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Evaluation of executive functions by NEUROPSI in patients who attend "AA" for drug and alcohol use

Evaluación de las funciones ejecutivas mediante NEUROPSI en pacientes que asisten a centro "AA" por consumo de drogas y alcohol

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Abstract

Executive functions are the set of skills of human beings that allow planning, organizing, regulating and exercising a correct behavior or decision making according to the environment in which he/she lives.

Objective: To evaluate neurocognitive and executive functions using the NEUROPSI neuropsychological battery in patients attending the "AA" Rehabilitation Center in the State of Durango.

Methodology: exploratory, non-experimental, observational research based on the NEUROPSI brief neuropsychological assessment instrument in Spanish.

Contribution: in a sample of 20 participants the following results were obtained: 60% of the population studied presented alterations in neurocognitive functions, 15% presented mild alteration, 25% moderate alteration and the other 20% severe alteration. Regarding executive functions, there is a correlation with marijuana consumption, which directly affects the ability of motor functions in terms of following instructions, sequence, execution and visuospatial coordination, with a p-value of 0.05.

Executive functions, addiction, Neuropsychological assessment, NEUROPSI

Resumen

Las funciones ejecutivas son el conjunto de habilidades del ser humano que permiten planificar, organizar, regular y ejercer un comportamiento o toma de decisiones acertadas según el entorno en el que se desenvuelve.

Objetivo: Evaluar las funciones neurocognitivas y funciones ejecutivas mediante la batería neuropsicológica NEUROPSI en pacientes que asisten al centro de Rehabilitación "AA" del Estado de Durango.

Metodología: investigación de tipo exploratorio, no experimental, observacional con base al instrumento de evaluación neuropsicológica breve en español NEUROPSI.

Contribución: en una muestra conformada por 20 participantes se obtuvieron los siguientes resultados, el 60 % de la población estudiada presenta alteraciones en las funciones neurocognitivas, el 15 % presenta alteración leve, el 25 % alteración moderada y el otro 20 % alteración severa. En cuanto a las funciones ejecutivas existe una correlación con el consumo de la marihuana, que afecta directamente a la habilidad de funciones motoras en cuanto a seguimiento de instrucciones, secuencia, ejecución y coordinación visoespacial, con una p de 0.05.

Funciones ejecutivas, adicción, Evaluación Neuropsicológica, NEUROPSI

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Introduction

Human beings have the ability to perform multiple tasks at different levels of complexity thanks to the cognitive functions we possess. According to Ardila, Matute & Rosselli, (2010), cognitive processes comprise a wide variety of mental functions, including attention, memory, perception, language and problem-solving skills. Each of these is correlated with the maturation of the central nervous system (CNS).

Within these mental processes we can mention the executive functions, Baron (2004) speaks of them as "Executive functioning skills allow an individual to perceive stimuli in their environment, flexibly change their direction, respond adaptively, anticipate future goals, consider consequences, and respond in an integrated or common sense manner".

It can then be understood that Executive Functions (EF) are complex mental activities necessary to plan, organise, guide, review, regulate and evaluate the behaviour necessary to achieve full performance of human beings in their environment. Bauemeister (2008)

The term Executive Functions (EF) is used to refer to the goal-oriented control functions of the PFC (prefrontal cortex), making it possible to lead a life within social norms, e.g., getting a suitable job, remembering study subjects, inhibiting impulsive and erratic behaviour, the ability to act correctly in unexpected situations and requiring greater control and attention. Luria (1974).

Some of the factors that can affect the performance of these functions is the use and abuse of toxic substances such as alcohol and drugs, which create direct damage in various brain areas, including the frontal region, prefrontal, cerebellum and others, where important processes that humans develop every day are created (Fernando Rubén Manzini and Christian Luis Bender pp 11-15, 2007).

Alcohol, a psychoactive substance with dependence-causing properties, has been widely used in many cultures for centuries. Harmful use of alcohol causes a high burden of disease and has important social and economic consequences (WHO 2005).

