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Neurocognitive assessment in alcohol abuse and dependence: implications for treatment

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Abstract

The aim of the Neuropsychology applied to the Alcohol Dependence field is the comprehension of the effects of brain dysfunction on cognition and human behavior. It investigates neurocognitive impairments and associates them to structural and functional neuroimaging findings (CT, MRI, PET and SPECT). Acute use of alcohol impairs attention, memory, executive functions and visuospatial skills, while chronic abuse causes neurocognitive deficits in memory, learning, visuospatial functions, psychomotor speed processing, executive functions and decision-making, and may lead to persistent amnesic disorder and alcoholic dementia. Executive Dysfunction related to frontal lobe has direct implications on treatment, by the choosing of strategies and for prognostic evaluation. It is presented an easy tool to screen cognitive impairments, the Frontal Assessment Battery – FAB[15]. Neuropsychological Assessment is useful for early detection of impairments and evaluation of their evolution and Cognitive Rehabilitation has a significant role on deficits recovery and psychosocial adjustment of these patients.

Keywords: *Alcoholic beverages. Therapy.*

Introduction

The use of alcohol is increasingly prevalent in our country and remains associated with innumerable social, economic and health problems. Considering that alcohol is a neurotoxic substance, it is common the occurrence of brain problems among patients, which have been proved by means of neuroimaging techniques (CT, MR, PET and SPECT)[1 2 3] not only in the first days of withdrawal, but also months after the last use of the substance.[1]

Neuropsychology, in turn, is a subarea of neurosciences, practiced by psychologists, which seeks the understanding of the relationship of brain impairment and the effects on the subjects' cognition and behavior.[4] In the alcohol abuse field, neuropsychology is committed to describe the cognitive, behavioral, and emotional alterations, and the quality of mental functioning, to perform the analyses of potentials, to predict the recovery course and to estimate the pre-morbid functioning (previous) of substance users.[4 5] It is also within neuropsychology that we accomplish activities to recover or attenuate the neurocognitive deficits found in patients, known as *cognitive rehabilitation*.[7]

Acute effects of alcohol

The impairing effects of alcohol in the cognitive function have been well studied in the final stages of alcoholic dependence.[v8] although the literature on its acute effects is still scarce. During the intoxication period, alcohol abusers have in general a state of confusion and decreased attention level, as well as deficits in most of the cognitive areas examined.[5] Weissenborn and Duka[9] have documented the effects of a moderate dose of alcohol (0.8 g/kg) in the cognition. They have observed that alcohol influenced negatively the executive functions, besides interfering with spatial recognition. According to Lezak,[4] the executive functions include the capability of starting actions, planning and predicting ways of solving problems, anticipating consequences and changing strategies in a flexible way, monitoring the behavior step

by step and comparing the partial results with the original plan. When compared, binge-drinkers had worse performance in the tasks of spatial recognition and short-term memory than moderate and heavy alcohol users. Verster et al.[10] have studied the effects of acute intoxication in the immediate and delayed memories, as well as in the maintenance of vigilance, assessed in the morning after an evening of binge drinking. The results show that immediate memory, related to short-time storage, remained unaltered, although with impairment in the delayed recall in the group of alcohol users. Vigilance was not altered, indicating that the impairment in delayed memory is not related to sedation, but directly to the capability of retaining information.

Chronic effects of alcohol

Although the patients' intellectual level remained almost intact,[6] alterations in several cognitive functions have been reported, even after abstinence periods, what evidence the long-term effects of alcohol in the brain general functioning. According to the literature, these deficits are increasingly worse the greater is the pattern of use, maintaining a continuum between social drinkers and alcohol-dependent subjects.[11] Cognitive alterations vary, from the severest neuropsychological deficits, such as those found in Korsakoff syndrome, up to the moderate impairment of alcohol-dependent subjects or to the alterations found in alcohol abusers. There is evidence that even social drinkers, who ingest 21 or more weekly doses (each dose contains 12 g of alcohol) already have neurocognitive alterations in some mental functions.

