Development of a screening test for cognitive impairment in alcoholic population: TEDCA

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Introduction. Several studies have found cognitive impairment in patients with a history of alcohol use disorder, affecting their psychosocial functioning and the achievement of therapeutic goals. In order to identify these effects, several cognitive screening tests have been used, though they were not specific for alcoholic population, possibly leading to an increase in the risk of error.

Objective. The aim of this study is to assess the main cognitive deficits in patients with history of alcohol use disorders, through the development of a specific screening test for alcohol-related cognitive impairment.

Methodology. The TEDCA (Test of detection of cognitive impairment in alcoholism) was designed based on three dimensions: Visuospatial Cognition, Memory / Learning and Executive Function. The study was divided in two phases: During phase 1, test items with greater capacity for discrimination between patients with different levels of cognitive impairment were selected, and during phase 2, the analysis for validity and reliability indexes took place. The sample consisted of 248 participants, 88 controls (phase 2) and 160 patients (phase 1: n=70 and phase 2: n=90).

Results. TEDCA test obtained a high reliability (Cronbach's alpha 0.754) value and the factor analysis confirmed the presence of the three dimensions previously defined. The present screening tool also discriminated between patients and control group, together with a good diagnostic validity of cognitive impairment.

Conclusions. TEDCA is a new screening test, which identifies the possible presence of cognitive impairment in patients with a history of alcohol use disorders, which can be used in the fields of psychiatry, primary care and research.

Keywords: Alcoholism, Cognitive screening, Cognitive impairment, Early detection

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Desarrollo de un test de detección de deterioro cognitivo en población alcohólica: TEDCA

Introducción. Numerosos estudios han encontrado alteraciones cognitivas en pacientes con historia de trastorno por consumo de alcohol, afectando su funcionamiento psicosocial y consecución de objetivos terapéuticos. Para identificar estas afectaciones se han utilizado pruebas de cribado cognitivo a pesar de que no han sido diseñadas para esta población, aumentando el riesgo de error.

Objetivo. Valorar los principales déficits cognitivos en pacientes con historia de trastorno por consumo de alcohol, para desarrollar una prueba de cribado de alteraciones cognitivas específica para estos pacientes.

Metodología. El TEDCA (Test de detección de deterioro cognitivo en alcoholismo) se diseñó en base a tres dimensiones: Cognición Viso-espacial, Memoria/Aprendizaje y Función Ejecutiva. El estudio se dividió en dos fases: En la fase 1 se seleccionaron las pruebas con mayor capacidad de discriminación entre pacientes con diferentes niveles de afectación cognitiva, y en la fase 2 se realizaron los análisis de validez y fiabilidad. La muestra estuvo formada por 248 participantes, 88 controles (fase 2) y 160 pacientes (fase 1: n=70 y fase 2: n=90).

Resultados. El TEDCA obtuvo una fiabilidad elevada (alfa de Cronbach 0.754), el análisis factorial confirmó la presencia de las 3 dimensiones definidas previamente, discriminó entre pacientes y controles, y presenta una buena validez diagnóstica de afectación cognitiva.

Conclusiones. El TEDCA es una nueva prueba de cribado, que permite identificar la posible presencia de afectación cognitiva en pacientes con historia de trastorno por consumo de alcohol, que puede ser utilizado en los ámbitos de psiquiatría, atención primaria e investigación.

Palabras Clave: Alcoholismo, Cribado cognitivo, Deterioro cognitivo, Detección temprana

INTRODUCTION

The harmful use of alcohol represents a global public health problem producing approximately 3.3 million deaths per year, also leading to dependency problems and increases in the risk of diseases such as liver cirrhosis and different types of cancer according to data from the World Health Organization[1]. Alcohol-related disorders occur in some cases associated with the use of other substances[2,3] and/or with the presence of different mental disorders[4,5]. Furthermore, alcohol use disorders are also related to social and family problems[6-8], as well as the presence of cognitive alterations[8] in approximately 50-70% of patients[9].

Numerous studies have found different types of neurocognitive alterations in patients with chronic consumption, in relation to processing speed[8,10], visuospatial cognition[11], alternating and divided attention[10,12], memory[13,14], working memory[8,15,16], decision making[16,17], cognitive flexibility[8,18], inhibition of predominant response (motor) and interference (cognitive)[12,14,17,19] or verbal fluency[14,20]. These deficits usually appear throughout the process of alcohol dependence and remain even in periods of abstinence[6], affecting the psychosocial functioning and quality of life[8], and even the achievement of objectives within the therapeutic interventions[10]. Their evaluation, identification and description is usually carried out by standardized tests or batteries of neuropsychological evaluation not specific for this population, though they allow to obtain a complete cognitive profile of the patients; However, the application is very long, so the required evaluation time is not always feasible and requires trained and specialized personnel in the field. Along with these traditional assessments, there are a number of short screening or screening tests that can quickly identify the possible presence of alterations in the cognitive functioning of individuals, such as the Mini-Mental State Examination (MMSE)[21], The Mini-Cognitive Examination (MEC)[22] or the Montreal Cognitive Assessment (MoCa)[23]. This type of test was created for the detection of cognitive deficits traditionally associated with aging; however, there is no evidence for a specific evaluation/assessment of the cognitive alterations/deficits related to alcohol consumption.

Some investigations have explored the ability of these screening tests to identify cognitive alterations in different populations from the ones they were originally created for, such as the use of the MoCa test in substance use disorders. Copersino et al.[24] used the test with individuals who presented a substance use disorder, without distinguishing between the type of substance, and being subsequently replicated in the Spanish population[25]. The main objective of these investigations was to evaluate the validity, precision and clinical utility of MoCa in the identification of cognitive impairment in patients with substance-related disorders in a clinical research context. However, it has been shown that the profiles of cognitive impairment differ between groups using different substances[26], and this test is not able to discriminate between them.

