# Cognitive functions of subjects with cocaine and crack dependency disorder during early abstinence

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**Introduction.** Cognitive effects caused by cocaine and crack consumption, especially deficits in executive functions may increase the likelihood of drug-seeking behaviour and interfere with the ability of users to assimilate and participate in rehabilitation programs.

**Aim.** To determine in early abstinence the state of executive functions, the impulsiveness and craving in cocaine and crack consumers.

**Subjects and methods.** This cross-sectional study functions, with a sample of 60 male aged between 31.38 ± 7.26 years old, distributed in three groups: inhaled cocaine users (CDP-I; $n$ = 15), with 23.13 ± 7.2 age of onset of consumption; crack cocaine users (CDP-C; $n$ = 26), with 20.81 ± 4.21 age of onset of consumption, and a control groups of no-addiction individuals ($n$ = 19). Sociodemographic, clinical and cognitive assessments were applied.

**Results.** The data showed that significant differences in socioeconomic level score and impulsiveness. Consumer groups have with lower scores with respect the control group. CDP-C group showed poor performances compared to the CDP-I and control groups, in the Berg Test, Tower of London, numbers in the direct order and subtraction. CDP-I group showed less score in planning compare with the other two groups.

**Conclusions.** In early abstinence crack users manifest a greater number of deficits, mainly in working memory, planning and cognitive flexibility.

**Key words.** Assessment. Cocaine. Crack. Craving. Early abstinence. Executive function.

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## Introduction

Substance use disorders represent a public health problem in the world [1,3], in particular, the cocaine (cocaine hydrochloride) that has been identified as a stimulant [4,5] with effects even more powerful in crack cocaine [6]. Cocaine dependence has an important impact particularly among adult males with negative psychological, social and health consequences [7-9].

Neuroimaging studies have revealed that cocaine abusers have metabolic and structural differences in particular prefrontal regions [10,11]. There are deficits in white and grey matter [12,13]. Decreased volume in the right amygdala [14] and contraction of nucleus accumbens has also been reported [15] as well as changes in volume the striatum and thalamus in crack cocaine addiction [16].

Currently systematic reviews have demonstrated that there are cognitive effects in both acute and long term cocaine and crack use [17]. However, effects on facial and emotion recognition and executive functions in early phases of abstinence requires greater description, because impairments in executive functions, which are associated with complex cognitive processes [18], may contribute to drug misuse and addiction, they may increase the likelihood of drug-seeking behaviour and interfere with users capacity to participate in rehabilitation programs and benefit from them.

Previous studies demonstrated that cocaine users usually present poor inhibition, increased response latencies and a higher number of commission errors in Go/No-Go and Stop-Signal tasks [19]. Also evident are higher levels of impulsiveness [20,21] and alteration on decision-making, measured by the Iowa Gambling Task, this alteration in decision-making could contribute to the maintenance of addiction and undermine attempts at abstinence [22]. Besides, these subjects can also exhibit impairments in attention, working memory and concept formation tasks [23]. In emotions recognition cocaine abusers show poorer recognition of facial expressions portraying negative emotions (anger and fear), but not positive or neutral emotions [24], these deficits on emotional decod-

ing remained significant during protracted abstinence [25].

Other studies have shown that individuals with crack cocaine dependence display multiple cognitive impairments, in particular in executive functioning, chronic use produces a dissociative pattern in performance for instance impairment on measures of spatial, but not verbal memory, confrontation naming, and Trail Making Test, perceptual-motor speed and cognitive flexibility. Also present are abnormalities in both social adjustment and decision making [26].

Remarkably, the acute effects and the effects of long-term cocaine use appear to oppose each other. In general, cocaine facilitates cognitive functions directly after administration, whereas the effects after long-term use it seem to impair cognition [27].

The implications for executive functioning in substance rehabilitation processes and in the duration of abstinence, opens the need for detailing the performance cognition in different populations of drug users, in particular in the cocaine variants. According to the National Addiction Survey in Mexico cocaine occupies the second preference in the country and higher predominance in men. Cocaine and crack in the early abstinence phase could cause effects on cognition and mood state, so it is important to describe them in order to verify the possible deficits and have parameters to formulate timely treatments. Hence, the main goal of this study was to determine in early abstinence the state of executive functioning, and impulsiveness and craving in cocaine and crack consumers.

