17/ 2148.71 **(.021)**	2717.81/ 2132.02 **(.025)**
SCWT PROPCC	732.55/ 808.19 (.714)	763.58/ 727.82 (.862)	586.71/818.67 (.325)	690.26/ 963.46 (.244)	610.36/ 1037.04 **(.045)**	660.82/ 970.63 (.138)
SCWT PROPCI	0.87/ 089 (.710)	0.86/ 0.89 (.566)	0.79/ 0.91 **(.022)**	0.85/ 0.94 **(.016)**	0.83/ 0.95 **(< .001)**	0.84/ 0.95 **(.001)**
SCWT PROPCCO	0.91/ 0.93 (.607)	0.91/ 0.93 (.421)	0.91/ 0.92 (.672)	0.92/ 0.92 (.978)	0.91/ 0.93 (.604)	0.91/ 0.93 (.598)
SCWT mean RT	1798.98/ 1404.21 (.39)	1756.64/ 1633.46 (.763)	2595.75/ 1334.43 **(.012)**	1929.7/ 916.86 **(.009)**	2077.36/ 950.2 **(.002)**	2015.43/ 948.48 **(.005)**
WCST Completed categories	3.24/ 3.65 (.415)	3.45/ 3.15 (.493)	2.67/ 3.62 **(.030)**	3.25/ 3.64 (.488)	3.10/ 3.82 (.121)	3.17/ 3.76 (.221)
WCST Correct	68.85/ 72.69 (.137)	68.45/ 71.74 (.205)	69.33/ 68.89 (.852)	68.10/ 75.54 **(.008)**	68.03/ 73.21 **(.031)**	67.78/ 74.55 **(.005)**
WCST Error	48.31/ 41.52 (.185)	46.71/ 46.85 (.976)	53.4/ 43.96 **(.048)**	49.14/ 38.23 **(.029)**	51.09/ 37.85 **(.004)**	50.14/ 38.38 **(.011)**
WCST SUMPE	6.19/ 5.26 (.214)	6.35/ 5.38 (.226)	6.60/ 5.72 (.417)	6.38/ 4.54 **(.036)**	6.12/ 5.70 (.644)	6.21/ 5.41 (.413)
WCST PE	19.43/ 20.88 (.761)	21.34/ 17.25 (.255)	17.49/ 20.72 (.421)	19.9/ 19.26 (.879)	17.64/ 24.12 (.125)	19.08/ 21.46 (.554)
WCST PR	7.58/ 6.82 (.481)	7.89/ 6.64 (.210)	7.44/ 7.39 (.970)	7.72/ 6.27 (.209)	7.27/ 7.69 (.700)	7.46/ 7.26 (.862)
WCST SFMS	1.35/ 1.48 (.670)	1.22/ 1.61 (.162)	1.6/ 1.28 (.289)	1.29/ 1.68 (.265)	1.31/ 1.51 (.503)	1.26/ 1.65 (.212)
WCST TRIAL FIRST	29.26/ 31.74 (.716)	29.08/ 31 (.755)	28.03/ 30.58 (.660)	30.62/ 26.95 (.597)	30.62/ 28.18 (.677)	30.61/ 27.86 (.657)
WSCT CI	21.30/ 27.15 (.126)	23.08/ 21.93 (.737)	24.44/ 21.87 (.511)	23.01/ 21.27 (.672)	22.61/ 22.68 (.983)	22.64/ 22.61 (.993)
WCST FI	33.57/ 26.26 (.081)	32.84/ 30.41 (.549)	36.64/ 29.91 (.111)	33.38/ 26.61 (.113)	34.79/ 25.95 (.023)	34.07/ 26.53 (.052)
WSCT NI	29.57/ 22.34 (.219)	28.96/ 26.27 (.616)	35.37/ 24.77 (.110)	29.44/ 22.47 (.227)	30.60/ 22.26 (.106)	28.63/ 26.16 (.656)
WSCT C2	12.19/ 15.31 (.464)	12.60/ 13.38 (.838)	8.64/ 14.7 (.112)	13.85/ 9.50 (.186)	1.23/ 14.28 (.595)	13.32/ 11.87 (.689)
WSCT DIFFC1F1	-12.27/ 0.89 **(.014)**	-9.76/ -8.49 (.811)	-12.20/ -8.03 (.446)	-10.37/ -5.34 (.373)	-12.18/ -3.27 (.071)	-11.42/ -3.92 (.158)
WSCT DIFFF1N1	4.59/ 3.92 (.922)	4.62/ 4.15 (.947)	1.27/ 5.78 (.597)	4.52/ 4.14 (.959)	4.80/ 3.70 (.873)	6.08/ 0.37 (.409)
IGT Total	1734.61/ 2200 (.080)	1816.93/ 1878.20 (.773)	1688.33/ 1904.93 (.336)	1874.50/ 1720.45 (.503)	1765.44/ 1995.45 (.318)	1807.64/ 1922.41 (.631)
IGT CA	46.65/ 52.96 (.156)	47.42/ 49.15 (.641)	44.97/ 49.41 (.295)	48.40/ 46.95 (.700)	46.97/ 50.39 (.401)	47.68/ 49.10 (.728)
IGT CDA	53.35/ 47.04 (.156)	52.58/ 50.85 (.641)	55.03/ 50.59 (.295)	51.59/ 53.04 (.700)	53.03/ 49.61 (.401)	52.32/ 50.90 (.728)
IGT NET 5 AD	9.68/ 11.13 (.261)	9.93/ 10.13 (.855)	9.93/ 10.04 (.925)	9.95/ 10.23 (.798)	9.63/ 10.79 (.304)	9.67/ 10.86 (.292)
IGT NET 5 DIS	10.40/ 8.87 (.236)	10.16/ 9.87 (.783)	10.07/ 10.04 (.983)	10.13/ 9.77 (.745)	10.45/ 9.21 (.268)	10.42/ 9.14 (.259)

