

# Enhanced impulsivity, poorer planning and rigid patterns when drawing in substance use disorder: a preliminary study.

Mayor impulsividad, peor planificación y patrones rígidos al dibujar en el trastorno por consumo de sustancias: un estudio preliminar.

Giulia Orlandi

Javier Comes Fayos

Concepción Blasco Ros

Ángel Romero Martínez

Luis Moya Albiol

Department of Psychobiology, University of Valencia (Spain)

Autor de correspondencia: javier.comes@uv.es

## **Abstract**

*Neuropsychological assessment has uncovered deficits in several executive functions in substance use disorder (SUD) individuals. Nevertheless, research has reported moderate ecological validity in current neuropsychological paradigms. In this regard, drawing is a well-known cross-cutting task that integrates complex cognitive and affective processes. Therefore, its potential for improving the ecological validity of neuropsychological assessments has been outlined. The aim of the present study was threefold. First, we analyzed the impulsivity and planning capacity of SUD individuals (n = 16) compared to controls (n = 15) through a self-reported questionnaire and a neuropsychological paradigm. Second, we explored the differences between groups in drawing variables by means of the diagnostic drawing series, a validated drawing paradigm. Finally, we examined the relationship between the neuropsychological markers and the drawing variables. Compared to controls, SUD individuals reported higher impulsivity scores and worse planning capacity. Regarding drawing variables, SUD participants needed more time to complete the artwork, occupied more space with a predominant color and reported a lower tendency to use warmer and cooler colors than controls. Additionally, across the whole sample, higher impulsivity and worse planning capacity were related to a greater use of a predominant color. Our findings suggest difficulties in functions related to inhibitory control, as well as an alternative drawing pattern in SUD individuals. Remarkably, poor inhibitory control was associated with less variability in drawing. Together, the present preliminary study seems to reinforce the use of drawing as a valid tool for adding both diagnostic and therapeutic information to classical neuropsychological paradigm.*

## **Keywords**

*Substance use disorder, impulsivity, planning capacity, drawing, colors, neuropsychological assessment.*

## **Resumen**

*La evaluación neuropsicológica ha puesto de manifiesto déficits en varias funciones ejecutivas en individuos con trastornos por consumo de sustancias (SUD por su nomenclatura en inglés). Sin embargo, las investigaciones han informado de una validez ecológica moderada en los paradigmas neuropsicológicos actuales. En este sentido, el dibujo es una tarea transversal bien conocida que integra procesos cognitivos y afectivos complejos. Por ello, se ha esbozado su potencial para mejorar la validez ecológica de las evaluaciones neuropsicológicas. El objetivo del presente estudio era triple. En primer lugar, analizamos la impulsividad y la capacidad de planificación de los individuos con SUD (n = 16) en comparación con los controles (n = 15) mediante un cuestionario autoinformado y un paradigma neuropsicológico. En segundo lugar, exploramos*

*las diferencias entre grupos en las variables de dibujo mediante la serie de dibujo diagnóstico, un paradigma de dibujo validado. Por último, examinamos la relación entre los marcadores neuropsicológicos y las variables de dibujo. En comparación con los controles, los individuos con SUD informaron de puntuaciones de impulsividad más altas y de una peor capacidad de planificación. En cuanto a las variables de dibujo, los participantes con SUD necesitaron más tiempo para completar la obra de arte, ocuparon más espacio con un color predominante e informaron de una menor tendencia a utilizar colores más cálidos y fríos que los controles. Además, en toda la muestra, una mayor impulsividad y una peor capacidad de planificación estaban relacionadas con un mayor uso de un color predominante. Nuestros hallazgos sugieren dificultades en las funciones relacionadas con el control inhibitorio, así como un patrón de dibujo alternativo en los individuos con SUD. Sorprendentemente, un control inhibitorio deficiente se asoció con una menor variabilidad en el dibujo. En conjunto, el presente estudio preliminar parece reforzar el uso del dibujo como herramienta válida para añadir información tanto diagnóstica como terapéutica al paradigma neuropsicológico clásico.*