## Subjects and methods

### Participants

One hundred participants were recruited as part of a main addiction project. Healthy controls were matched by age (± 2 years-old), sex and handedness. Education was matched as closely as possible. For this study was excluded 33 participants for having more abstinence time, and eliminated 7 participant because they did not complete the evaluation. Final sample size for the cognitive analysis was 60 male participants (31.38 ± 7.26 years-old), they were divided three groups; 19 healthy control individuals (30 ± 7.11 years-old) and 41 cocaine-dependent according to criteria from the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV), in this last group the administration route of the substance is differentiated, of which 15

with use of inhaled cocaine (CDP-I; (32.78 ± 8.18 years-old), and 26 users of crack cocaine (CDP-C; 31.62 ± 6.91 years-old).

The participants were invited through posters placed in several centers for addiction treatment the City of Mexico. Selection criteria for cocaine-dependent participants were: meeting the DSM-IV criteria for substance dependence; cocaine and crack as the main substance; absence of documented comorbid mood or personality disorders; absence of documented head injury or neurological disorders; indistinct sex; between 18 to 45 years-old; and minimum abstinence duration of 10 days before testing. Urine analysis for the presence of drugs before the cognitive assessment. The control individuals were recruited by open announcement and were subsequently selected to meet the conditions that they had not taken lifetime medication and psychoactive substances in the past, and they had no documented psychiatric or neurological disorders. The study was approved by the local ethics and research committees and performed at the National Institute of Psychiatry Ramón de la Fuente Muñiz in Mexico City, Mexico. The study was carried out according to the Declaration of Helsinki. All the participants explained and provided verbal and written informed consent.

### Procedure

The evaluations were performed individually and the battery was administered in a quiet room, during a session with an approximate duration of 120 minutes, to minimize fatigue subjects were encouraged to take a short break toward the middle of the battery. The first part of the session was signed informed consent and then the interview was administered and clinical information was collected. Finally, the instruments that measure executive functioning were applied. Tests were administered in a fixed order, on computer, following standard recommendations for cognitive assessment [28].

### Sociodemographic and clinical assessments

#### Sociodemographic and clinical data
Including, age, marital status, education and socioeconomic level, this last aspect was measured by means of a questionnaire that considered the educational level of the head of household, the number of complete bathrooms in the home, the number of cars in the home, possession of internet connection in the home, number of members in the home of 14 or more working, number of bedrooms in the house.

With has a maximum global score of 300 points, distributed in 7 socioeconomic levels [29].

In clinical data, the laterality, in the cocaine-dependent subjects the onset age of consumption and time drug use.

### Mini International Neuropsychiatric Interview (MINI-Plus) Spanish version 5.0.0

Is a brief structured interview for the major Axis I psychiatric disorders in DSM-IV and ICD-10, it is highly structured, easy to use for multicenter clinical trials and epidemiology studies, with an administration time of approximately 15 minutes, has acceptably high validity and reliability scores [30].

### Barrat Impulsiveness Scale version 11 (BIS-11)

Is a scale to assess impulsivity, in format of self-report. Consists of 30 items in Likert format, each item consists of four options for answer (rarely/never, occasionally, often, almost always/always). Offers a global score that shows the level of impulsivity, it is divided into three factors; attentional impulsivity, motor impulsivity and lack of planning. A higher score in this scale represents higher impulsivity. Has high validity and reliability scores, it is validated in Spanish [31].

### Cocaine Craving Questionnaire (CCQ)

Is a 45 item self-report questionnaire that assesses specific aspects of current craving for cocaine and average craving over the past week. Has an overall score of 225. It has five dimensions: desire to use cocaine; intent and planning to use cocaine; anticipation of positive outcome from using cocaine; anticipation of relief from withdrawal or dysphoria from using cocaine; and lack of control over use. It has been shown to have content validity and high reliability. A higher score in this scale represents of craving [32].

## Cognitive assessments

Cognitive assessments comprised a battery of seven test to assess the several domains related to executive functioning, including; flexibility, reacting, working memory, response inhibition, decision-making planning, performance monitoring and meta-memory.