Rational

Information provided by the World Health Organization (WHO, 2022) shows the increase and severity of substance use such as drugs and alcohol, which highlights the following:

– The increase in deaths due to harmful use of alcohol is represented by 5.3% worldwide.

– The permanent use of alcohol is implicated among the main factors for more than 200 diseases and disorders.

– A link has been established between heavy and continued alcohol use and mental and behavioral disorders as well as other non-communicable diseases and injuries.

In terms of drug use, the World Health Organization (WHO, 2011) reveals that in the Americas, drug use has emerged as a major contributor to disability and death. Drug use disorder is one of the top 10 factors contributing to the loss of healthy life years due to premature death and disability.

Following on from the World Health Organisation (WHO, 2012) report that during the pandemic, there has been an increase in the use of drugs and alcohol.

Taking this information into account, it seems essential to know the neurological repercussions obtained in people who consume these substances.

On the basis of this information, it can be argued that there is an increase in cases of cognitive damage, as well as an increase in the dysfunctionality of the people affected in the community, leading to death in serious cases. This research has been carried out with the aim of finding out the current state of executive functions after the consumption of substances harmful to health that have caused addiction.

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Problem

According to the report on the Situation of Mental Health and the Consumption of Psychoactive Substances in Mexico 2021 created by the Mexican Observatory of Mental Health and Consumption of Psychoactive Substances, the rate of consumption of psychoactive substances in the current situation was observed, in which it is stated that 35.8% of the people surveyed had been consumers of substances such as alcohol, tobacco, illegal drugs or medicines without medical prescription, with alcohol being the most consumed substance with 32.5%.

Another important factor highlighted in the report was the response to the questioning of the reasons why they were using drugs: 20.1% of the population surveyed said that they were using drugs to avoid problems that have arisen on a daily basis. Finally, 62.7% of users do not believe they need help related to the use of these substances (CONADIC, 2021, pp 17-20).

Based on the report on the Situation of Mental Health and the Consumption of Psychoactive Substances in Mexico, we can see the relevance that the consumption of toxic substances is having. From a health perspective, the population is increasingly resorting to narcotic drugs that progressively hinder neurological processes, causing an affectation of executive functions.

Hypothesis

H_i: Executive functions are affected by alcohol and drug use.

H_o: Alcohol and drug use do not affect the processing of executive functions.

Objectives

General Aim

To assess neurocognitive and executive functions using the NEUROPSI neuropsychological battery in patients attending the "AA" Rehabilitation Centre in the State of Durango.

Specific objectives

– Prevalence of total executive function scores in people who use drugs and alcohol.

– To identify the average total score of executive functions obtained in the NEUROPSI neuropsychological battery.

– Correlation between the variable executive functions and drug and alcohol consumption in patients attending AA.

– To investigate the total score obtained from the evaluation of neurocognitive functions by means of NEUROPSI.

Theoretical framework

One of the most important characteristics that differentiate us from other species and identify us as intelligent and rational beings is the development of the prefrontal cortex. The prefrontal cortex is the area of the brain in which complex, higher cognitive operations such as memorisation, metacognition, learning, reasoning, creativity and impulse and behaviour regulation are performed (Luria, 1989).

Historically, terms have been used that refer to the cognitive processes of behavioural control and regulation, and these concepts have been associated with the frontal lobe and prefrontal cortex.

The frontal lobes appear as anterior structures of the cerebral cortex, located in front of the central fissure and above the lateral fissure. They are further divided into three regions: the orbital region, the medial region and the dorsolateral region, each of which is subdivided into different areas (Ostrosky-Solís, Flores, 2008).

(Luria, 1973) assigned executive functions to the prefrontal cortex of the brain where he explained that the frontal lobes of the brain and its tertiary formations (including the prefrontal cortex) were the last parts of the hemispheres to form. The frontal lobes have the function of forming stable plans and intentions capable of controlling the subject's subsequent conscious behaviour.