According to an extensive review on the subject, Parsons[11]has outlined the main cognitive deficits found in alcohol-dependent subjects. The most common alterations are those related to problems of memory, learning, abstraction, problem-solving, visuo-spacial analysis and synthesis, psychomotor speed processing, speed of information processing and cognitive efficiency. Alcohol-dependent subjects tend to show more errors in the tasks and take more time to complete some activities. There were also found deficits in the executive functions (behavioral inhibition) and in working memory, which is related to a system involving the short-term memory, responsible for the maintenance and manipulation of information in the mind for the accomplishment of complex cognitive tasks.[2] The alterations found in alcohol-dependent subjects seem to represent diffuse brain damage and although they improve substantially during withdrawal, some deficits remain even years after the last alcohol ingestion.[11]

Subjects who use chronically alcohol, although being neurologically asymptomatic, may present dysfunctions in prefrontal lobe areas[12] (Figure 1), implying neuropsychological deficits in verbal fluency (expressive language) and in inhibitory control (difficulty to suppress habitual and automatic responses instead of more elaborated competitive behaviors). These problems seem to be related to the alterations in the executive functions and also in the working memory. According to Bechara et al.[13] pre-frontal cortex (PFC) alterations on alcohol-dependent subjects tend to impair mainly the decision-making process, leading patients to choose the most engaging options regarding immediate gains (as the act of drinking proper), instead of a behavior aimed at the analysis of the future consequences of their actions. PFC alterations, specifically in the orbito-frontal cortex are observed even months after alcohol withdrawal and are probably related to enduring problems in the gabaergic and serotoninergic activities in this region, which influence the decision-making process, the inhibitory control and the behavior of seeking alcohol again, maintaining the process of substance dependence[14]. In order to assess the screening of functions associated to PFC it is indicated the use of the Frontal Assessment Battery (FAB - Appendix I),[15] which is sensitive to frontal lesions and was recently translated to be used with the population of

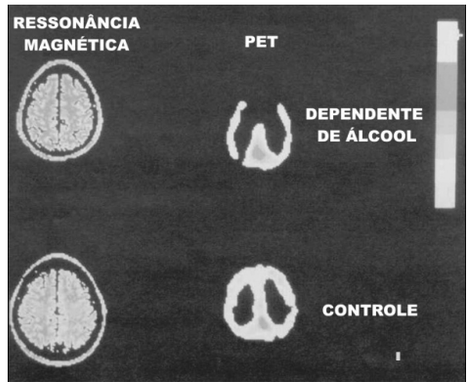


Figure 1- Magnetic Resonance (MR) and Positron Emission Tomography (PET) images in one alcohol-dependent subject (top part) and one healthy volunteer (control, bottom part). Frontal hypometabolism is clearly visible in the image of the patient (PET), together with mild cortical atrophy observed by MR (adapted from Dao-Castellana et al)[12]

drug-dependent subjects (Cunha and Nicastri, submitted).[16]

Brain alterations stemming from the chronic consumption of alcohol may reach very advanced stages of mental deterioration such as in the case of alcohol-induced persistent dementia and alcohol-induced persistent amnesic disorder (Korsakoff syndrome).[17]

Neurocognitive deficits and implications on the treatment

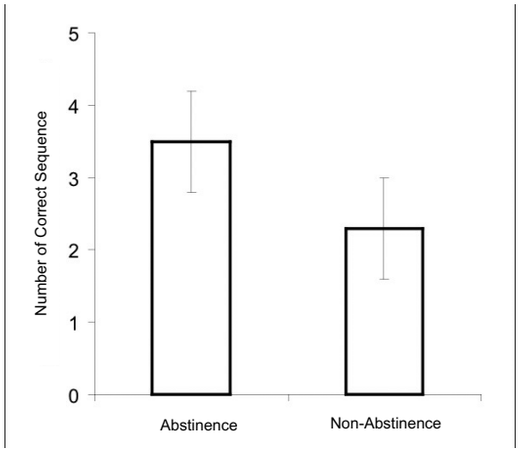
Cognitive deficits found in alcohol-dependent subjects have a direct implication on the treatment, both for the choice of the strategies to be adopted and for the prognostic evaluation.[18] However, most of the treatment programs neither consider the impact of cognitive impairment in the programs' efficacy nor employ techniques of cognitive rehabilitation to remedy the alterations found.[7]