### **Palabras clave**

*Trastorno por consumo de sustancias, impulsividad, capacidad de planificación, dibujo, colores, evaluación neuropsicológica.*

## I. INTRODUCTION

Substance use disorder (SUD) is a complex health condition that brings not only physical but also cognitive and emotional symptoms which influence behaviors (American Psychiatric Association, 2013; United Nations Office on Drugs and Crime, 2019.). Particularly, previous literature has reported that, despite individual differences, SUD causes the arising of a common neuropsychological profile characterized by a higher impulsivity (Kustepe et al., 2018; Moeller et al., 2002) and impaired executive functions (Beveridge et al., 2008; Glass et al., 2009; Verdejo-Garcia et al., 2019) such as planning, cognitive flexibility, working memory, inhibitory control and decision-making (Hagen et al., 2017; Holst & Schilt, 2011; Madoz-Gúrpide et al., 2011; Vitoria-Estruch et al., 2018). Additionally, the affective component of individuals with SUD involves a significant emotional dysregulation that frequently results in maladjusted socio-affective processing (Romero-Martínez et al., 2019; Parolin et al., 2017; Cheetham et al., 2010). In fact, some authors argue that individuals with SUD rely on substance use as a mechanism to help them regulate negative emotions, such as anger or sadness (Chadwick et al., 2020). Therefore, the combination of the above-mentioned cognitive and affective traits may induce long-term SUD persons to be at risk of acting impulsively (Rømer Thomsen et al., 2018; Goldstein & Volkow, 2002).

Indeed, several studies employing different experimental methodologies have provided evidence supporting this neuropsychological profile associated with SUD. In conjunction with self-report questionnaires focused on relevant psychosocial and affective domains, SUD research has used a variety of common neuropsychological measures, such as the Iowa Gambling Task or the Dice Game Task for the assessment of decision-making ability (Balconi et al., 2014; Brand et al., 2008), the Stroop task to measure attention and inhibitory control, or the Revised Strategies Application Test (R-SAT), which allows the quantification of self-regulation (Fernández-Serrano et al., 2009). Besides, these neuropsychological tasks have been reinforced by the findings of numerous neuroimaging investigations that have consistently reported a hypoactivation of the prefrontal cortex upon which both executive functions and emotional regulation rely (Ceceli et al., 2021; Goldstein & Volkow, 2002; Koob & Volkow, 2016). These classical neuropsychological paradigms have proven to be good instruments for SUD assessment, but the implementation of other additional methodologies could further improve the accuracy of the diagnosis, particularly from an ecological perspective. In fact, evidence has been provided that these types of tasks are capable of testing 18-20% of the real-world individual performance (Chaytor et al., 2006), particularly the ones which measure executive functions. This moderate percentage could be due to environmental cognitive factors not present during task administration and the inability of participants to apply compensatory strategies. Hence, although the neuropsychological tests were built to simulate daily life experience, they remain an artificial situation (Shamay-Tsoory & Mendelsohn, 2019).

Drawing, instead, is a task that everyone has been in touch with in their lives. Thus, it may accurately recreate a daily life experience, being consequently able to improve the ecological validity of the whole assessment (Cohen & Mills, 2015). Remarkably, it involves cognitive and emotional processes similar to those previously discussed. Drawing firstly needs the implication of diverse cognitive functions, from more basic processes (e.g., kinesthetic and sensory processes) to higher order processes (e.g., visuospatial representation processes, working memory, motor planning, or inhibitory control) (La Femina et al., 2009). In particular, within higher order processes, inhibitory control would allow better regulation of environmental or personal

distractors during the task (Papandreou, 2014). Meanwhile, cognitive flexibility could facilitate the artwork to change according to the individual's intentions and task demands (Brooks, 2009), and working memory would allow the ability to maintain and adjust necessary information throughout task execution (Papandreou, 2014). On the other hand, drawing also involves the affective domain (Lusebrink, 2010). A significant expression of the emotional influence on the drawing can be observed in the use of colors. It has been stated that colors are linked to specific affective states and may trigger particular emotions (Elliot & Maier, 2007; Hanada, 2018). Notably, this association appears to be context-specific due to cultural and biological reasons. Therefore, the production of graphic art could appear to provide valuable information about the individual's cognitive and affective functioning (Lusebrink, 2010; Masika et al., 2021). However, literature on this topic is scarce and the need for further research has been emphasized.