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In his book "The brain in action" (1974) he proposes three functional blocks which are organized as follows:

Tone and wakefulness regulation, responsible for maintaining alertness, stimulus regulation and sleep regulation. It is associated with subcortical structures (brainstem reticular formation, midbrain, thalamus and limbic system).

Receiving, processing and storing information, responsible for processing stimuli received through the analysers involved (visual, auditory and sensory). They are located in post-ronglandic sectors of the brain in the parietal, occipital and temporal lobes of both hemispheres.

Program, execute and verify mental activity. It is related to the more developed and complex anterior cortical structures in the human nervous system known as the frontal lobes and primarily the dorsolateral, orbital and medial prefrontal lobes. (Luria, 1974, pp 43 -45).

Based on previous research and on the last functional block mentioned by Luria, further research was carried out and new proposals were created. From then on, executive functions (EF) were defined as the ability to formulate goals, plan and solve problems (Lezak, 1982, p. 43).

On the other hand, Anderson (2008) indicated the evolution of the processes included in the executive functions, in which he incorporated four separable and closely related executive domains: attentional control, cognitive flexibility, goal setting and information processing, all of which act together to enable "executive control".

From this contribution, the executive control system (Anderson, 2002; Anderson and Reidy, 2012) is developed, which includes the following sections, all of which are interlinked.

Cognitive flexibility, including divided attention, working memory, conceptual transparency. Goal setting including planning, conceptual reasoning and initiation. Attentional control, including selective attention, self-regulation and automatization.

Information processing, which includes efficiency, fluency, speed of information processing.

That said, it has been found that people who have a lesion in frontal areas have an impaired capacity for emotional, cognitive and behavioural regulation. The lesions may be caused by an accident or traumatic event, or by long-term use of toxic substances.

According to the World Health Organisation (WHO 2012), a drug is defined as "any substance that when introduced into the living organism can modify one or more of its functions by altering thoughts, emotions, perceptions and behaviours in a direction that may make it desirable to repeat the experience, creating mechanisms of tolerance and giving rise to dependence".

When there is a prolonged consumption of harmful substances, brain processes begin to take place in a different way, affecting their correct function (Galindo Uriarte, et al., 2012).

Likewise, the Royal Academy of the Spanish Language (REA) defines the term addiction as dependence on substances or activities that are harmful to health or psychological balance, or extreme liking for someone or something. (REA, 2022).

Some activities or substances can become addictive because of a chemical response in the brain. When there is an addiction, loss of abilities or difficulty in performing tasks such as planning and executing certain activities can be observed, as well as the potentiation of some impulsive behaviours, thanks to the inhibition of reason; affecting short or long-term memory, as well as directly affecting the mood of people, causing different moods in short periods of time and above all a profound effect on the neurological processes of the user. (Galindo Uriarte, Angulo Rodríguez, Avendaño Palazuelos, 2012).

According to the World Health Organization (WHO, 2018), alcohol consumption is a causal factor in more than 200 diseases and disorders. It is associated with various diseases such as cirrhosis of the liver, some cancers and cardiovascular diseases as well as violent acts and traffic accidents.

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Alcohol consumption increases the risk of provoking a wide variety of social, physical and mental problems, both for oneself and others, and the greater the consumption of these substances, the greater the risk of these situations occurring (Galindo Uriarte, Angulo Rodríguez, Avendaño Palazuelos, 2012).

In this paper we will focus on how drugs directly affect the prefrontal cortex where executive functions are developed.

Damage to the frontal cortex and its relationship with executive functions.

Frontal damage produces very different cognitive and behavioural characteristics, depending on the area(s) that are damaged. For example, damage to the COF will produce alterations in affective and behavioural regulation, while damage to the CPFDL (dorsolateral prefrontal cortex) will mainly affect executive functions.

Flores & Ostroksy-Solís (2008), citing (Lezak, Howieson, & Loring, 2004), mention that the executive functions of the prefrontal lobe are high-level cognitive control processes; they are top-down processes that enable flexible behaviour directed towards goals and objectives. They enable the planning of strategies for initiating and executing actions, and are responsible for the inhibition of impulsive response. They act in conjunction with multiple processes that occur in different subregions of the prefrontal cortex and relate to each other.