Recently, the MoCa test has been applied as a screening test in a population with a history of alcohol consumption disorder in France[27]. The authors found that the test was able to differentiate between patients with severe, moderate and mild cognitive impairment in five of the eight domains measured: visuospatial, attention, naming, abstraction and long-term memory, being abstraction and denomination the most affected. Although the authors stated that MoCa was valid for the identification of cognitive affections at different levels in this type of patients, the problem is that the test was not designed specifically for the detection of problems in the addicted population, and for that reason it becomes insufficient in addressing important issues that are affected, such as working memory, decision making, cognitive flexibility and inhibition. Due to this particularity, the use of this test could lead to false negatives errors, and to possibly disregard important cognitive aspects that are affected due to prolonged consumption of alcohol and that are considered important in achieving a good adherence to treatment.

The aim of this study is to assess the main neurocognitive deficits in subjects with alcohol consumption disorder (DSM-5 criteria)[28], after at least one month of abstinence, for the subsequent development of a Screening test for cognitive impairment specific for patients with a history of alcohol consumption disorder (Cognitive Impairment Test in Alcoholism, TEDCA). Cognitive deficits were detected through neuropsychological assessment tests chosen for their high level of discrimination in the affection of the different cognitive domains of interest: Visuospatial Cognition, Memory/Learning and Executive Function. Subsequently, the tests/items that better discriminated between moderate and mild affection in patients were selected, in order to construct a tool for screening for cognitive impairment in alcohol consumption disorder, and posterior per-

form the analysis of reliability, validity, and percentile ranks computation of the test, which could be used in the fields of occupational medicine, psychiatry and primary care.

METHODOLOGY

A total sample of 248 subjects participated in this study. In phase 1 of the study, 70 patients diagnosed with a alcohol use disorder through DSM-5 classification[28] were included. In phase 2 of this study, 178 subjects were included, 88 inside the control group and 90 conforming patients' group. The recruitment of participants was carried out through a discretionary method of sampling. Patients group was composed by individuals attending to psychotherapy inside the Addictive Behavior Unit at the 12 de Octubre Hospital (Madrid). Selection for control group included companions, family members and hospital workers without alcohol-related dependence, paired with patients' group in age and gender. Exclusion criteria for both groups were presenting history of traumatic brain injury and unrelated to alcohol sudden brain injury or other neurological diseases; psychiatric comorbidity; being underage (<18 years old); and presenting consumption, abuse or dependence towards other substances. Table 1 displays the distribution for groups across each phase of the study.

Materials/Instruments

The main cognitive domains affected in alcohol-dependent individuals were evaluated: Visuospatial Cognition, Memory/Learning and Executive Function domains. For the neuropsychological assessment, the following instruments

Table 1 Sample distribution (mean and standard deviation) between phases and sociodemographic data

PHASE 1 (N=70)		PHASE 2 (N=178)	
Patients Group		**Patients Group**	**(n=90)**
Men	51	Men	60
Women	19	Women	30
Age (SD)	**49 (8.54)**	**Age (SD)**	**48 (10.29)**
Educational Level [%]	[%]	Educational Level [%]	[%]
· No Studies	[11.4]	· No Studies	[3.2]
· Primary	[21.4]	· Primary	[23.7]
· Mandatory Secondary Education/Vocational Training (Middle Grade)	[24.3]	· Mandatory Secondary Education/Vocational Training (Middle Grade)	[34.4]
· Baccalaureate/ Vocational Training (High Grade)	[15.7]	· Baccalaureate/ Vocational Training (High Grade)	[26.9]
· University	[15.7]	· University	[11.8]
Mean time of alcohol dependence years (SD)	**11 (6.97)**	**Mean time of alcohol dependence years (SD)**	**16 (10.43)**
		Control Group	**(n=88)**
		Men	49
		Women	39
		Age (SD)	**43 (15.92)**
		Educational Level [%]	[%]
		· No Studies	[2.2]
		· Primary	[10.1]
		· Mandatory Secondary Education/Vocational Training (Middle Grade)	[13.5]
		· Baccalaureate/ Vocational Training (High Grade)	[18]
		· University	[56.2]

were used: *Rey Complex Figure test*[29], *Bender Visuo-Motor Gestaltic Test*[30], *Texts I and II, Direct and Inverse Digits from the Weschler Memory Scale (WMS-III)*[31], *Trail Making Test A and B*[32], *Similarities Test, Matrices Test and Digit Symbol Coding test from the Wechsler Adult Intelligence Scale* (WAIS-IV)[33], the *semantic and phonological verbal fluency test* (FAS)[34,35], a *Go-No Go task* and the *Zoo test* (BADS)[36].

Procedure

The study was carried out in two different phases. The application of tests inside the first phase of this study did not require a control group, since standardized tables from each test were used for comparisons. In this manner, data obtained for each subject was converted to a standardized score. Patients were evaluated by neuropsychologists at the Addictive Behaviors Unit from 12 de Octubre Hospital (Madrid). The aim of this phase was to choose those individuals with clearly different scores from healthy subjects. At the end of this phase, the items composing the final test (TEDCA: Test of detection of cognitive impairment in alcoholism) were chosen.

Following the composition of TEDCA assessment test, during a second phase were two groups of study were included (patients and control subjects), for carry out the analysis of reliability, internal consistency, diagnostic and discrimination validity. Eventually, total percentile scores were computed and statistical analysis was performed through SPSS v.20.0[33] package.