In addition, art drawing has been employed as an efficient therapy tool in disorders characterized by difficulties in cognitive and emotional functions similar to those of an SUD. For example, drawing has been used for attention deficit hyperactivity disorder because it has been shown to reduce impulsivity (Safran, 2002). Likewise, artistic drawing has helped support the development of executive functions, particularly working memory, inhibitor control, and cognitive flexibility, both in adults with anxiety disorders (Abbing et al., 2019a; Abbing et al., 2019b) and in all children (Sonter & Jones, 2018). Art therapy has also been efficiently used to improve emotional expression (Dickson, 2007) and/or emotional regulation (Czamanski-Cohen & Weihs, 2016) in people with emotional dysregulation disorders (Jones et al., 2018). Therefore, drawing appears to integrate cognitive and emotional functions relevant to SUD-associated deficits. Considering these results, it seems logical to suggest that drawing could be useful as a tool to assess the cognitive and emotional processes of individuals with SUD, with a view to their diagnosis and subsequent treatment.

Bearing all this in mind, integrating drawing as a tool into neuropsychological assessments could add more ecological validity to the detection of cognitive and emotional symptomatology in individuals with SUD, ultimately providing a stronger basis for treatment planning. To clarify this premise, our preliminary study proposes three major objectives, the first one being the analysis of possible differences in inhibitory control (impulsivity and planning) in SUD men and women when compared with non-SUD controls. The former group has previously reported higher impulsivity and worse planning abilities (Kustepe et al., 2018; Verdejo-García et al., 2019). Consequently, we expect to find lower scores on markers related to inhibitory control in people diagnosed with SUD. Secondly, we aimed to explore differences in drawing variables (i.e., drawing time, predominant color, color prominence, color intensity, number of colors, and color category). Previous literature has reported difficulties in executive functions important for drawing in people diagnosed with SUD. Therefore, we expected that they would have greater difficulties in performing the drawing task, taking more time and showing less variation in color use, when compared to controls (Goldstein & Volkow, 2002). In this sense, since SUD involves significant emotional dysregulation (Parolin et al., 2017), we also expected to find in individuals with SUD a prevalence of colors associated with highly aroused negative mood states, such as red and black (Hanada, 2018; Pryke, 2009). Finally, we aimed to analyze whether difficulties in inhibitory control, as measured by a neuropsychological task and a self-report questionnaire, were related to specific drawing variables, regardless of group. Although we expected the SUD group to exhibit higher impulsivity on average, we hypothesized that higher levels of impulsivity would correspond

to specific color marks in art drawings.

## II. METHODOLOGY

### A. *Sample*

A sample of 31 participants, divided into two groups, was studied. Every person (n=16) of the experimental group (A) was recruited from Proyecto Hombre Burgos, a psychoeducational therapeutic program focused on the treatment, rehabilitation and socio-labor reintegration of individuals with SUD. The control group (B) consisted of individuals (n=15) with similar sociodemographic characteristics but without a diagnosis of SUD or history of substance use. Substance use, current or past, within the control group was assessed through an interview.