In the dorsal portion, the processes of planning, working memory, complex problem solving, cognitive flexibility, anticipation of responses, execution, seriation and sequencing are related, processes which have been considered as part of the executive functions (EF).

Prefrontal cortex: directs the ability to think, plan, solve problems, make decisions and control one's impulses. This is also the last part of the brain to reach maturity, which makes adolescents the most vulnerable (Flores & Ostroksy-Solís, 2008).

Some of the syndromes associated with damage to the prefrontal cortex are as follows (Basuela, E., 2008):

– Dorsolateral prefrontal syndrome

This syndrome, also called dis-executive syndrome, is characterised by a severe impairment in executive functions, causing a high degree of disorganisation in the sufferer. It is associated with impaired attention, deficits in working memory, planning and temporal integration of behaviour.

– Medial prefrontal syndrome

This syndrome presents characteristics of deficiency in the self-regulation of emotions, showing apathy, passivity and inertia, and also shows an affectation in the attentional system.

– Prefrontal syndrome

It presents failures in the self-regulation of emotions and behaviours, showing disinhibited impulsive and antisocial behaviours. Patients affected with this type of syndrome are related to hyperactivity.

Alterations of executive functions due to drugs or alcohol

Among the consequences of drug addiction we can find the appearance of a wide range of psychological disorders, sudden changes in moods and irritability, loss of self-sufficiency; in other cases the appearance of visual and auditory hallucinations, diminished cognitive capacity, deficient language, and the destruction of neuronal networks (Galindo Uriarte, Angulo Rodríguez, Avendaño Palazuelos, 2012).

Drugs directly influence the neurological processes that take place, altering the sending and receiving of stimuli. Although some drugs mimic the brain's own chemical substances, they are not processed in the same way, causing irregularities in neuronal networks, releasing abnormal amounts of neurotransmitters or preventing their correct transport. Drugs such as opioids alter the brainstem, which is involved in functions essential for life (heart rate, breathing and sleep). In case of overdose, they can weaken breathing and cause death (Galindo Uriarte, Angulo Rodríguez, Avendaño Palazuelos, 2012).

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The way in which addiction is generated is due to the constant need to obtain a reward for a stimulus. The corticostriatal circuit is involved in generating the emotions and motivation to obtain the reward after having received the stimulus in question. The areas directly involved are the basal ganglia, amygdala. This circuit is in charge of the frontal cortex that cognitively evaluates the response obtained with stimulus (Lopez, 2018).

The basal ganglia, which play an important role in positive forms of motivation-including the pleasurable effects of healthy activities such as eating, social interaction or sexual activity-and are also involved in the formation of habits and routines. These areas constitute a key node in what is sometimes called the brain's reward circuit. Drugs generate hyperactivity in this circuit, which produces the euphoria felt when taking them. But when the presence of the drug is repeated, the circuit adapts and becomes less sensitive, making it difficult for the person to feel pleasure from anything other than the drug (Lopez, 2018).

The extended amygdala plays a role in stressful sensations such as anxiety, irritability and restlessness, which are characteristic of withdrawal once the drug is out of the system and motivate the person to use again.

Changes in the balance between this circuit and the basal ganglia and extended amygdala circuits cause a person with a drug use disorder to compulsively seek the drug and have less impulse control.

As drug use increases, this circuit becomes increasingly sensitive. And over time, a person with drug use disorder no longer uses drugs to achieve a state of euphoria, but to temporarily alleviate that discomfort. (Lopez, 2018)

When there is damage to the frontal lobe due to habitual and constant drug use, it can give way to various syndromes, resulting in executive dysfunction, which can present itself as (Mariño, N; Castro, J y Torrado, J., 2012):

– Deficiencies in planning, organising and executing activities.

– Difficulty in initiating and completing a task.

– No or little cognitive flexibility.

