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EVALUATION IN THE THEORY OF MIND AND EXECUTIVE FUNCTIONS IN POPULATIONS WITH DRUG ABUSE

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Abstract. Research into neuropsychological alterations and alterations in social cognition caused by substance abuse has received special interest in recent decades due to the implications involved the design of therapeutic plans and the social consequences that this problem entails. The following project shows an experimental study in order to find significant differences in what refers to the functioning of the Theory of Mind (ToM) and the Executive Functions (EFs) in a population with a diagnosis for substance abuse disorder. ToM is the ability to assign thoughts and different intentions to the behavior and attitude of people. On the other hand, the EFs are the cognitive capacities to carry out the accomplishment of a task thanks to the planning. To verify the proposed objective, two groups were used in the clinical sample: 10 participants with alcohol use disorder and 10 patients with cocaine use disorder, compared to a control group of 20 people of general population. Besides this, it is sought to establish differences in the alterations between both groups of drug-dependent subjects. The results show the participants with cocaine use disorder, in comparison with the control group, have deficit in several elements that make up the EFs and ToM, while the group with alcohol use disorder does not show significant differences, although it does have lower scores than the control group. It can be concluded the existence of differences between people with cocaine addiction and general population in terms of the functioning of EFs and ToM, as well as differences in the implications of alcohol compared to those of cocaine.

Keywords: Theory of Mind, Executive Functions, Drug addiction, Alcohol, Cocaine.

Introduction

Substance abuse disorders (SAD), according to the DSM-V (American Psychiatric Association, 2014), are encompassed by different classes of drugs, their consumption causing an activation of the brain reward system, involved in the generation of reinforcement. Each drug produces disparate effects, but all induce a state of pleasure. A pathological pattern of behavior related to substance abuse is the basis for the diagnosis of SAD.

SAD presents symptoms at the executive, memory, or attentional, behavioral, aggressive and unhealthy behavioral and physiological levels. In terms of diagnostic criteria, it is defined as a problematic use of a substance that generates significant distress. It is manifested by at least two of the following events within 12 months: a) the substance is consumed in high quantities or for a prolonged period of time; b) attempts to stop consumption have failed; c) the time required to obtain the substance is high; d) consumption results in failure to perform daily life tasks and impairment of social life; e) there are physically dangerous situations due to consumption; f) tolerance to the substance appears; and g) withdrawal symptoms appear when consumption is interrupted. (Dolengevich, Rodríguez, Mora & Quintero, 2015).

One of the most serious problems is alcohol use disorder (AUD), being the criteria to establish its diagnosis those established for SAD, specifying that the substance is alcohol. (American Psychiatric Association, 2014) It is a psychoactive substance depressant of the Nervous System (NS) and its intake generates damage to health and socially. (Guitart et al., 2011) The impact it has on health encompasses different diseases. In the cognitive area, the Wernicke-Korsakoff syndrome stands out, divided into: a) Wernicke syndrome, of short duration and characterized by lack of motor coordination, confusion and deficit of control in eye movement and b) Korsakoff syndrome, conic, presents symptoms such as amnesia, difficulty in new learning and apathy. (Shield, Parry & Rehm, 2014)

Referring to cocaine, it is included within the stimulant use disorder. It is an excitatory substance of the NS, the second most consumed illegal drug and it is usually initiated after the twenties. (WHO, 2015) To establish the diagnosis, the same criteria have to be met as for the other SAD, specifying that the substance is cocaine. (American Psychiatric Association, 2014) The effects it causes are: euphoria, alertness, agitation, insomnia, hypersexuality and altered judgment of reality. (Becoña, 2012) In terms of medical conditions, the following stand out, according to the National Institute of Drug Abuse (NIDA, 2010) a) weight loss; b) respiratory failure; c) myocardial infarction and d) stroke.

The substances exert a strong effect on the functioning of the motivational, cognitive, emotional and executive systems. Their consumption causes neuropsychological disorders, especially alterations in memory, attention and EF (Verdejo, In press). It has been demonstrated that the deficit in the mechanisms of inhibition of behavioral control and decision making increases the possibility of consumption and substance dependence. The active search for consumption may be propitiated by the affection at the executive level and behavioral control, which would refer to alterations in the frontal lobe (FL). (Yucel & Lubman, 2007).