Both groups were balanced in terms of age: the ages ranged between 21 and 55 years (mean 37.45). In addition, each group exhibited an equivalent prevalence of women (n=3). The presence of other psychiatric disorders, mental disability, brain disease and/or advanced age at risk of developing cognitive deficits were established as exclusion criteria. Prior to enrollment in the therapeutic program 'Proyecto Hombre,' each experimental subject was required to undergo psychiatric assessments to investigate the presence of comorbid mental disorders. For the current study, participants diagnosed with SUD without comorbid disorders were selected based on psychiatric evaluation. Additionally, prior to the experimental session, each control subject underwent an ad hoc semi-structured clinical interview conducted by a trained psychologist in order to explore their medical history and detect possible psychopathological symptoms. It was also necessary for all participating to have basic schooling and a basic linguistic level of Spanish in order to be able to understand and express themselves.

### B. *Ethical considerations*

Every participant was previously informed about the tasks and the objectives of the study and participated voluntarily in the experimentation after having signed written consent. The study was completely anonymous, respecting personal data and following the Helsinki Declaration principles. The experiment was approved by the Ethics Committee of the University of Valencia (procedure number: H1538385543901).

### C. *Procedure*

The experimental session was conducted via one-on-one in-presence interviews. Firstly, through direct questions, the personal information of participants was collected: age, gender, and education level. Secondly, participants were asked to make three drawings according to the Diagnostic Drawing Series (DDS) (Cohen & Mills, 2015) (specified later). Finally, difficulties in inhibitory control were evaluated through a self-report questionnaire and a neuropsychological task (specified below).

### D. *Instruments*

#### 1) **Diagnostic drawing series, DDS**

The DDS paradigm (Cohen & Mills, 2015) was used to perform the neuropsychological assessment of drawing. This paradigm is used for the evaluation of psychopathology and psychiatric symptomatology from the analysis of patients' drawings. It consists of making three artworks with a time limit of fifteen minutes each. Participants are provided with three sheets of white A4 paper, one per drawing, which can be oriented horizontally, vertically or diagonally. The first drawing to be made by the participants is a freestyle artwork, evaluating their graphic performance without constraints. The second part of the paradigm restricts the drawing to the concept of a tree, evaluating their graphic performance based on stipulated rules. Finally, the last drawing must represent how they feel at that moment, expressing their emotions through lines, shapes and colors, evaluating graphic performance based on abstract intrinsic concepts. Participants are provided with twelve pastels (black, gray, white, red, pink, orange, yellow, brown, light and dark green, blue and purple) that they can use in a variety of ways creating different effects in the painting. For example, by drawing with the pastel edge, precise lines are obtained, while using its ash, shaded content is generated.

## 2) Inhibitory control assessment

Impulsivity was measured by means of a self-report questionnaire, the Plutchik Impulsivity Scale (Plutchik & Van Praag, 1989), used in its Spanish validated version (Páez et al., 1996). It is composed of fifteen items the participants have to answer, according to a four-level Likert scale representing the frequency of their impulsive behavior described in the item (possible answers: “never”, “sometimes”, “often”, “always”). A total score was obtained from the Plutchik Impulsivity Scale, in which a higher score was interpreted as greater impulsivity.

Planning capacity was assessed through the Zoo Map Test, a performance-based neuropsychological task (Wilson et al., 1998). It belongs to the Behavioral Assessment of the Dysexecutive Syndrome Battery (BADS) (Wilson et al., 1998), whose aim is to evaluate dysexecutive syndrome. Participants must go through certain predetermined places along a map that is presented to them (an imaginary zoo). Participants must respect strict movement rules that make the task difficult (single vs. multiple movements, or a specific order of the places to be visited, among others). There are only four ways to complete the test correctly, so a high level of planning capacity is required. There are two versions of the task: (1) version *a*, with no indications on how to do the route; (2) version *b*, where the participants have to follow the given guidelines. Although this neuropsychological task does not directly measure inhibitory control difficulties, its correct performance depends on this last function: in fact, greater inhibitory control difficulties correspond to low planning ability and vice versa. A total score was obtained from the Zoo Map Test, in which a higher score was interpreted as greater planning capacity. The time required to perform the test was also recorded.