– Difficulty in evaluating results and inability to switch between tasks.

– Inconveniences in solving problems efficiently and accurately.

– Problem visualizing consequences of different actions or situations.

– Lack of emotional self-regulation.

– Conflict in carrying out tasks that require greater attention and retention of information.

– Appearance of impulsive and inappropriate behaviour.

NEUROPSI

Brief neuropsychological assessment in Spanish. It is a neuropsychological instrument that allows the assessment of cognitive processes in psychiatric patients, patients with neurological problems, among other medical problems. Its application is individual, with a time variation ranging from 20 to 25 minutes in the general population and 35 to 40 minutes in the clinical population. It has a range of application from 16 to 84 years of age. From the age range, the educational level ranges from none, 1-4 years, 5-9 years and 10-24 years.

The areas that are possible to be assessed by such a test include I. Orientation (level of awareness and general state of arousal) II. Attention and concentration (ability to focus and sustain attention) III. Memory IV. Language V. Visuospatial skills VI. Executive functions VII. Reading, writing and arithmetic. The data provided are qualitative and quantitative. From the independent data of each cognitive ability, an individual profile of the subject's abilities and disabilities in the areas that have been evaluated is established. With this, classifications of the degree of impairment can be obtained, ranging from: normal, moderate impairment to severe impairment (F. Ostrosky-Solís, A. Ardila and M. Roosselli, 2000).

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Methodology of the research

This is an exploratory, non-experimental, observational, cross-sectional and correlational study using Pearson with a descriptive statistical analysis. The complex variable, neurocognitive functions, was analysed to determine the prevalence of altered neurocognitive functions, and the signal variables of age, gender and schooling were also considered. For the statistical analysis of the characteristics of the population studied, measures of central tendency and dispersion were used.

Inclusion criteria were considered to be patients attending the alcoholics anonymous first of May group in Durango, Dgo, who wished to participate in the study and had signed a previous letter of informed consent, therefore those patients who did not wish to participate were excluded; as an elimination criterion, those patients who decided to withdraw their informed consent at any time during the evaluation, or those who still had active drug use were discarded; due to this criterion, 3 cases were eliminated, leaving a total of 20 valid cases.

Procedure

Participants were patients who attend a 24-hour alcoholics anonymous group called Primero de Mayo in the city of Durango. Data collection was carried out during the period of September 2020, culminating at the end of September of the same year.

Informed consent was obtained after signing the informed consent form in accordance with the official Mexican standards 004-ssa3-2012 on clinical records and 040-ssa2-2004 on information, and the instruments for data collection and interpretation of the results were applied.

For the study of neurocognitive functions in the patients, the NEUROPSI BRIEF neuropsychological evaluation was used, which is a brief, reliable and objective instrument that allows a broad spectrum of cognitive functions to be evaluated.

It consists of 6 sections that evaluate neuropsychological functions, which are the orientation section with 3 items, attention and concentration with 3 items, the memory section with its sub-sections of encoding and recall memory which consist of 5 items between the two sub-sections, the language section consists of 5 items, the reading and writing section consists of 3 items and finally the section of conceptual and motor executive functions which consists of 7 items.

Rated by the following values: high normal, normal, moderate and severe. Each item is rated according to each sub-area and according to the age range and level of schooling of each subject assessed.

The identification of the signalistic variables and academic performance (gender, age and school average) was obtained through the application of a clinical survey. The statistical analysis of the information obtained was carried out using Excel software.

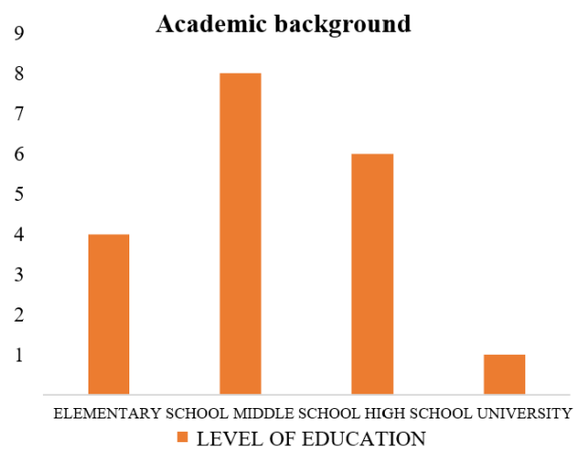
Results

For the results of this research, a total population of 20 people belonging to the 24 hrs Alcoholics Anonymous group "Primero de Mayo" was taken as a sample, explained in the following table.