Note. SDU = 0 patients who have consumed 0 standard drink unit per day in the last month; SDU ≤ 2 patients who have consumed 2 or less standard drink unit per day in the last month; patients with a GGT (gamma-glutamyl transferase) equal or lesser value than 50; patients with a MCV (mean corpuscular volume) equal or lesser value than 88; OCDS: Obsessive Compulsive Drinking Scale; OCDS OBSESSIVE ≤ 5 patients with a score less than or equal to 5 in the obsessive subscale of the OCDS; OCDS COMPULSIVE ≤5 patients with a score less than or equal to 5 in the compulsive subscale of the OCDS; OCDS TOTAL ≤ 10 patients with a score less than or equal to 10 in the total subscale of the OCDS. SCWT: prop correct: Proportion of correct total responses; mean RTCC: Mean response time for congruent correct responses; mean RTCI: Mean response time for incongruent correct responses; mean RTCCO: Mean response time for correct responses; PROPCC: Proportion of congruent correct responses; PROPCI: Proportion of incongruent correct responses; PROPCCO: Proportion of correct responses; mean RT: Mean response time for total correct responses; IGT: Total: Total score achieved; CA: Correct responses; CDA: Incorrect responses; NET 5 AD: Correct responses in the last 20 trials; NET 5 DIS: Incorrect responses in the last 20 trials; WCST: SUMPE: Sum of all incorrect attempts with errors; PE: Percentage of perseverative errors; PR: Perseveration percentage in the tests; SFMS: Total number of occasions in which an incorrect card is selected; TRIAL FIRST: Number of trials needed to complete the first category after at least 5 correct; CI: Percentage of errors in the first color category; NI: percentage of errors in the first number category; FI: Percentage of errors in the first form category; C2: Percentage of error rate in the second color category; DIFF: Difference in error percentages between adjacent categories.

can be seen that there is an improvement in the different cognitive domains (significant for anterograde memory, divided attention, and interference resistance). This trend towards improvement has been found in other follow-up studies (Ros-Cucurull et al., 2018). In this regard, Wollenweber et al. (2014) found that the cognitive impairments primarily affected frontal-executive functions, while memory was relatively spared, and concluded that cognitive deficits tend to improve with abstinence.

The difficulty seems to lie in determining the time it takes these improvements to occur for each domain (Pelletier, Nalpas, Alarcon, Rigole & Perney, 2016). In our present study, after 6 months of treatment, all functions improved, some more remarkably, such as anterograde memory, working memory, and resistance to interference, but none of the cognitive functions reached the level found in the controls.

Kopera et al. (2012) found differences in neurocognitive performance between short-term abstinent (less than one year) and long-term abstinent (longer than a year) individuals. The first group made more errors on both attention and working memory tests than healthy controls and patients with longer durations of abstinence. This is consistent with our results which also showed that, after 6 months of treatment, compared with controls, patients continue to show impairment in attention, both sustained (d2 test) and divided and resistance to interference (Stroop test), and also in working memory (Digit symbol). In addition, we found impairment in other cognitive domains such as processing speed, memory, abstract reasoning, and verbal fluency.

There are neuroimaging data proving that short-term sobriety – 6 weeks in this case – may be sufficient to observe some brain-volume recovery, but does not result in equivalent brain volumes for recovering chronic alcoholics and healthy controls (Zahr & Pfefferbaum, 2017). If the neuroimaging findings reflect cognitive functioning, this would indicate that there is at least a partial improvement in these functions, but they do not reach the level of healthy people. This assumption is consistent with our results, where "intermediate" results were found at 6 months.

In summary, in our study, we see a general trend toward cognitive improvement after 6 months of follow-up, but this trend in not homogenous for all cognitive variables. Anterograde memory, working memory, and interference resistance improve faster, and the others improve more slowly.