### E. *Analysis*

#### 1) Variables coding

To analyze drawings, the main artwork coding systems known in literature adopt the matching of raters' judgments (Cohen, 1986; Hacking et al., 1996; Gantt & Anderson, 2009). However, in this study, we chose to apply the Image Color Summarizer program (Krzywinski, 2006), as it is software specifically created for analyzing colors, in order to reduce the subjectivity necessarily present in human evaluators. This program, by analyzing the color information of a drawing, is able to return descriptive data of the entire color range of an image and to divide it into parts depending on the color used (Figure 1). Furthermore, it

quantitatively calculates, for each color (cluster), its average, median, minimum and maximum by ranking them according to their prevalence in the picture. In addition, together with the outputs extracted from the Image Color Summarizer program, direct observation of the execution of the artwork was integrated to ensure the consistency of the data. In total, the following color variables were extracted: predominant color, color prominence, color intensity, number of colors, and color category (warm, cold or neutral). Considering that every person made three drawings and to simplify the statistical analysis, the mean of all the variables of each participant's drawings was considered (see Table 1).

## 2) Statistical analysis

First, the normality of the data was tested with the Shapiro-Wilk test ( $p < 0.05$ ). A chi-square analysis was performed to evaluate the differences between both groups (individuals diagnosed with SUD versus controls) in the variable "gender". Afterwards, independent samples t-tests were also performed for assessing group differences (SUD individuals vs. controls) for "age", "years of education", "inhibitory control scores" (i.e., impulsivity and planning), and "drawing variables" (i.e., drawing time, predominant color, color prominence, color intensity, number of colors, and color category). Effect sizes for the between-group differences were calculated using Cohen's  $d$  (Cohen, 1992). Finally, simple bivariate correlations were applied to examine relations between drawing variables and inhibitory control scores, considering both groups together. Data analyses were conducted using IBM SPSS Statistics for Windows, version 26.0 (Armonk, NY). Values of  $p < .05$  were considered statistically significant.

## III. RESULTS

### *Characteristics of participants*

For sociodemographic data, there was no significant difference between the groups in gender [ $\chi^2 (2) = .008, p = .930$ ] or age [ $t (29) = 1.06, p = .296$ ]. However, there was a significant difference between both groups in years of education ( $t (29) = -3.487, p = .002$ ), being lower in participants diagnosed with SUD.

Regarding markers of inhibitory control, the total score of the Plutchik questionnaire was higher in participants diagnosed with SUD [ $t (29) = 2.556, p = .016$ ]. In addition, they showed worse performance on the Zoo Map test [ $t (22.6) = -4.762, p = .000$ ] and longer planning time for version one of the task [ $t (20.9) = -2.936, p = .008$ ]. Nevertheless, groups did not differ in the planning time for version two of the task [ $t (29) = -.178, p = .859$ ] (Figure 2).

### *Drawing variables*

As for drawing variables, SUD participants required, on average, more time to complete the artworks [ $t (17.0) = 2.390, p = .029$ ]. Additionally, with respect to color use variables, the predominant color in their drawings occupied more space compared to controls [ $t (22.5) = 3.328, p = .003$ ]. In other terms, they mainly adopted a particular color, unlike controls, whose predominant color did not dominate so much above the others employed.

Besides, although no differences in color prominence, color intensity or number of colors used were

found between the groups [ $t(17.9) = 1.228, p = .235$ ;  $t(29) = -.397, p = .694$ ;  $t(23.6) = -1.596, p = .124$ , respectively], independence t-test analyses showed that SUD participants had a significantly lower tendency to use warmer [ $t(29) = -2.389, p = .024$ ] and colder [ $t(20.6) = -2.157, p = .043$ ] colors than controls, although no differences were found for neutral colors [ $t(29) = .587, p = .465$ ] (see Appendix 1).