### Berg's Card Sorting Test

Berg's card sorting test. Is a test to assess mental flexibility through the results of various response categories including total errors, perseverative responses, perseverative errors, and the number of categories completed. Integrated of a 128 card deck displayed on a computer screen. Each card contains a different combination (shapes, colors, and quantities). Four key cards are displayed at the top of the screen as a guide to help determine which of the four stacks the deck's up-card is sorted to. The deck is revealed one card at a time, and the visible card is matched to key cards depending on the particular rule (unknown to the examinee) for a given set. After ten cards have been successfully matched, the set is completed and the sorting rule changes (also unknown to the examinee). The new rule must be discovered using trial and error via feedback received after each card is sorted [33,34].

### Flanker Task

Is a task of cognitive psychology, used as a measure of selective attention, filtering, and/or conflict resolution and performance is considered to reflect the executive attention network. In this task the participants must keep their attention waiting for a central arrow on the computer monitor (central arrow) whose address tells them the button to press to answer correctly. The central arrow is 'flanked' by other arrows that may be in the same direction of the target arrow (congruent) and therefore, facilitate the subject's response) or in the opposite direction (incongruent). The participants must therefore inhibit the contradictory information presented by the incongruous 'flankers', which causes an increase in the reaction time to these stimuli. The difference between reaction time to congruent stimuli and reaction time to incongruent is considered a measure of the time that cognitive inhibition takes in the subject and is called the 'flanker effect' [35].

### Go/No-Go

This task is used to measure response inhibition or sustained attention and employs a continuous stream of two different stimuli for which a binary decision must be made, such that one stimulus type requires a response (go) and the other stimulus type requires the participant to withhold a response (no-go) [36].

### Digit span, letter and numbers

This complex dual task is used to evaluate short-term memory, attention and working memory storage capacity. It requires storing a set of numbers and letters and manipulating them into a sequence. In the forward order portion of the test, the participant is asked to repeat a set of random numbers given orally by the examiner; a new digit is added to the sequence with each correct repetition. In the

**Table I.** Sociodemographic characteristics (frequencies, percentage, mean, standard error and Kruskal-Wallis Test, depending on the case) for the three groups.

| | | Control (n = 19) | CDP-I (n = 15) | CDP-C (n = 26) | KW ($\chi^2$) | Sig. |
|---|---|---|---|---|---|---|
| Age (mean ± SD) | | 30 ± 7.11 | 32.73 ± 8.18 | 31.62 ± 6.91 | 1.14 | 0.565 |
| Socioeconomic level (mean ± SD) [b] | | 154 ± 51.46 | 89.42 ± 23.1 | 72.5 ± 65.15 | 18.40 | 0.000 |
| Education [a] | Elementary school | 1 (4.8%) | – | 3 (11.5%) | 6.61 | 0.037 |
| | Middle school | 5 (23.8%) | 5 (31.3%) | 13 (50%) | | |
| | High school | 5 (23.8%) | 2 (12.5%) | 2 (7.7%) | | |
| | Technical career | 2 (9.5%) | 3 (18.8%) | 6 (23.1%) | | |
| | University | 8 (38.1%) | 5 (31.3%) | 2 (7.7%) | | |
| Marital status [b] | Single | 12 (57.1%) | 7 (43.8%) | 9 (34.6%) | | 0.000 |
| | Married | 7 (33.3%) | 4 (25%) | 12 (46.2%) | | |
| | Divorced | 1 (4.8%) | 3 (18.8%) | 5 (19.2%) | | |

CDP-C: group of crack cocaine; CDP-I: group of inhaled cocaine; KW: Kruskal-Wallis; SD: standard deviation. [a] $p < 0.05$; [b] $p < 0.001$ (detailed only for the contrasts that have proved significant).

backward order, the participant must repeat the set of numbers in the reverse (backward) sequence dictated by the examiner. In the set of random numbers and letters given orally by the examiner the participant must repeat first the numbers and then the letters in alphabetical order. The total score is computed by the maximum number of digits the participant can repeat correctly in each step [37].

### Tower of London
Is a neuropsychological instrument designed to evaluate planning and problem-solving abilities. The goal of the task is to move colored beads from an original or initial configuration to the meta setting displayed on a screen board in the least number of possible moves. There are 13 exercises in total with levels of increasing complexity [38].