Data analysis

In the beginning of the analysis, tests where patients scored lower than the standardized test scores were detected. With the purpose of obtaining better discrimination values between patients with mild and moderate cognitive affectation, the Johnson Reactive Discrimination procedure was used. According to this procedure, total scores, arranged by ascending order, were computed and compared between subjects with 27% higher scores (superior to 73 percentile) and subjects with lower scores (inferior to 27 percentile)[37,38]. Further, Chi-Square (ordinal qualitative variables) tests and Student T comparisons for independent samples (continuous quantitative variables) were computed, prior to the selection of tests with better discrimination values from experts (psychiatrists and clinical neuropsychologists).

During the second phase of this study, differences between groups were analyzed for each applied item through Student T test for independent samples. Cronbach's alpha coefficient was employed for reliability and internal consistency analysis. Factorial analysis was carried out through Barlett and Kaiser-Meyer-Olkin tests, along with the correlations matrix's determinant. Construct validity was computed through the Principal Component Factor Analysis, extracting three theoretical expected factors (*Visuospatial Cognition, Memory/Learning and Executive Function*). Factor rotation was carried out through the Direct Oblimin method. In order to demonstrate TEDCA's discrimination capacity between patients and healthy subjects, one-factor ANOVA analysis was used, in relation to total scores obtained on the test and scores obtained for each factor. Diagnosis validity was calculated by means of ROC curve analysis, with sensitivity and specificity values, as well as cutoff points.

RESULTS

Phase 1

First phase comparisons between results obtained by patients and standardized tests scores showed values inferior to the mean for: *Rey Complex Figure* (Copy, time required for copy and recall); *Digits, Letters and Numbers, and Learning List* (WMS III); *Bender Test*; *TMT-A*; *TMT-B*; *Texts I*, *Texts II*, *Similarities, Matrices and Digit Symbol Coding* (WAIS IV); *Phonological and Semantic Verbal Fluency*; *Go-No Go* performance and *Zoo* test (BADS) (Table 2).

Regarding the selection for tests where patients had poorer performance, the sample was divided in two groups: those with inferior to 27 percentile scores and those where scores were superior to 73 percentile, with the aim of making possible the discrimination between patients with mild cognitive affectation and moderate cognitive affectation, by finally selecting the following tests: *Rey Complex Figure* (Copy) ($p<0.000$), *Direct Digits* [item: 3 ($p<0.000$) and item 4 ($p<0.000$)], *Inverse Digits* [item: 3 ($p<0.000$) and item 4 ($p<0.000$)], *Numbers and Letters* [item: 2 ($p=0.078$) and item 3 ($p<0.000$)], *Learning List* ($p<0.000$), *TMT-B* [time ($p<0.000$) and errors ($p<0.000$)], *Similarities* [item 4 ($p=0.014$), item 6 ($p<0.000$), item 7 ($p=0.010$), item 8 ($p=0.027$), item 9 ($p<0.000$), item 10 ($p=0.001$) and item 11 ($p=0.010$)], *Matrices* [item 5 ($p=0.010$), item 6 ($p=0.003$), item 7 ($p=0.001$), item 8 ($p<0.000$), item 9 ($p<0.000$), item 10 ($p<0.000$), item 11 ($p<0.000$)], *Bender Test* [item 4 ($p<0.000$), item 5 ($p=0.001$) and item 6 ($p=0.005$)], *Phonological and Semantical Verbal Fluency* [Animals ($p<0.000$) and phonetic keys F ($p<0.000$), A ($p<0.000$) and S ($p=0.000$)], *Go* [Errors ($p<0.000$) and *No Go* [Errors ($p<0.000$) performance].

Finally, items/tests chosen by clinical experts (psychiatrists and neuropsychologists) for TEDCA's composition, considering their discrimination capacity were: *Rey Complex Figure* (Copy), *Bender Test* (item: 4), *Direct Digits* (item: 4), *Inverse Digits* (item: 3), *Numbers and Letters* (item: 3), *Lear-*

Table 2 Values obtained (mean and standard deviation) by the group of patients in phase 1 compared to those obtained by the population sample corresponding to each test

Test	Mean (SD)	Population Mean (SD)
Rey Complex Figure Test		
Copy	29.39 (4.66)	30.48 (3.45)
Copy Time (seconds)	237.15 (149.64)	192 (0.99)
Memory	14.55 (6.81)	21.48 (5.54)
WMS III (35-54)		
Digits	12.85 (3.61)	15 (0.33)
Numbers and Letters	7.44 (3.17)	10 (0.33)
Learning List	27.81 (6.38)	36 (0.33)
Texts I	6.17 (2.88)	39 (2.33)
Texts II	4.41 (2.74)	24 (1.33)
WAIS IV		
Similarities	17.27 (5.42)	20.5 (0.83)
Matrix	12.62 (5.88)	17.5 (0.83)
Digit Symbol Coding Test	49.20 (18.53)	62 (2.33)
TMT-A		
Error	0.18 (0.66)	-
Time (seconds)	67.41 (43.66)	29
TMT-B		
Error	1.55 (1.99)	-
Time (seconds)	155.04 (119.30)	75
Bender	4.81 (3.52)	0
Verbal Fluency		
F	10.18 (3.35)	11 (3.16)
A	10.21 (4.10)	10.82 (2.72)
S	10.98 (4.29)	12.53 (3.24)
Animals	16.12 (4.94)	21.82 (3.84)
Go-No Go 1 (Error)	0.60 (1.06)	-
Go-No Go 2 (Error)	1.37 (1.54)	-
Zoo	3.31 (1.55)	2.44 (1.13)

ning List, *TMT-B* (Errors), *Similarities* (items: 6 y 9) and *Go-No Go* performance, with the discrimination values displayed in the previous section.