Figure 1. Image Color Summarizer output example



Table 1. Drawing variables description

Drawing time	The time required by participants to conclude the artwork
Predominant color	The space taken by the color predominant in relation to the sum of the other colors. It is obtained by marking the percentage of space occupied by the predominant color in relation to the total space filled by the other colors minus the ones in the background.
Color prominence	The percentage of quantity of color in relation to the whole paper, regardless of the color used. It is obtained by subtracting the background's space to the totality, 100 %.
Color intensity	It corresponds to the mean of S of the HSV index. S is the indicator of saturation, which indicates the luminosity of a color. A higher S index refers to a higher vividness of the color.
Number of colors	It refers to the number of colors used in the drawing, considering every pastel employed during the artwork's execution.
Warm colors	The number of warm colors used in the artwork (red, pink, orange, yellow and brown)
Cold colors	The number of cold colors used in the artwork (blue, dark and light green, purple)
Neutral colors	The number of neutral colors used in the artwork (black, white, grey)



Figure 2. Zoo Map total score and planning time for each group.

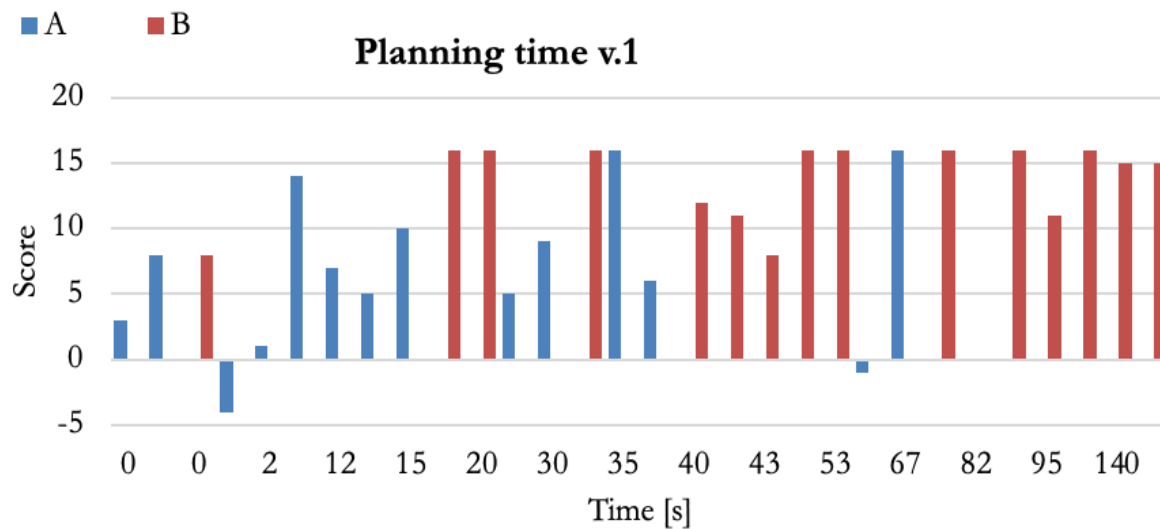


Table 2. Pearson correlation analyses

Correlations	1	2	3	4	5	6	7	8	9	10
1. Plutchik total score	1									
2. Zoo map total score	-.375*	1								
3. Drawing time	.052	-.171	1							
4. Predominant color	.360*	-.399*	.680**	1						
5. Color prominence	.262	-.040	.675**	.926**	1					
6. Color intensity	-.001	.237	.299	.258	.422*	1				
7. Number of colors	-.059	.331	.130	.070	.262	.475**	1			
8. Warm colors	-.194	.383*	-.027	-.059	.074	.412*	.775**	1		
9. Cold colors	-.212	.244	.018	-.029	.181	.356*	.899**	.582**	1	
10. Neutral colors	.189	.207	.389	.276	.318	.169	.454**	.050	.333	1

Note. Statistical significance \*p < .05, \*\*p < .01

#### *Relationship between drawing results and inhibitory*

There was a significant correlation between the Plutchik total score and the predominant color ( $r = .360$ ,  $p = .047$ ). Moreover, a negative correlation was found between the Zoo Map total score and the predominant color ( $r = -.399$ ,  $p = .026$ ). Finally, a positive relation was found between the Zoo Map total score and warm color use ( $r = .383$ ,  $p = .034$ ), as well as a tendency toward significance between the Zoo Map total score and number of colors used ( $r = .331$ ,  $p = .069$ ). No other correlation was found between inhibitory control markers and drawing variables (see Table 2).