Alcohol consumption is associated with different deficits, including: a) alterations in visuo-perceptual organization; b) psychomotor alterations; c) alterations in processing speed and attention; d) alterations in memory and e) alterations in EF. (Gruber & Yurgelun-Todd, 2001) Regarding visuoperceptive and psychomotor impairment, it is complex to establish whether it is due to a motor deficit or to the impairment in EF, since these are involved in the performance of spatial tasks.

Regarding cocaine use, the most significant deficits are: a) attentional and processing speed; b) memory and c) EF. Regarding attention, research has found deficits in selective, sustained, and divided attention without specifying specific impairment. (Landa-González, Lorea & López-Goñi, 2011) In memory functioning, impairment in the visual and verbal component has been established. It has been found that users with cocain

use disorder (CUD) make more errors of omission and commission, which makes them less able to cognitively control behavior. (Frazer, Manly, Downey & Hart, 2017)

The EF concept was established by Lezak (1982) as a set of capabilities related to goal setting, planning for their attainment, and execution of that planning. (Tirapu & Luna-Lario, 2011) It includes skills of behavioral organization, goal selection, initiation and maintenance of mind during their execution, and ability to regulate action. In conclusion, EFs are related to organization, planning, anticipation, inhibition, working memory, self-regulation and control, and flexibility. They can be grouped into five components: working memory, verbal fluency, inhibition capacity, cognitive flexibility and decision making. They are located in the FL, an area capable of planning, regulating and controlling multiple psychological processes and that organizes behaviors according to motivations, achieving goals that can only be reached through procedures and rules. (Flores & Ostrosky-Solís, 2008) The affection of this region causes the person to present difficulties in the management of environmental control, to develop new behaviors and strategies, lack of cognitive flexibility and alterations in the capacity of abstraction of ideas, generating the impossibility of anticipating behavioral consequences and greater impulsivity. (Blanco-Menéndez & Vera de la Puente, 2013).

Research has focused its interest in demonstrating the alterations of alcohol consumers in EF. It highlights the disejective syndrome, characterized by: a) difficulties to focus on a task and finish it without help; b) inability to create new behavioral repertoires; c) deficit in using creative behavior and d) increased impulsivity. (Landa, Fernández-Montalvo & Tirapu, 2004) Patients with AUD present difficulties in the capacity of response inhibition and interference control and, in cognitive flexibility, there is an inability to alternate behavioral schemes. (Landa-González, Lorea & López-Goñi, 2011) Other studies have highlighted the difficulty in working memory and behavioral planning. Also, a generalized impairment in EF has been determined, which hinders planning and problem solving. It has been demonstrated the existence of difficulties in decision making, which may be given by the alteration in reward postponement (Verdejo, In press). (Verdejo, In press) However, it is complex to draw conclusions about the type of damage that has this ability. What has reached a consensus is the alteration in the FL in alcohol consumers, determining that the alteration in EF is the most characteristic in this population. (Landa-González, Lorea & López-Goñi, 2011).

Impairment in EF is one of the major problems generated by cocaine abuse. The capacity for response inhibition is one of the most affected elements, associated with greater difficulty in impulse control and failures in the management of consequences (Madoz-Gurpide & Ochoa-Mangado, 2012). (Madoz-Gurpide & Ochoa-Mangado, 2012) There is inability for delay of gratification and prior reflection of a behavior. (Landa-González, Lorea & López-Goñi, 2011) Cognitive flexibility is another aspect that shows affection, being the ability to change behavioral patterns more rigid than in population without consumption. Difficulty in decision making has been demonstrated, since this type of population prioritizes short-term results related to the reinforcement of consumption, making it impossible to learn and assess long-term consequences. (Landa-González, Lorea & López-Goñi, 2011) Impaired executive control of behavior has been determined in cocaine users, associated with impulses, with impaired working memory, response control and decision making (Vergara-Moragues et al., 2017; Bonet, Salvador, Torres, Aluco, Cano & Palma, 2015).

The term ToM finds its origin in 1978 thanks to Premack and Woodruff and refers to the ability to understand and anticipate the behavior of other people, their knowledge,

intentions and beliefs. It is the ability to infer other mental states. Its capabilities encompass the interpretation of basic emotions, the capacity for metaphorical understanding, lies or irony, the interpretation of social emotions and empathy. It is linked to working memory, verbal fluency and EF. (Sanvicente-Vieira, Kluwe-Schiavon, Corcoran & Grassi-Oliveira, 2016) It has been divided into two levels, the first being the ability to think about what another person thinks and, the second, the ability to think about what a person thinks about a third party. (Tirapu-Ustárroz & Sánchez-Cubillo, 2011) It is a process in which mechanisms work to perceive, process and evaluate stimuli and elaborate a representation of the social environment. The regions involved are located in the temporal lobe and work with structures such as the amygdala and the orbitofrontal cortex. (Calle, 2014)