Phase 2

Along the second phase, items with better discriminant capacity were slightly modified with the purpose of accelerating and reducing the time needed for application. *Bender Test* item score was inverted (modified), meaning, a "2" score would correspond to a perfect execution, "1" to a rotation error in the figure (or at least part of it in 45 degrees or more) or an integration error (failing in the integration of the square and the circle) and "0" for both rotation and integration errors. *Direct* and *Inverse Digits* were reduced from two to one series, on both tests. Regarding *Numbers and Letters*, series were reduced from three to two. *Learning List* was reduced in trials, from four to three and in number of words from twelve to nine. Finally, Go-No Go performance was carried out without considering number of errors, only taking into account successful completion.

Following the described transformations, TEDCA was applied to the sample from the second phase of this study, constituted by 88 control subjects and 90 patients, whose results for each item were: Rey Complex Figure [Pc (Mean for Patients): 18.76 (6.77); Ctr (Mean for Controls): 26.36 (6.02); t=7.906; p<0.000], Bender [Pc: 1.12 (0.44); Ctr: 1.62 (0.48); t=7.184; p<0.000], Digits [Pc: 1.16 (0.76); Ctr: 1.54 (0.64); t=3.567; p<0.000], Numbers and Letters [Pc: 1.23 (0.83); Ctr: 1.68 (0.57); t=4.173; p<0.000], Learning List [Pc: 18.55 (3.41); Ctr: 20.48 (3.28); t=3.846; p<0.000], TMT-B (Errors) [Pc: 1.50 (1.82); Ctr: 0.35 (0.83); t=-5.419; p<0.000], Similarities [Pc: 0.91 (0.74); Ctr: 1.05 (0.76); t=3.950; p<0.000], Go-No Go [Pc: 1.28 (0.65); Ctr: 1.50 (0.66); t=2.136; p=0.034]. Time of application for TEDCA is 8 to 10 minutes.

Starting with this second application, the manner of scoring items was unified in a scale from 0 to 4. In order to do this transformation, 20, 40, 60, 80 and 100 percentiles were obtained from items in phase 1, with different original scoring, with reference to Rey Complex Figure and Learning List.

Final scores are included in Appendix 2 (Table *TEDCA Scores*). After converting direct scores, internal consistency and reliability, construction and discrimination validity indexes were obtained for patients and control groups, as well as the diagnostic validity for TEDCA and the percentile rank total scores.

Reliability and internal consistency of the instrument according to Cronbach's alpha was α=0.754, showing high significance values p<0.001 (F=77.130; 8 items, n=178;

p<0.000), with a high homogeneity level between the 8 items. Hence, TEDCA's final version reliability was considered suitable.

For the construction validity computation, a factorial analysis was employed, with the objective to demonstrate the adjustment of the test to previous findings pointing that 3 factors are mainly affected in alcohol use disorders: *Visuospatial Cognition, Memory/Learning and Executive Functioning*. The following outcome stand so: In the beginning of the analysis the fulfillment of conditions of correct use was checked, with 0.653 value for KMO test (usually above 0.600 following Tabachnick and Fidell)[39], this way, showing an adequate sampling. The determinant of correlational matrix between the 8 items (0.030) next to the Bartlett sphericity test (Chi-Square: 607.017; p<0.000) allowed to reject the hypothesis of identical matrix with p<0.001, concluding data presented an adequate structure for factoring. For factor extraction, the Principal Component method was used, stopping the extraction process in 3 factors.

All components showed characteristic roots above 1. Total explained variance was 67.78%. Rotation was completed by Direct Oblimin method, obtaining items saturation in 3 factors above 0.400 (Table 3) and demonstrating the theoretical structure of TEDCA in the following manner: *Visuospatial Cognition, Rey Complex Figure Copy and Bender Figure, Memory/Learning: Digits, Numbers and Letters and Learning list; Executive Function: Similarities, TMT-B, Go-No Go performance. Visuospatial Cognition* dimension could be considered as the main factor, since it explains 38.96% of total variance. Following, Memory/Learning explained 15.20% and *Executive Function* explained 13.60% of total variance.

Table 3 TEDCA rotated factor matrix

	Component		
	1	2	3
Rey Complex Figure Test	0.972		
Bender	0.971		
Digits		0.869	
Numbers and Letters		0.688	
Learning List		0.653	
TMT-B (Error)			0.719
Similarities			0.849
Go-No Go			0.472

Extraction method: Main component analysis.
Rotation method: Oblimin normalization with Kaiser.

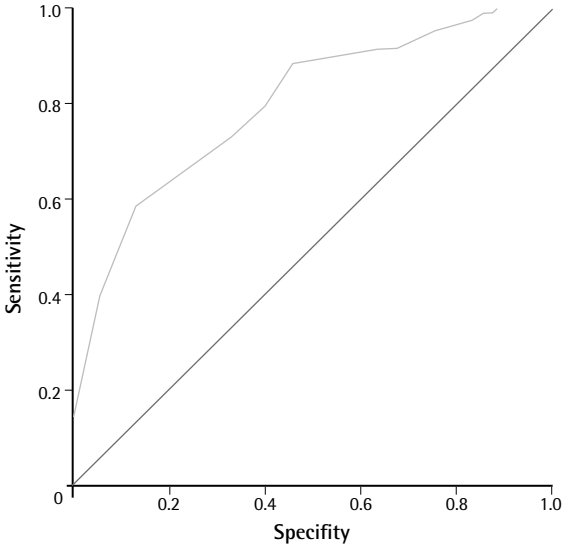


Figure 1 ROC curve in the TEDCA: Total score.