In neuroimaging exams, alcohol-dependent subjects who remain abstinent tend to demonstrate recovery in specific brain areas[1,3,19] and some neuropsychological functions.[3 11] Besides, patients with cognitive and neuroimaging alterations, mainly in frontal brain regions, tend to have a worse prognosis, associated with a higher number of relapses during treatment.[20]

One study by Noël et al.[2] assessed 20 alcohol-dependent subjects, comparing them to 20 normal volunteers, in exams which included neuropsychological tests, involving the functions of inhibitory control, working memory, abstraction capability and verbal memory, as well as analysis of brain function through SPECT. Patients were at the end of a detoxification program, with a mean of 18.8 days of withdrawal. The results indicated problems in the neuropsychological and brain function of patients, when compared to controls, mainly in behavioral inhibition and working memory functions. The findings showed significant correlation with worse functioning of brain frontal regions in alcohol-dependent subjects.[2]

In one follow-up study,[3] patients were contacted again, two months after the first assessment, in order to verify those who had remained abstinent and those who had relapsed during that period. It was observed that, of the 20 alcohol-dependent subjects, 11 had relapsed and nine had remained abstinent. Regarding the results, the researchers found that patients who had relapsed in that period showed, in the period of detoxification, worse performance in tests involving behavioral inhibition and working memory (Figure 2), as well as already shown higher frontal alterations, regarding those who had remained abstinent.

According to the authors, there are several possible clinical interpre-



Graph 1. Relationship between neurocognitive performance of al- cohol-dependent subjects and maintenance of withdrawal

NOTE: *The results are represented by the mean and standard deviations regarding the number of correct sequences. The test used (Alpha-span Test) measures the working memory of patients, which is the capability of storing and manipulating verbal information in the mind. The data analysis indicated a statistically significant difference ($p<0.05$) between the performance of abstinent alcohol-dependent subjects from those who relapsed after two months (adapted from Noël et al.)*[2]

tations for these findings. First, that the executive functions, which involve the working memory and behavioral inhibition, are crucial to control the 'automatic' behavior of drinking and consequently to prevent relapses. Besides, behavioral inhibition and working memory would be important functions to plan daily life activities, such as following a conversation, maintaining and accomplishing projects, etc.[3]

Neuropsychological reassessment and cognitive rehabilitation of alcohol-dependent subjects

Patients with persistent cognitive problems or progressive deterioration in the mental functioning may profit from periodical neuropsychological assessments, which allow a systematized analysis of the changes occurred in the cognitive functioning, indicating the benefits of treatment or the evolution of the neuropsychiatric condition.[5]

Besides, neuropsychology has cognitive rehabilitation techniques, which enable the adequate treatment of these deficits on alcohol-dependent subjects, helping them, initially, to recognize the cognitive alterations as a consequence of alcohol abuse,[21] and, afterwards, to recover the functions or attenuate the suffering and the feeling of psychosocial inadequacy.[7 18] Nowadays, it is known that neuropsychological training and rehabilitation tasks can accelerate and even revert cognitively altered conditions, contributing for the acquisition of new capabilities and for the treatment success.[22]

Conclusions

There are several neuropsychological deficits found in alcohol-dependent subjects, both in acute and chronic use. The cognitive alterations are directly related to compliance with treatment and maintenance of withdrawal, and may be transformed in degenerative disorders as well. However, depending on some factors, such as severity of impairment, age and clinical disorders involved, recovery from the neurocognitive problems found on patients is possible. Neurocognitive assessment, in turn, may be a useful instrument for the detection and assessment of the progress of these alterations, as well as for the cognitive rehabilitation and psychosocial reinsertion of those patients.

Appendix I. Frontal Assessment Battery (FAB)

The Frontal Assessment Battery (FAB) is a new instrument for neurocognitive assessment, which has proven useful to screen problems in the executive functions, associated with the function of the human frontal cortex. The FAB has been already tested in patients with several known frontal disorders[15,] as well as among recovering chemically-dependent subjects.[16]

Form of application

The administration of the FAB takes nearly 10 minutes. The battery has six sub-tests, which assess the conceptualization (abstraction), lexical fluency (mental flexibility), motor programming, sensitivity to interfe rence (tendency to distraction), inhibitory control and autonomy.