In relation to consumption, several studies have shown impairment of this capacity. Patients with AUD show lower capacity for behavioral inhibition, and this suggests that such behavior is regulated by impaired cognitive processes (Maurage, De Timary, Tecco, Lechantre & Samson, 2015) Facial emotion recognition is impaired in people with AUD. Given the executive-level implications, such a condition may influence demands for ToM. This is supported by the fact that alcohol reduces attentional capacity, such that the processing of irrelevant information, is performed less efficiently. (Johnson, Skromanis, Bruno, Mond & Honan, 2018) The implications of this substance on ToM reflect mixed results, but there is evidence that it causes impairment.(Sanvicente-Vieira, Romani-Sponchiado, Kluwe-Schiavon, Brietzke, Brasil & Grassi-Oliveira, 2017).

Research on the affection generated by cocaine in ToM has not been able to establish anything conclusive, although it generates difficulties in managing personal and social problems and this is related to ToM. (Sanvicente-Vieira, Kluwe-Schiavon, Corcoran & Grassi-Oliveira, 2017) Response inhibition is impaired, probably due to the alteration presented by these areas. (Frazer, Manly, Downey & Hart, 2017) Studies have shown impairment in patients with CUD in areas related to social reward and emotional and cognitive empathy. (Preller et al., 2013) The results are mixed, given that in some cases there are no significant differences with respect to the non-using population and, in others, only in some components of the ToM. It is also unclear whether it is the substance that generates the condition or whether there is a previous alteration that induces consumption. (Sanvicente-Vieira, Kluwe-Schiavon, Corcoran & Grassi-Oliveira, 2016).

Method

The present study aims to analyze the existence of possible differences in the functioning of ToM and EF between the population with ToM, the population with CUD The hypothesis proposed from the general goal is that the impairments in EF and ToM are different depending on whether the person suffers from AUD and ToM, in addition to the fact that both groups of consumers present deterioration in both capacities with respect to the control group.

Design

The research design is empirical-analytical, using quantitative methodology to respond to the hypothesis. It is a quasi-experimental study, which aims to identify differences in EF and ToM skills between the population with alcohol abuse, the population with cocaine abuse and the population without substance abuse problems.

Participants

The study involved 10 patients with CUD and 10 with AUD, divided into two experimental groups. The inclusion criteria for participants with addiction problems were: a) being of legal age; b) meeting the diagnostic criteria according to the DSM-V (American Psychiatric Association, 2014) and c) presenting a period of abstinence of at least 2 weeks, in order not to present symptoms related to deprivation or intoxication. Regarding sociodemographic characteristics, patients with AUD are in age range between 26-50 years old, being their mean of 37.60 and standard deviation of 8.03. The participants with CUD showed an age range of 35-59 years, with a mean of 46.40 and standard deviation of 8.73. Regarding the gender of alcohol consumption, all the participants were men except for 1 woman, and the years of education ranged from 6-12 years. Regarding cocaine consumption, the group is formed mostly by men, with 2 women, and the years of studies are in the range of 6-20.

A group with 20 control participants was formed in order to test the specific objectives. The inclusion criteria were: a) not having any type of substance abuse problem, both legal and illegal; b) not presenting psychopathological disorders; c) not attending any type of psychological/psychiatric treatment; d) not being a smoker and e) not having presented SCT at any time during the life cycle. The sociodemographic characteristics show that this is a group aged between 20-55 years, with a mean of 39.30 and standard deviation of 11.79, with 17 men compared to 3 women and with education between 6-18 years. In order for the study to be as reliable as possible, both groups were balanced in terms of age, gender and years of study.

Table 1 shows a summary of the sociodemographic characteristics of the sample.

Table 1

Sociodemographic characteristics of the participants

	Group					
	Control		Alcohol		Cocaine	
	N=20		N=10		N=10	
Age. Mean and standard deviation	39.30	11.79	37.60	8.03	46.40	8.73
Gender. Total male and female	17	3	9	1	8	2
Studies. Min and Max	6 - 18		6 - 12		6 - 20	

Procedure

This project was carried out in collaboration with the Psychology Department of the European University of the Atlantic and the Cantabria Human Project center. It was endorsed by the respective ethics committees of the university. Participation in the project was voluntary and was recorded in the respective informed consent form. The pertinent evaluation instruments were selected, and the evaluation was carried out individually at the facilities of the Cantabria Human Project center.