In order to test TEDCA's ability to differentiate between patients with alcohol use disorders and healthy subjects, discriminant validity was computed through one-factor ANOVA testing, for each factor and total scores. Obtained means for each of the 3 factors and total scores show that patients scored significantly lower [*Visuospatial Cognition dimension*: 1.85 (1.82); F: 59.55; p<0.000; *Memory/Learning dimension*: 2.18 (1.73); F: 24.60; p<0.000; *Executive Function dimension*: 3.25 (1.73); F: 19.73; p<0.000; Total scores: 7.30 (3.85); F: 63.73; p<0.000)] than controls [*Visuospatial Cognition dimension:* 4.03 (1.93); *Memory/Learning dimension*: 3.48 (1.76); *Executive functions dimension*: 4.27 (1.28); Total score: 11.79 (3.65)]. These outcomes support TEDCA's validity to discriminate between groups of patients and healthy controls.

Diagnostic validity was performed through ROC curve analysis, establishing sensitivity and specificity values, together with cutoff points of total scores. The value for area under the curve was 0.800 (I.C=95%: 0.736-0.864) with p<0.001, hence, displaying a good diagnostic capacity. The

optimal cutoff point was established at 10.5 score, so that subjects with similar or inferior scores would exhibit cognitive deficits. Sensitivity values for TEDCA reached 0.670 and specificity values were close to 0.767, where false positive would be of 33% and false negatives errors of 23%.

Finally, percentile ranks were computed for the test, inside patients and control groups (Appendix 2).

DISCUSSION

By means of this study, TEDCA (Test of detection of cognitive impairment in alcoholism) shows to constitute a brief, easy application and valid tool for cognitive screening in alcohol-dependent individuals.

On one hand, several studies have used the MoCa screening test in order to asses cognitive alterations in alcohol-dependent patients[24,27]. This test was originally created for cognitive impairment detection in different target populations (e.g. cognitive impairment due to aging), addressing in a superficial manner cognitive aspects that are related to alcohol use difficulties (working memory, decision-making, cognitive flexibility and inhibition)[8,14-19]. On the other hand, TEDCA screening test presents a series of advantages comparing with MoCa. Firstly, it integrates the main affected dimensions in patients with alcohol use disorders: *Visuospatial Cognition*, *Memory/Learning* and *Executive Function*, contributing to an improvement in cognitive evaluation of this type of patients. Secondly, TEDCA allows a flexible and brief assessment. Finally, its use would facilitate early cognitive affectation detection in non-specialized consulting rooms such as Primary Attention, being able to distinguish between different levels of impairment (mild and moderate).

Regarding psychometric properties, TEDCA shows suitable reliability and internal consistency values for its items. As to construct validity, the factorial analysis confirms that the selected and transformed items were distributed in line with research bibliography[11]. The *Visuospatial Cognition* dimension explores visuo-perceptive, visuo-spatial and visuo-construction abilities and it reflects the capacity to identify stimuli as patterns or objects. This dimension is associated to object spatial localization, distance conceptualization, area and volume estimations and it illustrates the organization of spatial relations when elaborating objects[11]. With respect to *Memory/Learning,* this dimension shows the capacity to store information for brief and long periods of time[11]. The *Executive Function* dimension records superior cognitive capacities, requiring the synchronization of several subprocesses so as to reach conscious and non-conscious aims[40]. The most relevant subprocesses include alternate/divided attention, working memory, planning, organization, problems resolution, and abstraction and response inhibition[11].

Concerning discriminant validity, patients' scores were significantly different from healthy participants for each dimension and the total final score. Further, TEDCA presented excellent sensitivity and specificity values when differentiating between groups and checking for presence or absence for cognitive affectation. Comparing to Copersino et al.[24] study, where MoCA was applied to patients with substance use disorders, TEDCA screening test shows lightly smaller sensitivity values, although it has higher specificity. Even though both tests are at similar positions regarding sensitivity and specificity values, MoCA test presents the limitation of being initially created for cognitive impairment detection in other type of patients, whereas, TEDCA screening test has been designed to evaluate specific cognitive alterations found in alcoholic patients, promoting a better cognitive exploration.

Nevertheless, this study presents a series of limitations, such as the sample size. Although this number is sufficient for the presented work's pretensions, an extension in the sample size would raise more specific outcomes and allow to observe the influence of different levels of consumption severity. Concerning future perspectives, a longitudinal application of TEDCA should be considered and evaluated, in terms of sensitivity to changes in cognitive affectation through time-course and abstinence maintenance. Taking into account TEDCA's characteristics, its application should not be limited to the clinical field; it could also be valid for research purposes.

CONCLUSIONS

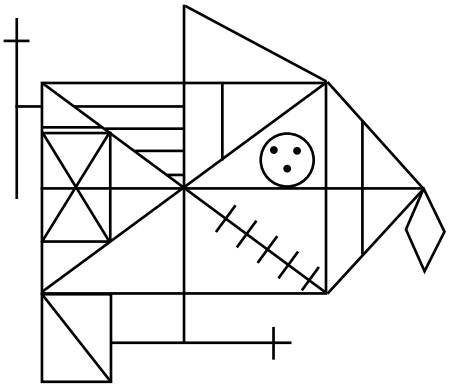
In short, data indicates the constructed test is valid and reliable for cognitive affectation detection in patients with alcohol history consumption, constituting an easy, brief administration by non-specialized healthcare personnel in the clinical and research field.