### Iowa Gambling Task
This task seeks to simulate in real time, the decision-making process of real life including factors such as the non-certainty of the premises or results as well as punishments and reinforcers. In the task, 4 decks of cards equal in appearance and size are placed in front of the subject and an initial loan of fictitious money is provided for 2000. The game requires that the evaluated person make a long series

of card choices until he is asked to stop (after 100 trials). After each election a prize (money) is received, the amount of which varies according to the chosen deck and the position of the card within the deck. After some elections in addition to receiving a prize, you must pay a penalty whose amount also varies according to the position of the card in the deck. In all cases the order is unknown to the subject. The instructions are: maximize the profit on the initial loan; freely choose how many times you want from any of the decks; but, the subject does not know when the test will end. The order in which punishments and awards are accommodated, allows to establish two clear conditions; On the one hand, decks 1 and 2 give high prizes (100), but the future gain is always negative, that is, after 10 elections in either of these two decks, the penalties have exceeded the total amount of the prizes. On the other hand, decks 3 and 4 grant smaller prizes (50), however the future gain is positive [39].

### Reading Mind in the Eyes Test (RMET)
Is a task that measures mind reading abilities. During the task, is presented with an image of a pair of eyes and four single-word descriptors. The options relate to the emotions and intentions of the target person, the subject must identify what the person in the photograph is feeling or thinking and recognize the correct mental state among three other confounding mental states. The test has a definition manual in which the subject can consult the definition and a prototypical example of each descriptor in case of not being sure what the word refers to [40].

## Data analysis

Descriptive analysis was applied to demographic data taking frequencies and non-parametric Chi Square test to categorical variables and central tendency measures to continuous variables.

Due to differences in group and overall sample size non parametric statistics where used for all comparisons between users and controls.

Data processing and data analysis were performed using the statistical programme SPSS v. 20.0.

## Results

### Sociodemographic and clinical data

In the analyzed population, the sample was divided in these three groups: control, CDP-I and CDP-C. The data is shown in table I.

There were statistically significant differences in the socioeconomic level score with average ranges in each groups of CDP-I (23.80), CDP-C (24.54) and control (43.95), consumer groups showed a lower score among in relation to the control. There was also significant differences in education and marital status in all groups.

Clinical data shows significant differences in the scores of BIS-11.

CDP-I group had higher average ranges in the subscales, attentional (42.57), motor (41.63) and total (39.23), with respect to CDP-C and control. In contrast, CDP-C group had a higher average range only in the subscale of non-planning (39.56). This shows the consumer groups had to higher impulsivity scores with respect to control group.

In the consumer groups the CCQ showed that there are no differences in the craving. Instead in the MINI Plus confirm that more than 87% participants have a substance use disorders mainly cocaine and the existence past of alcohol dependence and abuse, this data were statistically significant (Table II).

## Cognitive performance

Non-parametric analysis of the cognitive evaluation showed scores statistically significant.

In the task of Berg's that measures cognitive flexibility, there had differences significant in the five criteria that were considered for that study.

CDP-I group showed average ranges low in completed categories (22.47) and high ranges in essays to complete the first category (41.07), while CDP-C showed average ranges low in correct answers (23.83) and more total errors (36.75) and high ranges in total perseverative errors (36.75) (Table III).

Assessment of working memory and attention showed that scores had statistically significant differences, particularly in two tasks; numbers in the direct order and subtraction 3 for 36s. In this case CDP-C group showed lower aver-age range (23.38 and 23.08 respectively) compared the groups control and CDP-I (Table IV).

In the decision-making and planning evaluated by the tower of London task there were statistically significant scores, in the correct answers and total movements CDP-I had high average range in total movements (36.30) and CDP-C presented low average range in correct answers (24.63) (Table IV).

## Discussion

This study highlights the importance of determin-

ing the state of executive functions and, the impulsiveness and craving during early abstinence in cocaine and crack consumers.

In accordance with the literature, the use of cocaine produces heterogeneous and diffuse cognitive impairments. These systemic and functional consequences are clinically evident and, the data found in this study has corroborated that there are scores with statistically significant differences in the clinical tests and cognitive tasks between CDP-I, CDP-C and control group. Specifically, the main impact was observed in the BIS-11 that evaluate impulsivity the groups showed differences in total impulsivity scores ($p < 0.001$). Consumers groups had higher scores with respect to the control group. Clinically it may be a manifestation of more impulsivity.

In the case of craving, measured by the CCQ, the groups of consumers although they do not differ in the scores of craving, these if they are near the maximum score of test, this could be translated clinically in a possible indication of craving. This data is concurrent with studies that indicate that cocaine use is associated with impulsivity and craving, possibly because neuroanatomically there are changes in various areas of the cortex, in particular the frontal cortex as well as subcortical structures such as the amygdala and accumbens [41].