#### **IV. DISCUSSION**

Our data revealed that groups differed in the scores of the markers associated with inhibitory control. Specifically, SUD participants displayed higher scores on impulsivity and lower scores on planning performance on the Zoo Map test. Regarding drawing variables, compared to the control group, participants with SUD needed more time to complete artwork and occupied more space with the predominant color. Their tendency to use warmer and cooler colors was lower, although no differences in color prominence, color intensity, or number of colors were found between both groups. In addition, across the whole sample, a higher Plutchik total score was related to a greater use of the predominant color. Interestingly, a higher Zoo Map total score was related to a lower use of predominant color. Besides, a higher Zoo Map total score was also related to the use of warmer colors.

Regarding our first objective, and as expected, participants with SUD reported greater impulsivity and poorer planning ability than controls. Inhibitory control has been exposed as critical in conceptual models of addiction, both as a susceptibility factor and as a mediator of the incremental transition from use to abuse, and to dependence (Jentsch & Pennington, 2014). Thus, our results are in line with the literature, which has consistently shown difficulties in inhibitory control in people diagnosed with SUD, derived from a profile characterized by increased impulsivity and impairment of executive functions, such as planning (Hagen et al., 2017; Holst & Schilt, 2011; Kustepe et al., 2018). Consequently, our results support the notion that participants with SUD are more impulsive and have less planning abilities than controls (Goldstein & Volkow, 2002), which predisposes them to maladaptive behavior (Vitoria-Estruch et al., 2018).

Secondly, we aimed to explore possible differences in the drawing variables. As expected (Goldstein & Volkow, 2002), SUD participants needed, on average, more time to complete the artworks and integrate more of their predominant color into their drawings compared to controls. In other words, people with SUD mostly adopted one particular color, as opposed to the controls, whose predominant color did not dominate as much over the other colors used. As mentioned above, literature has reported difficulties in executive functions important for drawing in people diagnosed with SUD. In this regard, several authors have argued that difficulties in the domains of impulsivity and planning could hinder the use of multiple strategies to address a demanding situation (Verdejo-García & Albein-Urrios, 2021). Therefore, a possible explanation for the drawing differences in SUD participants, such as the use of a single color (for a longer period of time), could be due to a greater perseveration, which is associated with difficulties in pattern change (Kozak et al., 2019). However, contrary to our hypothesis, they used warm and cold colors less frequently than controls did

(see Figure 3), which could be explained by a different pattern of emotional expression. Previous research has shown that people with maladaptive emotional processing (e.g., depressed patients) use a lower diversity of colors in their drawings (Heredia & Miljkovitch, 1998). In fact, several authors have hypothesized that colors are intimately related to an individual's emotional state (Amarin & Al-Saleh, 2020; Singh & Srivastava, 2011). Regarding drawing, using a greater variety of colors has been associated with greater emotional expressiveness and with a reduced anxiety emotional state (Gruber & Oepen; 2018; Osaka, 2022; Volmat, 1956). This is of particular interest, since emotional dysregulation is another typical characteristic of SUD. Congruently, the scarce diversity in the colors used in the drawings by SUD participants could be providing relevant information about the emotional expression capacity of this population. Together, the drawing results seem to be in line with the neuropsychological profile of SUD participants, characterized by poorer inhibitory control and maladaptive emotional processing (Verdejo-García et al., 2015).

Figure 3. Examples of Group A and B drawings.