Appendix 1 | **TEST OF DETECTION OF COGNITIVE IMPAIRMENT IN ALCOHOLISM (TEDCA)**

TEST OF DETECTION OF COGNITIVE IMPAIRMENT IN ALCOHOLISM (TEDCA)	Name: Birth date: Age: Assessment date: Withdrawal time: Age of consumption onset : ID:

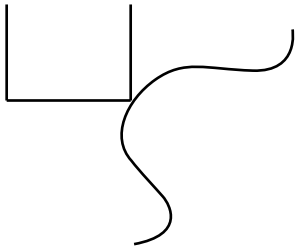
Visuospatial Cognition (___/ 6)

Item 1: Rey Complex Figure Adapted Score (___/ 4)



Score: _____ / 36

Item 2: Bender Figure Adapted Score (___/ 2)



Memory/Learning (___/ 6)

Item 3: Digits (___/ 1)	**Item 4: Letters and Numbers** (___/ 1)
Direct: 4-2-7-3-1	T-9-A-3 (3-9-A-T)
Inverse: 3-2-7-9 (9-7-2-3)	V-1-J-5 (1-5-J-V)

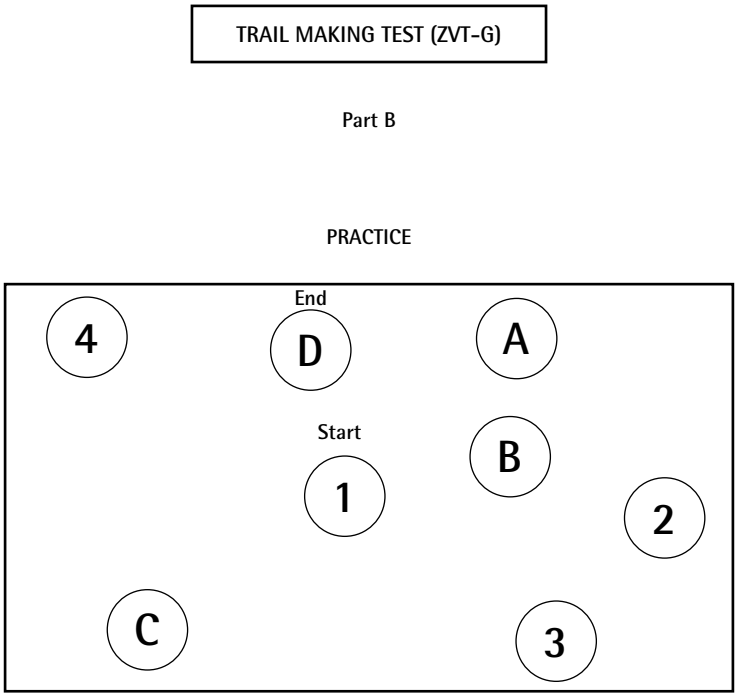
Item 5: Learning List **Adapted Score (___/ 4)**

Words	Trial 1	Trial 2	Trial 3	Total Recall (_____/27)
Bullseye				
Finger				
Sun				Perseverations:
Crocodile				Intrusions:
Coin				
Subway				
Student				
Traffic				
Pine				

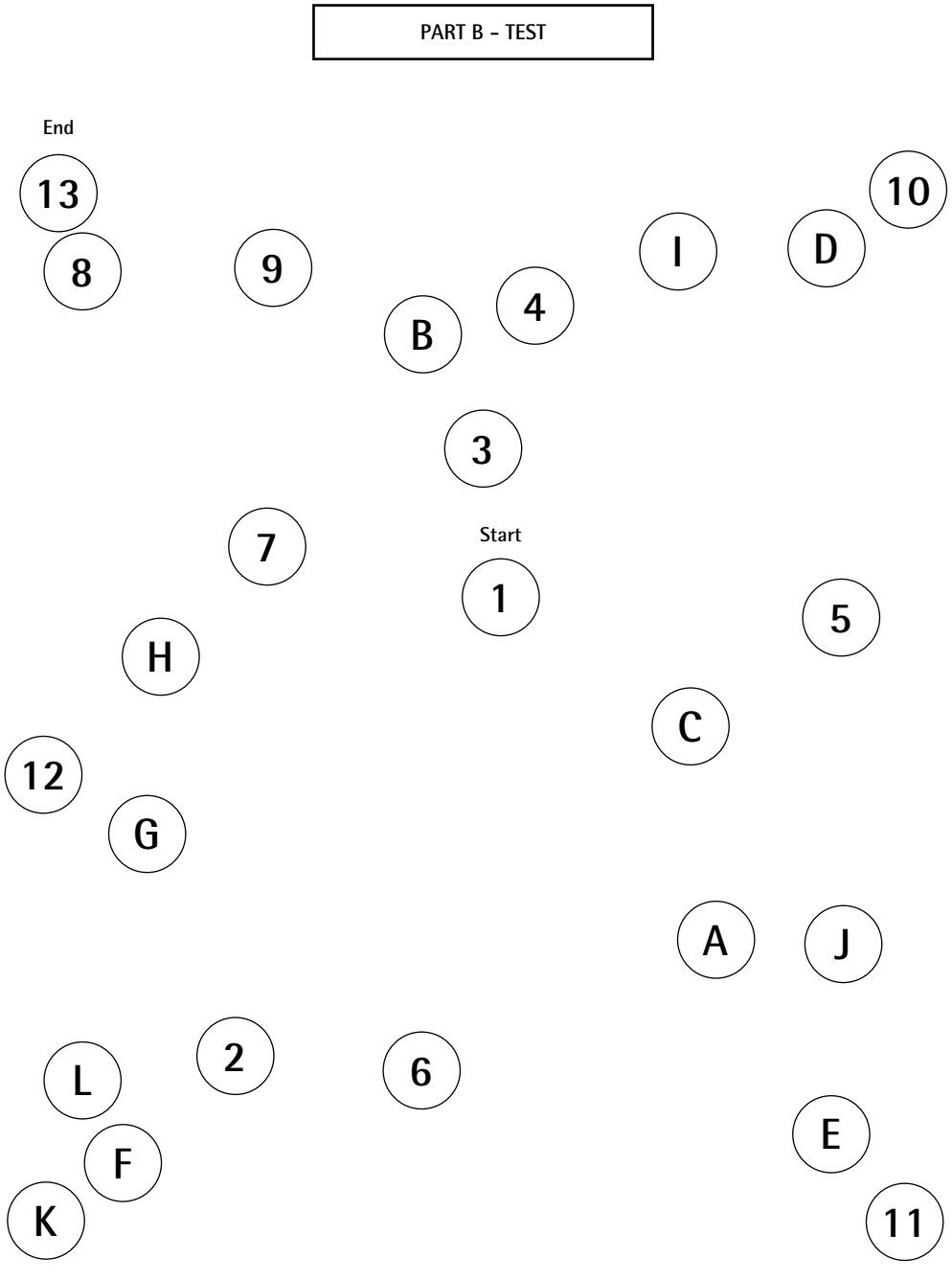
Executive Functioning (___/ 6)