Population		Percentage
Female	3	15%
Men	17	85%
Total	20	100%

Table 1 Sample population

The age range obtained was between 20 and 69 years, with an average age of 33 years.



Graphic 1 Academic history of the population evaluated

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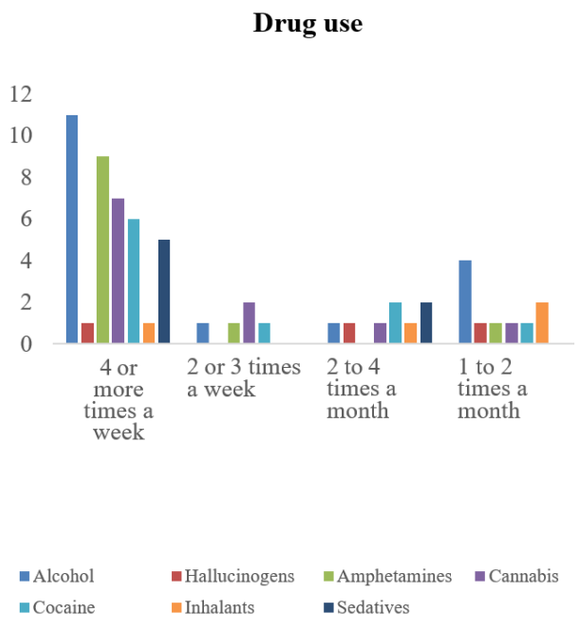
Graphic 1 explains the academic history of the test participants. 4 participants completed primary school, 8 participants completed secondary school, 6 people completed high school and 1 person completed university.

A survey was used which was attached to the clinical history of each patient. It contains information on the type of substance consumed as well as the frequency of consumption.

The results of the survey showed that the substance consumed with a frequency of 4 times or more per week was alcohol by a population of 11 people. On the other hand, amphetamines were found to be the second most frequently used substance in a week by 9 people, and the least frequently used substances in a week were hallucinogens and inhalants.

With less frequency of consumption of one to two times a month in the people evaluated, alcohol prevails in first place, with a population of 4 people who have this preference. As for inhalants, there was a population of 2 people with a low consumption per month, while the rest of the substances such as cocaine, amphetamines, hallucinogens and cannabis all have a lower prevalence of consumption.

Graphic 2 of the drug consumption of the evaluated population is shown below, which is the result of what was collected through the clinical history before the start of the evaluation.



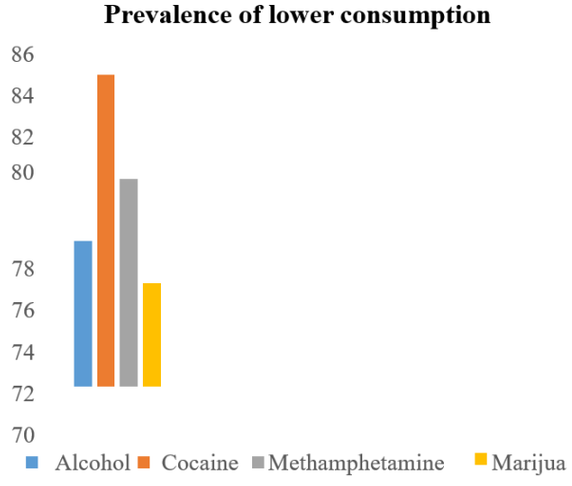
Graphic 2 Drug use

The results obtained by means of the NEUROPSI neuropsychological assessment were a consequence of the evaluation of all areas and sub-areas. The data showed that 40% of the population had a normal result, 15% had a mild result, 25% had a moderate result and 20% had a severe result. Thus, adding the mild, moderate and severe results, we have that 60% of the population has alterations in neurocognitive functions (see table 2).