1) Similarities: it consists of questions about the similarities between apparently different elements. It is considered a measure of the capability of abstraction. The examiner asks 'in what way are X and Y alike?', considering X and Y the elements contained in the answer sheet. Each correct answer scores one point, and the most complete answers are considered as correct (e.g., a banana and an orange are fruits; a table and a chair are pieces of furniture; a tulip, a rose and a daisy are flowers), totaling at most three points. If, in the first question (banana and orange), the patient completely fails, answering that they 'are not alike', or partially fails and answers that 'both have rinds' or "they are yellow', the examiner should help the patient saying 'a banana and an orange are...'. Anyway, the patient will not score points in this item. The examiner should not help the patient further in the next two items.

2) Lexical Fluency (cognitive flexibility): the person should say as many words as he/she can beginning with the letter 'S', in a 60-second time. The examiner will give the following instructions: 'say as many words as you can beginning with the letter "S", except for verb variations and proper names'. If the patient fails to answer in the first 5 seconds, the examiner could give an example, stimulating the subject to start verbalizing the words. If the patient remains silent for 10 seconds, stimulate him/her again, saying 'any word beginning with the letter "S'. The words are recorded on the answer sheet and, at the end, will be added and grouped according to the category of right answers. For up to three correct words, the patient does not receive points (zero). If the patient is right about three up to five words, he/she scores 1 point, and from six up to nine, 2 points. Above nine words verbalized within one minute, the patient will score the maximum punctuation, 3 points.

3) Motor series: motor functions are also related to the frontal lobes. The examiner, sitting in front of the patient, ask the examinee to look carefully to the fist-palm-edge (FPE) motor series, performed only with the left hand. And then, asks the patient to do this movement, but with his/her right hand, initially following the examiner, and afterwards alone. The punctuation is scored according to the number of correctly performed sequences (FPE), with or without the examiner's help. If the patient does not succeed to follow the examiner in three consecutive series, he/she does not scores points. If he/she follows the examiner in the first three series but fails to perform the movements alone, he/she scores 1 point. But if he/she succeeds to follow at least three series without the examiner's help, he/she scores 2 points, and achieving six or more series (CPS) alone, he/she scores 3 points (maximum punctuation).

4) Conflicting Instructions: the patient should emit a motor answer, immediately after the emission of a sound stimulus produced by the examiner, which contrast with the initial behavior. It is a task in which the verbal orders conflict with the sensorial stimulation, inducing distraction in the accomplishment of the task. Firstly, the examiner explains to the patient that he/she must tap on the table twice when

hearing a tap. Then the example is given, and the patient is requested to follow according to the explained rule. Next, a new rule is inserted, indicating that the patient should tap just once in case he/she hears two taps on the table. After the examples are understood, the patient should follow the rules in a mixed way, in which the examiner will mix one tap with two, in the following series: 1-1-2-1-2-2-2-1-1-2. In order to record the information, patients do not score points if they imitate the examiner (e.g., for one tap, answers with one tap). One point will be scored for those patients who display more than two errors. In case patients display 1 to 2 errors, they score 2 points, while three points are given to those who had no errors during the exercise.

5) Inhibitory control (*Go - No Go*): task similar to the previous one, although the order of movements is modified. In this phase, the patient should inhibit what was previously learned, controlling the tendency to repeat the behavior. The task consists of the patient taping once on the table, after hearing a tap. After the example, he/she should stop taping when hearing two taps. After following the two examples, the patient should follow the same previous series: 1-1-2-1-2-2-2-1-1-2. Regarding the punctuation, the patient does not score a point, if he/she follows the previous pattern for four consecutive times. One point is scored for patients who present two errors or more, and two points are scored for those who display from 1 up to 2 errors. The maximum punctuation is scored for those who have no errors during the task.