Instruments

Wisconsin Card Sorting Test (WSCT). Developed by Heaton, Chelune, Talley, Kay & Curtiss (1948) and its Spanish adaptation, Wisconsin Card Sorting Test, by De la Cruz (1997). Aimed at the evaluation of planning, organized inquiries and schema reorganization capacity, it consists of 128 response cards, which the individual must place at the bottom of the 4 control cards, according to shape, number or color. The participant discovers the form of classification at each moment. When a certain number of correct answers have been obtained, the classification criterion is modified. It is applied individually, with a variable duration. Reliability is .93 for perseverative responses, .92 for perseverative errors and .88 for non-perseverative errors.

Stroop Color and Word Test (STROOP). Developed by Golden (1935) and adapted under the name of Color and Word Test (Bernardino, 2010) Its objective is to identify neurological alterations. It measures the ability to resist verbal and non-verbal interference, evaluating the ability to select information and react to it. Three sheets are used. The first one is composed of the words red, green, and blue printed in black ink. The person being evaluated must read as many as possible in the established time. The second shows stimuli grouped in the shape of an X and printed in red, blue, and green, which the person must name. The last one contains the stimuli of the first sheet, printed in the color of the second one, and the individual must verbalize the color of the ink, omitting the reading since it presents a different color. Its application is individual, with a duration of 45 seconds per sheet. It presents a test-retest reliability value of .884 and the values of the scores between the lowest and highest age quartiles do not present significant differences, which provides information on construct validity.

Cognitive and Affective Empathy Test (TECA, *Test de Empatía Cognitiva y Afectiva*). Developed by López-Pérez, Fernández-Pinto & Abad (2008), it evaluates empathy through 33 Likert-type items (scale from 1 to 5). It provides information on the cognitive elements of empathy (Perspective Adoption and Emotional Understanding) and the affective ones (Empathic Stress and Empathic Joy). Provides a total empathy score. It can be taken individually or collectively, in about 5-10 minutes. Construct validity for the TECA ranges from .352 to .484.

Symbol Digit Modalities Test (SDMT). Created by Smith (1973) and adapted by Arribas (2002) as the Symbol Digit Modalities Test. Used to detect brain dysfunctions. It consists of transforming geometric symbols into numbers from a key. Applicable individually or collectively, in a time of 90 seconds.

Facially Expressed Emotion Labeling Test (FEEL). Desarrollado por Kessler, Bayerl, Deighton & Traue (2002), es una prueba computarizada que mide la capacidad para reconocer emociones básicas de manera facial, con un alfa de Cronbach de .77. Los estímulos a identificar se ofrecen en fotografías que muestran seis emociones: enfado, miedo, alegría, tristeza, sorpresa y asco. Evaluación individual con una duración de 10-15 minutos.

Data Analysis

Data recording and analysis were carried out using the SPSS statistical program.

To test the hypothesis, the ANOVA (one-way analysis of variance) statistical test was used to analyze whether the 3 groups differed from each other in means and variances. This statistic offers the possibility of testing whether two variables (one independent and one dependent) are related, based on whether the means of the dependent

variable are different in the groups of the independent variable. Using one-factor ANOVA results in the calculation of F and its significance. The more the means of the dependent variable differ with the groups of the independent variable, the higher the value of F. The higher the result will show that there are more differences and a stronger relationship. As for significance, it is understood as the probability that the F value is by chance. With a confidence level of 95%, if the significance is less than 0.05, it will be established that the two variables are related. Once the existence of differences between the means was established, the post hoc Tukey test was used to determine which means differed from each other.

Results

The three groups were compared in EF capacity. Table 2 shows significant differences between the control group and the CUD group. These differences appear in some of the variables of the instrument, with the mean number of attempts used to complete the test being higher in the case of cocaine users, the number of complete categories being lower in the experimental group, and the number of perseverative responses and perseverative errors being higher in the CUD group. Although there are no significant differences between the control group and the alcohol group, the score is lower in this experimental group.