Item 6: TMT-B (___/ 2)	Time:	Error:
Item 7: Similarities		(___/ 2)
A: Socks and Shoes:	B: Food and Gasoline:	
Item 8: Go-Nogo Tests		(___/ 2)
A: 1-2-2-2-1-1-2-1-2-1-1-1-1-2-2-1-1-2-1-2-2 (_____)	B: 1-2-2-2-1-1-2-1-2-1-1-1-2-2-1-1-2-1-2-2 (_____)	
	Total Score: _____ / 18 **Normal > 10,5**	

Appendix 1 | **Continuation**

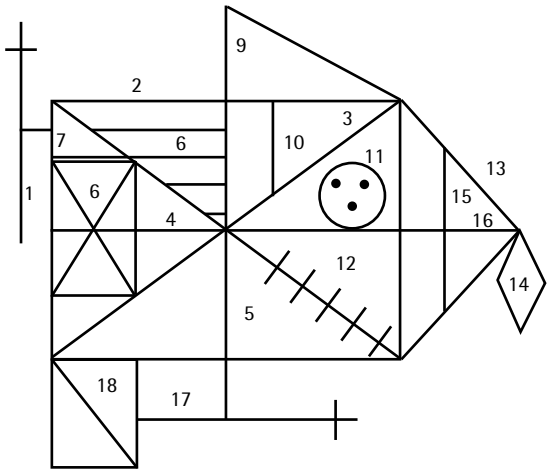


Appendix 1 | **Continuation**



Appendix 1 **Continuation**

Rey Complex Figure Correction Template

Elements	Score
1. Cruz izqui1. Left cross, out of the rectangle 2. Big rectangle 3. Diagonal 4. Horizontal midline of rectangle 2 5. Vertical Line 6. Small rectangle inside 2, on the left 7. Small segment above 6 8. Parallel small lines, inside 2, top left 9. Triangle above 2 10. Small vertical line, inside 2, under 9 11. Circle with 3 points inside, inside 2 12. 5 parallel lines inside 2, that cross 3 13. Sides of the triangle attached to 2 14. Square attached to 3 15. Vertical line inside the triangle 13, parallel to vertical 2 16. Horizontal line inside 13. Continuation of 4 on the right 17. Cross on the bottom 18.Square attached to 2, down left TOTAL	

Additional Notes:

Appendix 2 TEST OF DETECTION OF COGNITIVE IMPAIRMENT IN ALCOHOLISM (TEDCA)

Application and correction protocol

DIMENSION 1: VISUOSPATIAL COGNITION

This dimension is formed by the items 1 and 2 (Rey Complex Figure test and Bender Figure respectively). The total score of this dimension is 6 points.

Item 1: Rey Complex Figure

Application instructions:

The figure will be shown to participants and they will be explained that the task consists in copying the figure inside the box, without be exact necessary. However, is important to pay attention to the proportions and to not forget any element.

Correction instructions:

For the correction of this test, the evaluator will have to take in account 2 aspects: The reproductions quality of the specifics elements in the figure and the placement of these.

Based on the facilitated correction template, the execution of each element will be scored by these criteria.

- Correct execution:
  - Wrong/Incorrectly placed: 1 point
  - Well/Correctly placed:2 points
- Incomplete or distorted execution:
  - Wrong/Incorrectly placed: 0.5 points
  - Well/Correctly placed: 1 points
- Missing or unrecognizable item: 0 points

Total score: 36 points. The values range for the final score assignation, with 4 points as maximum, will be these:

- 0-15 points → 0
- 16-20 points → 1
- 21-25 points → 2
- 26-30 points → 3
- 31-36 points → 4

Note: When interpreting this test's results, it is recommendable to have previous information about the subject's psychomotor skills. A deficit in this aspect can produce a poor execution in the task, that, however, is not due to any visuo-perceptive deficiency.

Item 2: Bender Figure

Application instructions:

The figure will be shown with the instruction of copying the figure inside the box, without the need of executing an identical copy. However, is important to pay attention to the proportions and do not forget any element.

Correction instructions:

The assess of this test has these criteria:

- Perfect execution → 2 points
- Execution with rotation or integration → 1 point
- Execution with rotation and integration → 0 points

Appendix 2 | **Continuation**

DIMENSION 2: MEMORY/LEARNING

This dimension is formed by the item 3, 4 and 5 (Digits, Letters and Numbers, and Learning List respectively). The total score of this dimension is 6 points.