6) Prehension behavior (autonomy): the examiner is placed in front of the patient asking him/her not to touch the examiner's hands. The patient, whit his/her palms up, should inhibit the tendency observed in frontal patients who end spontaneously shaking the examiner's hands. The more the patient shows to depend on environmental clues, the more impaired may be the functioning of his/her frontal lobes. If the patient takes the examiner's hands, he/she is oriented not to do it again and, then, the exercise is repeated. The patient does not score a point, if he/she takes the examiner's hands, even after the second instruction. If this occurs only in the first attempt, he/she scores one point. If, while feeling the examiner's hand he/she hesitates (e.g., moving his/her hands) and is in doubt about taking or not the examiner's hands, he/she scores two points and if he/she does not take them, scores the maximum punctuation (3 points).

Total Punctuation

According to what was described above each of the sub-tests is equivalent to, at most, three points. Added, the six sub-tests will total 18 points, which are the maximum possible punctuation obtained in the FAB. In table 1, it is possible to observe the results obtained in the validating sample of the FAB,[15] as well as some data from samples of chemically-dependent subjects and normal controls in our population[16].

According to the data in Table 1, patients with known frontal lesions display, often, total FAB score with mean of 10.3 (sd=4.7). Punctuations between 16 and 18 remain within the mean range, including the standard deviation, but scores lower than 15 may indicate a dysfunctional pattern in the patient's frontal lobe regions (although not assuring the existence of those disturbances).

Final considerations about the FAB

It is important to highlight that this assessment battery represents only the beginning of the exam of frontal functions, being, therefore, a cognitive screening test. Only the specialist in neuropsychology may confirm or not the presence of an executive dysfunction, mainly if the result is corroborated by relevant clinical information (age, gender, cultural background, pre-morbid cognitive level) by other tests for frontal assessment, such as Digits (WMS-R), Stroop Color Word Test (SCWT) and Trail Making Test (TMT)[4].

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Table 1 – Sociodemographic and performance characteristics in the FAB of subjects examined in available studies

EXAMINED GROUPS	N	AGE	FAB
Patients with Frontal Lesions[15]	121	64.4 (9.3)	10.3 (4.7)
Chemically-dependent subjects (Cocaine)[16]	15	31.80 (8.30)	15.73 (1.16)
Normal controls - Elderly[15]	42	58.0 (14.4)	17.3 (0.8)
Normal controls – young adults[16]	13	26.85 (7.35)	17.15 (1.14)

Scores: result =mean (± standard deviation)

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FRONTAL ASSESSMENT BATTERY(FAB)

Name: _____

1. Similarities: 'In what are _____ and _____ alike?'	Points (0 or 1)
a) banana and orange*:	
b) table and chair:	
c) tulip, rose and daisy:	
Total: ❒ 0 ❒ 1 ❒ 2 ❒ 3	

2. Lexical fluency (mental flexibility):.

_____

_____

Total: ❒ 0 (<3 words) ❒ 1 (3-5 words) ❒ 2 (6-9 words) ❒ 3 (>9 words)

3. Motor series (programming)

Total: ❒ 0 (0 following) ❒ 1 (3 following) ❒ 2 (3 alone) ❒ 3 (6 alone)

4.Conflicting Instructions (sensitivity to interference)

Examples: 'Tap twice when I tap once' (1-1-1); 'Tap once when I tap twice' (2-2-2)

Series: 1-1-2-1-2-2-2-1-1-2.

Total: ❒ 0 (performs as the examiner) ❒ 1 (> 2 errors) ❒ 2 (1-2 errors) ❒ 3 (no errors)

5. Inhibitory control (*Go-No Go*)

Examples: 'Tap once when I tap once' (1-1-1); 'Do not tap when I tap twice' (2-2-2)

Series: 1-1-2-1-2-2-2-1-1-2.

Total: ❒ 0 (repeats 4 consecutive times) ❒ 1 (> 2 errors) ❒ 2 (1-2 errors) ❒ 3 (no errors)

6. Prehension behavior (environmental autonomy)

Total: ❒ 0 (takes the examiner's hands, even after being told not to do so) ❒ 1 (takes the hands) ❒ 2 (hesitates and asks what to do) ❒ 3 (does not take the examiner's hands)

Total (FAB): ____ points