Several previous studies have been done with separate samples of users of crack and cocaine, but to date not a cognitive battery that will compare the performance of both groups in Mexican population. This population has particular criteria that were considered and measured among them the socioeconomic and education level.

It is important to mention that the nature and severity of cognitive deficits depend on many factors, including patterns of drug use and the individual's early development [42] and the sociocultural [43] environment in which the subject develops.

The results showed that cocaine and crack users presented particularities in executive functioning. For example crack users showed poor performances compared to the control group in the Berg's, Tower of London, numbers in the direct order and subtraction. Evidencing more errors and perseverations and fewer correct answers. This may reflect less cognitive flexibility, difficulties for planning and decision-making, less working memory and attention. These are components of the activity of the prefrontal dorsolateral circuits [44]. In contrast, cocaine users only presented less performance in planning measured tower of London task.

These poor performances in planning aspects could interfere directly or indirectly with socioeco-

**Table II.** Clinical characteristics (frequencies, percentage, mean, standard error, *U*-Mann-Whitney Test and Kruskal-Wallis Test, depending on the case) for the three groups.

| | | Control (n = 19) | CDP-I (n = 15) | CDP-C (n = 26) | KW (χ²) | Sig. | U | z |
|---|---|---|---|---|---|---|---|---|
| Laterality | Right | 18 (85.7%) | 14 (87.5%) | 21 (80.8%) | 1.32 | 0.515 | | |
| | Left | 2 (9.5%) | 1 (6.7%) | 2 (7.7%) | | | | |
| | Ambidextrous | 1 (4.8%) | – | 3 (11.5%) | | | | |
| Onset age of consumption | | – | 23.13 ± 7.2 | 20.81 ± 4.21 | | 0.463 | 168 | −0.733 |
| Time drug use | | – | 5.93 ± 4.97 | 9.23 ± 6.88 | | 0.158 | 143 | −1.413 |
| BIS-11 | Attentional [b] | 12.63 ± 4.73 | 20.4 ± 5.82 | 16.12 ± 5.83 | 15.16 | 0.001 | | |
| | Motor [a] | 14 ± 6.87 | 21.67 ± 7.73 | 15.46 ± 7.13 | 8.97 | 0.011 | | |
| | Non-planning [b] | 16.62 ± 7.5 | 22.53 ± 7.59 | 26.85 ± 7.32 | 16.2 | 0.000 | | |
| | Total [b] | 43.52 ± 14.89 | 64.6 ± 18.53 | 58.42 ± 15.03 | 14.98 | 0.001 | | |
| CCQ | Desire to use cocaine | – | 24.67 ± 13.31 | 30.88 ± 11.85 | | 0.116 | 137 | −1.573 |
| | Intention to use cocaine | – | 25 ± 12.79 | 29.69 ± 10.57 | | 0.249 | 152.5 | −1.152 |
| | Positive expectancies for cocaine consumption | – | 24.53 ± 13.52 | 28.04 ± 11.26 | | 0.349 | 160.5 | −0.936 |
| | Anticipation of relief from withdrawal or dysphoria from using cocaine | – | 28.13 ± 10.71 | 27.12 ± 11.99 | | 0.597 | 175.5 | −0.529 |
| | Lack of control over use | – | 32.67 ± 12.76 | 36.54 ± 7.09 | | 0.481 | 169 | −0.705 |
| | Total | – | 135 ± 56.21 | 152.27 ± 37.98 | | 0.239 | 151.5 | −1.178 |
| MINI-Plus | Alcohol abuse now | – | 12 (81.3%) | 16 (61.5%) | | 0.125 | 145 | 0.125 |
| | Alcohol dependence past [a] | – | 1 (6.3%) | 1 (3.8%) | | 0.024 | 117.5 | −2.25 |
| | Alcohol abuse past [a] | – | 13 (81.3%) | 14 (53.8%) | | 0.048 | 130 | −1.98 |
| | Substance use disorders (cocaine) [a] | – | 14 (87.5%) | 22 (87.6%) | | 0.056 | 127.5 | −1.912 |

BIS-11: Barrat Impulsiveness Scale version 11; CCQ: Cocaine Craving Questionnaire; CDP-C: group of crack cocaine; CDP-I: group of inhaled cocaine; KW: Kruskal-Wallis. [a] $p < 0.05$; [b] $p < 0.001$ (detailed only for the contrasts that have proved significant).

nomic aspects. In this case, there are differences in the socio-economic level score, the user groups having the lowest scores. Nevertheless, it is essential to continue investigating the direct consequences on the life of the subjects derived from such deficiencies.