An association between substance-use disorders (SUDs), including alcohol, and impulsivity has been stablished in many studies (Carmona-Perera et al., 2019; Körner, Schmidt & Soyka, 2015; Leeman, Hoff, Krishnan-Sarin, Patock-Peckham & Potenza, 2014; Patton et al., 1995; Verdejo-García, Rivas-Pérez, Vilar-López & Pérez-García, 2007). In this regard, in our previous paper, we found this same result, showing higher impulsivity in the patient group than in the control group. However, 6 months after starting treatment, no within-group differences were observed in patients. This could just mean that the treatment time was less than necessary to detect changes in this aspect or that the relation between alcohol use disorder and impulsivity is bidirectional (Kaiser, Bonsu, Charnigo, Milich & Lynam, 2016), i.e., not only does alcohol use cause impulsivity, but impulsivity can also lead to alcohol use. Körner et al. (2015) found higher impulsivity scores on the BIS-11 in alcohol abstainers (between 2 weeks and 38 years) than in healthy individuals.

In our study, we observed that a reduction in alcohol use or abstinence is related to a reduction in impulsivity, and the three subscales of the OCDS reflect a decrease in the intensity of addiction.

Our data suggest that when patients reduce their alcohol intake and craving as measured with the OCDS, SDU, and biological variables, there is a significant improvement in their cognitive skills, mainly working memory, interference resistance, cognitive flexibility, abstract reasoning, and verbal fluency. In parallel to this cognitive improvement, as expected, we also found a reduction in impulsivity. Thus, it becomes quite clear that patients need to reduce their alcohol intake in order to improve their cognitive performance and reduce their impulsivity.

The OCDS provides us with a useful tool to measure the different aspects of craving (Anton, 2000; Connor, Jack, Feeney & Young, 2008). Our findings show significantly lower scores on the three subscales after 6 months of treatment, reflecting decreases in obsessive thoughts about alcohol and compulsive drinking behaviour.

As we hypothesized, the SDUs consumed daily during the last month, which is a marker of recent use, together the parameters that measure the negative effects of alcohol abuse on blood tests (GOT, GPT, GGT and MCV), had decreased significantly after 6 months of cessation treatment (Giuffredi, Gennaro, Montanari, Barilli & Vescovi, 2003; Harada, Agarwal, Goedde & Miyake, 1985).

It is recommended that all patients at risk of alcohol-related brain damage be evaluated once they have completed at least one week of abstinence to detect the patients most affected and therefore at a higher risk of not responding correctly to treatment (Hayes, Demirkol, Ridley, Withall & Draper, 2016). Our data support this statement. After 6 months of follow-up, there was a significant association between reporting more alcohol addiction with the OCDS and more alcohol intake through SDUs and biological variables and worse baseline performance on the following cognitive functions: working memory, interference resistance, and abstract reasoning. Therefore, patients with worse cognitive performance at baseline made less improvement in drinking reduction,

which is why they need to be detected so that they can receive extra care.

In summary, after 6 months of treatment, anterograde memory, working memory, and resistance to interference significantly improved in patients. However, we still found the effects of alcohol-related brain damage with the rest of the cognitive assessment tools. Our research also shows that the OCDS has predictive utility over time to determine the association between alcohol use and cognitive function. The OCDS is more significantly associated with the cognitive function results than the analytical parameters (GGT and MCV) and the SUD, which were less sensitive for determining this association. This makes the OCDS a good tool in clinical practice. On the other hand, our data shows a trend toward a small but significant cognitive improvement related to a reduction in alcohol use and impulsivity. Executive function, verbal fluency, and working memory are the cognitive functions most significantly influenced by reduction in alcohol use and impulsivity.

All of this leads us to conclude that cognitive impairment can be considered a prognostic factor in outpatients with moderate to severe AUD. Our study shows that cognitive disorders associated with AUD influence the outcomes of outpatient alcohol dishabituation, and this fact is important for daily practice.

Limitations

The present study has limitations that should be noted. The final sample is heterogeneous due to the fact that not all patients achieved abstinence. Estimation of premorbid IQ was not determined, which could influence performance and recovery in neuropsychological tests. Neuropsychological tests give rise to practice effects when used several times in a row. These might partially account for the cognitive improvement between the baseline and the follow-up assessment. Experienced clinicians determined that patients had no symptoms of intoxication prior to evaluation, but no other monitoring methods such as urinalysis or breathalyser were used. Our results show that there is a tendency for cognitive function to improve in different domains but, despite the longitudinal design of this study, it is probable that such improvement continues beyond 6 months of treatment, as reported by Stavro et al. (2013) and Bartels et al. (2006). Thus, it would be interesting to perform another longer-term evaluation. Despite the longitudinal design of this study, it does not establish a relationship between impulsivity measured with the BIS-11 and alcohol use disorder due to the bi-directionality between the two parameters. It must be taken into account that the inclusion and exclusion criteria used in this study meant that patients with low severity AUD were excluded, and the conclusions of this study are therefore applicable only to patients with moderate to serious AUD. Finally, a larger sample size would have provided stronger confirmation of the results obtained.

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Conflict of interests

All authors declare a lack of conflicts of interest regarding the subject matter or materials discussed in the manuscript.

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