Item 3: Digits

Application instructions:

The test is composed by 2 phases, with the following instructions:

- Participants will be explained that a sequence of digits will be read to them. Then, they have to repeat the sequence.
  - Direct: A sequence of digits will be read aloud. Then, they have to repeat it in the same order.
  - Inverse: Participants will have to repeat the sequence or digits in the inverse order. Next, a sequence of digits will be read aloud. Then, they have to repeat in the inverse order (3-2-7-9 → 9-7-2-3).

Participants can practice to ensure that they understand correctly the inverse mode. For example: "4-2-9-5 → 5-9-2-4" (Never practice with the test sequence).

Correction instructions:

This item will be scored by these criteria:

- Direct and Inverse correct sequence → 1 point
- Direct and/or Inverse correct sequence → 0 point

Item 4: Letters and Numbers

Application instructions:

- It is formed by 2 sequence of letters and numbers.
- Participants will be explained that a sequence of letters and numbers will be read to them, and they have to repeat the numbers in ascendant order and the letter in alphabetic order (T-9-A-3 → 3-9-A-T).

Correction instructions:

- This item will be scored by these criteria:
  - Correct execution in both sequences → 1 point
  - Incorrect execution in one of the two sequences → 0 points

Item 5: Learning List

Application instructions:

It is formed by 3 trials. In each one, a list of words will be read to participants and they have to remember. Then, they have to repeat all words that they remember (in any order).

Correction instructions:

At the end of the third trial, a total recount of recalled words will be done.

- This item will be scored by these criteria:
  - 0-15 remembered words 0 point
  - 16-18 remembered words → 1 point
  - 19-21 remembered words → 2 points
  - 22-24 remembered words → 3 points
  - 25-27 remembered words → 4 points

Appendix 2 | **Continuation**

DIMENSION 3: EXECUTIVE FUNCTIONING

This dimension is formed by the items 6, 7 and 8 (TMT-B, Similarities and Go-No Go tests respectively). The total score of this dimension is 6 points.

Item 6: TMT-B

Application instructions:

This item can be found in the appendix part of the TEDCA document. The instructions will be these:

- They have to link with a line the circles containing numbers and letters in an ascendant and alphabetical order, starting with "1" and ending with "13". In the same manner, they will be informed that is recommendable to not cross the circles.
- Simultaneously, they have to alternate the numbers and letters according to their progress (1-A-2-B-3-C...).
- The time used to complete the sequence and the error will be noted.
- Any alteration in the sequence will be an error.

Correction instructions:

The final scores will be these:

- 2 or more error in the sequence → 0 point
- 1 error in the sequence → 1 point
- 0 error in the sequence → 2 point

Note: In the interpretation of this item, must be taken in account the subject´s psychomotor and vision skills (They have to be able to do a visual discrimination of the circles).

Item 7: Similarities

Application instructions:

The next question will be performed:

"What do these two elements have in common or how are they similar?"

1- Socks and Shoes.
2- Food and Gasoline.

Correction instructions:

- The correct response for the first question is: For (cover/wear) the feet; Clothes (footwear/garment) for the feet; Garment/clothes/complements; Footwear; Clothes for walk.
- The correct response for the second question is: Energy; Source of energy; Give (produce) energy; Fuels; That allows to function; Food; Necessary; Make (person/things) go.
- The final scores will be these:
  - 2 correct answer → 2 points
  - 1 correct answer → 1 point
  - 0 correct answer → 0 point

Appendix 2 | **Continuation**

DIMENSION 3: EXECUTIVE FUNCTIONING (Continuation)

Item 8: Go-No Go Test

Application instructions:

It is formed by 2 sequence of numbers, A and B. The evaluator will hit the table in function of the sequence: "1" → 1 hit, "2" → 2 hits.

- Sequence A: Participants will be explained that every time that the evaluator hits 1 time the table, they have to hit 2 times the table, and if the evaluator hits 2 times the table, they have to hit 1 time the table.
- Sequence B: They will be explained that every time that the evaluator hits 1 time the table, they have to hit 2 times the table, and if the evaluator hits 2 times the table, they do not have to hit the table.

Correction instructions:

- Final scores:
  - Correct execution in both sequences → 2 points
  - Correct execution in one of the two sequences → 1 point
  - Incorrect execution in both sequences → 0 point

TEDCA SCORE						
ITEM VALUE		0	1	2	3	4
Test						
Rey complex figure	Pe	<20	<40	<60	<80	≤100
	Dc	≤15	16-20	21-25	26-30	≥31
Bender figure		Execution with rotation and integration	Execution with rotation or integration	Perfect execution		
Digits		1 or 2 errors	No error			
Letters and numbers		1 or 2 errors	No error			
Learning list	Pe	<20	<40	<60	<80	≤100
	Dc	≤15	16-18	19-21	22-24	25-27
TMT-B		2 errors	1 error	No error		
Similarities		2 errors	1 error	No error		
GO/NO GO		2 errors	1 error	No error		

Pe: Percentile; Dc: Direct score.

Appendix 2 | **Continuation**

PERCENTILE RANK BY GROUPS FOR THE TEDCA		
	Direct Scores	
Centile	Controls	Patients
100	16<	12<
98	15	
96		11
85		10
81	14	
75		9
68	13	
66		8
60		7
58	12	
46	11	6
37	10	
35		5
31	9	
27		4
23	8	
18		3
16		2
12	7	
10	6	
9	5	1
5	4	
3		0
2	3	
1	2	
0	0	
Mean (SD)	11,79 (3,65)	7,30 (3,85)
The standard deviation is shown between parenthesis.		

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CONFLICTS OF INTEREST

None of the authors holds conflicts of interest with any public or private entity.

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