The identification of this type of deficit, in particular the flexibility and planning, allows us to detail the characteristics of the groups and with this to adapt the treat in the future, discriminating between the cognitive and behavioral techniques that best adapt to these profiles, with the sole purpose of

increasing effectiveness, as reported by analogues studies [45].

A better understanding of the characteristics of this population, benefits the creation of prevention and intervention policies and, the recognition of cognitive commitments there are important for the development of adequate individualized intervention programs. Comprehensive executive functions evaluation is fundamental in the process of detoxification treatment, because they are useful to enhance the functional processes and rehabilitate aspects with deficits, the sole purpose being

**Table III.** Cognitive characteristic (mean. standard error and Kruskal-Wallis Test. depending on the case) for three groups.

| | | Control (n = 19) | CDP-I (n = 15) | CDP-C (n = 26) | KW ($\chi^2$) | Sig. |
|---|---|---|---|---|---|---|
| Berg's Card Sorting Test | Completed categories [b] | 6.11 ± 2.28 | 2.8 ± 2.85 | 3.15 ± 2.31 | 15.71 | 0.000 |
| | Correct answers [a] | 89.32 ± 16.91 | 73.67 ± 20.01 | 69.04 ± 20.76 | 12.20 | 0.002 |
| | Total errors [a] | 36.26 ± 19.07 | 54.33 ± 20.01 | 57.5 ± 21.59 | 12.16 | 0.002 |
| | Total perseverative errors [a] | 19 ± 9.33 | 27.73 ± 17.16 | 30.34 ± 18.99 | 5.83 | 0.054 |
| | Essays to complete the first category [a] | 24.05 ± 26.82 | 42.2 ± 35.35 | 28.84 ± 37.35 | 7.44 | 0.024 |
| Flanker | Congruent hits | 140.05 ± 21.52 | 121 ± 31.58 | 129.5 ± 27.46 | 4.21 | 0.122 |
| | Incongruent hits | 132.73 ± 27.06 | 119 ± 33.42 | 121.77 ± 33.31 | 1.90 | 0.387 |
| | Congruent errors | 9.21 ± 9.68 | 17.13 ± 16.32 | 12.85 ± 13.53 | 3.07 | 0.215 |
| | Incongruous errors | 15.73 ± 16.02 | 18.2 ± 14.01 | 17.85 ± 17.08 | 0.731 | 0.694 |
| | No congruent answers | 9.89 ± 11.63 | 21.27 ± 21.25 | 18.65 ± 20.32 | 3.60 | 0.165 |
| | Non-incongruous answers | 11.52 ± 13.85 | 22.6 ± 23.31 | 20.85 ± 24.29 | 3.06 | 0.216 |
| | Congruent reaction time | 451.68 ± 60.68 | 447.45 ± 76.12 | 482.67 ± 64.32 | 3.09 | 0.212 |
| | Incongruent reaction time | 462 ± 60.98 | 456.73 ± 63.98 | 496.2 ± 63.27 | 4.47 | 0.107 |
| | Time of congruent errors | 666.4 ± 184.51 | 673.5 ± 183.77 | 688.13 ± 157.42 | 0.358 | 0.836 |
| | Time of incongruous errors | 624.49 ± 152.26 | 674.47 ± 173.14 | 21.19 ± 33.06 | 1.48 | 0.477 |
| | Commission errors | 9 ± 11.4 | 27.47 ± 40.79 | 137.35 ± 146.86 | 2.84 | 0.241 |
| | Effect flanker | 10.31 ± 12.97 | 9.28 ± 34.43 | 10.32 ± 12.97 | 1.18 | 0.552 |
| | Effect flanker part 1 | 16.48 ± 26.91 | −0.57 ± 30.45 | 7.78 ± 37.11 | 2.15 | 0.340 |
| | Effect flanker part 4 | 1.18 ± 32.58 | 7.20 ± 78.7 | 20.6 ± 29.08 | 3.93 | 0.140 |
| Go/No-Go | Hits | 151.84 ± 12.94 | 133.27 ± 40.12 | 341.91 ± 146.86 | 4.78 | 0.092 |
| | Reaction time commission errors | 354.9 ± 147.19 | 383.77 ± 70.12 | 36.19 ± 9.62 | 0.153 | 0.926 |
| | Hits part 1 | 37.1 ± 4.25 | 32.73 ± 10.84 | 261.51 ± 196.09 | 1.16 | 0.559 |
| | Reaction time commission errors part 1 | 354.12 ± 162.55 | 281.06 ± 194.08 | 34 ± 10.99 | 2.15 | 0.340 |
| | Hits part 4 | 38.26 ± 5.82 | 32.07 ± 12.36 | 217.24 ± 179.9 | 2.94 | 0.229 |
| | Reaction time commission errors part 4 | 210.402 ± 213.3 | 328.66 ± 204.57 | 13.53 ± 27.24 | 3.93 | 0.140 |