n	Persons	Percentage
Normal	8	4%
Mild	3	15%
Moderate	5	25%
Severe	4	20%

Table 2 NEUROPSI results

The reliability of the results obtained by means of the brief neuropsychological battery in Spanish NEUROPSI was 0.05, which is a good value of reliability, likewise by means of the parametric test of Pearson that was used in the study allows identifying the relationship between the data obtained; the greater the consumption of toxic substances harmful to health, the greater the affectation of neurocognitive functions, mainly observed in the areas of attention and concentration, memory, executive functions and reading.



Graphic 3 Prevalence of lower consumption

Based on the results of graph 3, the prevalence of the most consumed substances, altered executive functions in patients with alcohol dependence, cocaine, methamphetamine and marijuana is shown.

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In this graph, it can be seen that all the toxic substances cause alterations in executive functions, with marijuana in first place, alcohol in second place, methamphetamine in third place and cocaine in last place, with the least alteration, according to the results of the Neuropsychological Battery, NEUROPSI.

With regard to executive functions, in the sub-area of motor functions, the greatest difficulty is found in changing hand position according to the NEUROPSI test, which evaluates visuospatial coordination, sequence and execution. With a reliability of 95% with a P= 1.73.

Conclusion

Understanding that the brain acts as a whole and not as isolated areas, it is evident that the consumption of psychoactive substances affects the whole brain functioning, however there are areas where the affectation is reflected to a greater extent.

Based on the results obtained from the Neuropsychological NEUROPSI evaluation, the following data were collected, in which it stands out that on average 40% of the evaluated population is classified in a normal range, 15% appears in a mild range, 25% in a moderate range and 20% in a severe range.

Authors such as Bauemeister (2008) define executive functions as the set of complex skills that are indispensable for planning, regulating behavior, habituating, and self-regulating in order to achieve adaptation in the environment in which each person develops.

On the other hand, Flores & Ostroksy-Solís (2008), taking up what has been said (Lezak, Howieson, & Loring, 2004), argue that executive functions act in conjunction with multiple processes that occur in different subregions of the prefrontal cortex, relating to each other. Dorsolateral prefrontal syndrome is characterized by a severe impairment in executive functions, causing a high degree of disorganization in the sufferer. It is associated with impaired attention, deficits in working memory, planning and temporal integration of behavior.

Behaviors that are observable in people who consume alcohol, according to the DSM-IV mentions some of the symptoms presented in people who have consumed alcohol: incoherent language, poor motor coordination, as well as unsteady gait, impaired attention or memory, difficulty in responding to a stimulus (stupor).

Continuing with the DSM-IV, according to the section on cannabis use, psychological or behavioral changes can be observed, also mentioning the presence of motor difficulties, problems in the ability to respond to a stimulus and decision-making, and the presence of varying emotions ranging from euphoria to anxiety. Thus, the consumption of toxic substances coincides with the alteration of skills that are considered to be executive functions. Emphasis was placed on the abuse of alcohol and marijuana due to the ease with which it is possible to obtain these substances in comparison with cocaine and methamphetamines.

It can be concluded that in the 24-hour group of Alcoholics Anonymous "Primero de Mayo" users who participated in the study, 40% were found to be in a normal parameter according to the NEUROPSI evaluation scale, while 60% presented neurocognitive alterations in the areas of attention and concentration, memory and reading comprehension; however, it is recommended that the sample be expanded with a greater number of people who are in different recovery centers.

An invitation is made to the population to create campaigns to prevent the use of drugs and toxic substances such as alcohol at different levels, with emphasis on the secondary and high school levels, since the results showed that most of the participants were vulnerable during this school stage, completely changing their lives, including causing them to abandon their studies.

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