Table 2

Univariate differences between groups in WSCT results

	Group						F	Sig.
	Control N=20		Alcohol N=10		Cocain N=10			
	M	St	M	St	M	St		
1. Number of attempts	94.45c	20.72	105.80	25.82	121.90a	16.37	5.65	.007
2. Complete categories	5.35c	1.42	4.70	1.83	3.30a	2.26	4.52	.018
3. Failures Maintain Attitude	.55	.83	1.10	1.20	1.30	1.25	2.05	.143
4. Preservatives	6.95c	16.53	11.90	15.26	31.00a	25.43	5.54	.008
5. Perseverative errors	5.05c	12.31	9.10	10.80	23.10a	21.79	4.96	.012
6. Non-perseverative errors	20.70	12.50	23.00	20.28	29.20	16.36	.99	.383

Note: Differences by group, being control (a), alcohol (b) and cocaine (c), according to Tukey's post hoc test.

Regarding the STROOP, there are significant differences between the means of the control group and the group formed by cocaine users, present in the score of the colored items performed and in the score of the words printed with colored ink read, both higher in the non-user population. Between the patients with AUD and the control group the differences are not significant, although in the alcohol group they are smaller. These results are reflected in Table 3.

Table 3

Univariate differences in STROOP results between groups

	Group						F	Sig.
	Control N=20		Alcohol N=10		Cocain N=10			
	M	St	M	St	M	St		
1. Word	104.70	11.49	99.50	16.11	103.80	13.98	.519	.599
2. Color	75.95c	11.24	68.50	10.59	60.50a	19.80	4.35	.020
3. Word and Color	51.00c	7.48	41.80	12.80	40.90a	10.65	4.86	.013
4. Intereference	7.0435	4.89	1.40	8.92	5.8400	8.61	1.88	.167

Note: Differences by group, being control (a), alcohol (b) and cocaine (c), according to Tukey's post hoc test.

The results of the SDMT are shown in Table 4. There are differences between the control group and the CUD group, the latter showing a lower mean number of correct scores. The group composed of patients with AUD presented lower scores in relation to the control group, with no significant differences.

Table 4

Univariate differences in SDMT scores between groups

	Group						F	Sig.
	Control N=20		Alcohol N=10		Cocain N=10			
	M	St	M	St	M	St		
1. Total successes	47.95c	7.98	40.20	11.85	37.20a	11.13	4.64	.016

Note: Differences by group, being control (a), alcohol (b) and cocaine (c), according to Tukey's post hoc test.

The three groups were also compared in terms of ToM abilities. Table 5 shows the differences found through the TECA, which appear between control participants and CUD patients. They are present in the cognitive empathy (CE) and affective empathy (AE) scales. In the first case perspective adoption (PA) and emotional compression (EC) is lower in patients with cocaine use and, secondly, empathic joy (EJ) is also lower in the experimental group. The participants with AUD have lower scores compared to the control group, although they are not significant.

Table 5

Univariate differences in TECA scores between groups

	Group						F	Sig.
	Control		Alcohol		Cocain			
	N=20		N=10		N=10			
	M	St	M	St	M	St		
1. Perspectives Adoption	28.65c	3.23	26.10	1.91	25.60a	3.63	4.21	.022
2. Emotional Understanding	28.35c	2.11	29.90	3.25	30.90a	3.07	3.29	.048
3. Empathic Stress	20.85	3.25	23.50	5.74	22.50	5.56	1.22	.306
4. Empathic Joy	27.25c	3.13	27.10	3.64	35.80a	15.76	4.04	.026
5. Total Score	105.10	6.24	107.30	7.85	109.80	9.60	1.31	.282

Note: Differences by group, being control (a), alcohol (b) and cocaine (c), according to Tukey's post hoc test.

Finally, the mean number of correct scores in facial emotion recognition showed no distinction between the 3 groups. However, the clinical groups show lower results, with the group formed by alcohol consumers obtaining lower scores. These results are shown in Table 6.

Tabla 6

Univariate differences between groups in FEEL test scores

	Group						F	Sig.
	Control		Alcohol		Cocain			
	N=20		N=10		N=10			
	M	St	M	St	M	St		
1. Total successes	36.30	3.67	33.60	6.08	34.40	6.02	1.13	.333

Note: Differences by group, being control (a), alcohol (b) and cocaine (c), according to Tukey's post hoc test.

Discussion and conclusions

The main objective of the research has been partially demonstrated, since the differences between the population with CUD and the population without any type of SAD, in terms of the functioning of the EF and ToM, have been detailed. However, it has not been possible to find these differences between the group with alcohol consumption and the group without addiction. As for the hypothesis, it is partially accepted, since there are differences in the implications of alcohol versus cocaine on EF and ToM, but there are no differences between patients with SAD and patients with CUD. If the results obtained with the present investigation are compared with other studies, different conclusions appear.