*A) Examples of drawings of SUD individuals*



*B) Examples of drawings of controls*



**Note:** SUD individuals employed a predominant color that dominates above others.

Finally, and consistent with our hypothesis, the use of a predominant color was related to higher scores on the Plutchik questionnaire and lower performance on the Zoo Map test, regardless of the group to which they belonged. These results suggest the existence of a relationship between the use of a predominant color and impulsivity, as well as with planning ability (a positive and negative relationship, respectively). Thus, it seems that participants who tend to use a specific color that predominates over the others are likely to present higher impulsivity and lower planning competence, functions highly related to low inhibitory control. In addition, a positive relationship was found between the total score on the Zoo Map and the use of warm colors. On this matter, it has been previously discussed that individuals with perseverative patterns and anxiety-related emotional processing, such as those with SUD, have a lower predisposition to use warm colors in their drawings (Amarin & Al-Saleh, 2020; Peters & Merrifield, 1958). Thus, it could be suggested that higher levels of planning (a function linked to pattern change capacity) would enable the use of a wider range of colors, as in the case of warm colors. This hypothesis is reinforced by a trend toward significance in the relationship between performance on the Zoo Map test and the number of colors used. It is important to note that, in our study, these relationships were observed in the entire sample, regardless of their belonging to the SUD group or the control group. This cross-sectional result could be due to the fact that the relationship between drawing and inhibitory control variables is not pathology-dependent, suggesting that the use of drawing assessment may be useful in various populations. However, greater impulsivity and planning difficulties are specific characteristics of participants with SUD, which may be evidence that drawing might be especially pertinent for the assessment of SUD. Nonetheless, it is worth emphasizing that more research in this area is needed to optimize assessment through drawing.

## V. LIMITATIONS AND FUTURE RESEARCH

To the best of our knowledge, this is the first preliminary study that relates neuropsychological variables with drawing variables in SUD participants. However, the study is not free of limitations. The main one is the small sample size. This is due to the high difficulty in accessing people diagnosed with SUD. Indeed, a limitation arising from the small sample size is the performance of correlation analyses for the entire sample. Therefore, although the results obtained provide relevant information, further research is necessary to provide more evidence and strengthen our findings.

A second limitation is the absence of a questionnaire used to assess potential deficiencies in emotional processing in SUD participants. While it is true that difficulties in emotional processing are at the basis of SUD, it would be interesting to explore the possible relationships between emotional processing in SUD participants and drawing variables in future research. Also, the current study lacks a standardized diagnostic test for comorbid disorders. It is worth noting that the assessment of psychopathological symptoms has been carried out by healthcare professionals experienced in working with SUD individuals. Nevertheless, the need to incorporate specific diagnostic tests in future studies is emphasized.

Finally, it should be noted that participants were involved in SUD therapeutic programs. The treatment entails a medical detoxification process along with the enhancement of socio-affective skills and the bolstering of social support. The therapeutic program involves residential care and spans approximately one year. Given that this program aims to improve socio-affective skills pertinent to the task presented in this study, results

should be interpreted with due caution. Thus, bearing all in mind, we also consider necessary to conduct future research integrating people diagnosed with SUD undergoing treatment and without treatment.

## **VI. CONCLUSIONS**

In conclusion, people diagnosed with SUD showed differences in several components of drawing, including a greater presence of a dominant color over other colors, as well as using fewer warm colors and less overall variability in the colors used. Overall, they spent more time and fewer resources on drawing. Furthermore, our results suggest a relationship between common characteristics of the neuropsychological profile of SUD and a specific pattern of drawing. Specifically, markers related to poor inhibitory control, such as high impulsivity and worse planning capacity, were associated with less variability in drawing. Taken together, this preliminary study provides evidence that reinforces the use of drawing as a valid instrument to add diagnostic information to classical tools and to be used in the therapeutic approach.

## **VII. ACKNOWLEDGMENTS**

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## Appendix 1. Subject Drawings

Figure 1: SUD drawings



Figure 2: control drawings



Comparisons: SUD group tend to have one predominant color and to use less warm and cold colors than control.