In the affection of the EF in patients with ED, the study by Corral, Rodríguez & Cadaveira (2002) established that there was a deficit in mental flexibility in patients with ED, evaluating it through the WSCT, an aspect that has not been found in this research.

On the other hand, Ihara, Berrios & London (2000), with the use of the STROOP and the WSCT, were able to establish that there was a deficit in the ability to solve problems, in mental flexibility and in the inhibition of automatic responses, results that are opposite to those of the present study.

The differences in the results between this research and the cited studies may be due to several factors, such as the small sample size of this project, the heterogeneity in the severity of the disorder, the period of abstinence of the participants, and the possible interference of extraneous variables or environmental limitations during the evaluation.

In patients with CUD, according to the study undertaken by Ambrosio & Fernandez (2011), it was established that this type of population possessed deficits in this ability, a result that agrees with those of this work. In addition, research conducted by Lorea, Fernández-Montalvo & Tirapu (2010), found that among the most affected components were problem solving and cognitive flexibility, in the same way as seen in this work.

The study by Maurage, et al. (2011) on ToM in patients with AUD has shown that this type of population shows difficulties in recognizing facial emotions, a result that does not correspond to that obtained in this study.

The results of the work of Gizewski, et al. (2013) on empathy also show deficits in this area in patients with alcohol abuse, which does relate to the results of the present project. Regarding CUD, the work of Preller, et al., (2013) shows alteration in empathic capacity in this type of people, as in this work.

However, according to Fernández, Moreno, Pérez, & Verdejo (2012) facial recognition in patients with CUD is altered, which differs from the results of this study. The divergence of results lies in what refers to facial recognition of emotions and the cause of this, in addition to the aspects formulated, may be the choice of instruments for this study, since those of the cited research could be more accurate.

The results obtained in this work can be beneficial for clinical psychology and the treatment of drug dependence in several aspects. Knowing the implications in the case of alcohol and cocaine, emphasis can be placed on preventing their consumption and psychoeducation programs could focus on explaining the alterations generated by their abuse. In addition, programs aimed at training and rehabilitation of EF and ToM could be developed in the drug-dependent population, specifically in patients with CUD, since this is the group in which the main differences with respect to the population without SAD lie, according to the results of this study. Such programs could be approached from a specialized and personalized approach to the harm of each patient. Finally, since several investigations have proven the relationship between EF and ToM (Doenyas, Yavuz &

Selcuk, 2018; Li et al., 2017), an improvement in rehabilitation could be carried out, enhancing the work of the best-preserved capacity, managing to increase the other, in addition to being able to combine activities that simultaneously work both constructs.

As for the limitations, referring to the evaluation of the clinical groups and the collection of data, it has been costly due to the mortality of the sample, since several individuals have dropped out. Another methodological difficulty is the heterogeneity of the population. The type of consumption and its severity vary from one patient to another, which has made it difficult to establish inclusion criteria. It is likely that, consequently, the results obtained did not fully conform to those expected, since the pattern of consumption is variable. Likewise, the sample size used is quite small, which has limited the strength of the results, implying that they cannot be extrapolated to the rest of the population, influencing the fact that the conclusions found do not fully conform to those expected. The battery of instruments used may have limitations in terms of measurement precision, especially those applied for the evaluation of ToM. Finally, the presence of extraneous variables during the evaluation, such as the evaluator's experience, the way in which the test instructions were given and/or the environmental conditions. As a consequence, the results of this project may have differed from what was expected to be established.

Considering the possibility of continuing the research, it has been considered relevant to expand the number of participants, for a more reliable extrapolation of results. New patients with addictive disorders to other types of substances could be included. It would also be of interest to include a population with drug use disorders and even a population with pathological gambling disorders. Thus, the differences in addictions in relation to the presence or absence of a substance could be verified. On the other hand, due to the complexity of EF and ToM, it would be beneficial to increase the number of psychometric tests used for their evaluation, in order to cover the greater number of components that form them and establish more accurate results. As for facial recognition of emotions, a differentiation could be made to check whether there are emotions that are more difficult to identify. The reaction time required by the participants to issue a response could be added, trying to find more accurate and reliable conclusions. Finally, the number of hypotheses could be expanded, considering, firstly, to deepen the relationship between ToM and EF to determine whether the affection in one of them generates alteration in the other. Secondly, due to the relationship that seems to exist between EF and ToM with impulse control, including the study and analysis of impulsivity and the ability to control it in the population with a diagnosis of addiction disorder would be highly attractive.

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