CDP-C: group of crack cocaine; CDP-I: group of inhaled cocaine; KW: Kruskal-Wallis. [a] $p < 0.05$; [b] $p < 0.001$ (detailed only for the contrasts that have proved significant).

**Table IV.** Cognitive characteristic (mean, standard error and Kruskal-Wallis Test, depending on the case) for three groups.

| | | Control (*n* = 19) | CDP-I (*n* = 15) | CDP-C (*n* = 26) | KW ($\chi^2$) | Sig. |
|---|---|---|---|---|---|---|
| Iowa Gambling Task | Total index | 10.84 ± 25.9 | 12.4 ± 15.44 | 7.54 ± 19.72 | 0.245 | 0.885 |
| | Advantageous elections | 55.42 ± 12.95 | 56.2 ± 7.72 | 53.77 ± 9.86 | 0.245 | 0.885 |
| | Reaction time of advantageous choices | 2019.03 ± 721.78 | 1844.3 ± 771.96 | 2173.73 ± 672.32 | 3.72 | 0.155 |
| | Disadvantageous elections | 44.58 ± 10.37 | 43.8 ± 7.72 | 46.23 ± 9.86 | 0.245 | 0.885 |
| | Reaction time of disadvantageous choices | 2305.95 ± 1.186.25 | 2214.61 ± 466.9 | 2291.24 ± 1121.56 | 0.233 | 0.890 |
| Reading the Mind in the Eyes | Total hits | 24.42 ± 5.1 | 21.93 ± 4.65 | 21.69 ± 4.1 | 3.21 | 0.201 |
| | Hit positive states | 5.79 ± 1.54 | 5.33 ± 1.83 | 5.08 ± 1.52 | 2.10 | 0.350 |
| | Hit negative states | 7.32 ± 2.28 | 6.33 ± 1.58 | 6.46 ± 1.98 | 2.80 | 0.246 |
| | Hit neutral states | 11 ± 2.26 | 9.67 ± 2.74 | 9.69 ± 1.95 | 3.27 | 0.195 |
| Working memory and attention | Direct order [a] | 8.53 ± 2.22 | 8.2 ± 1.82 | 6.92 ± 1.32 | 7.85 | 0.020 |
| | Reverse order | 5 ± 1.82 | 4.73 ± 1.62 | 4.5 ± 1.55 | 0.763 | 0.683 |
| | Letters and numbers | 9.21 ± 2.69 | 7.87 ± 2.13 | 7.23 ± 2.58 | 5.36 | 0.068 |
| Subtraction | Answers without interference | 15 ± 0 | 15 ± 0 | 14.88 ± 0.588 | 1.30 | 0.520 |
| | Subtraction 3 for 18s | 10.42 ± 3.7 | 9.07 ± 3.39 | 7.88 ± 3.02 | 5.13 | 0.077 |
| | Subtraction 3 for 36s [a] | 10.53 ± 2.83 | 10 ± 2.82 | 8.08 ± 2.71 | 8.52 | 0.014 |
| | Subtraction 7 for 36s | 10.47 ± 2.89 | 9.33 ± 2.76 | 3.06 ± 0.6 | 5.16 | 0.076 |
| Tower of London | Correct [a] | 7.26 ± 2.15 | 5.4 ± 1.72 | 5.04 ± 1.92 | 12.08 | 0.002 |
| | Total movements [a] | 76.05 ± 14.99 | 94 ± 24.13 | 92.15 ± 24.17 | 7.92 | 0.019 |
| | Start time | 99.76 ± 44.48 | 85.84 ± 35.1 | 91.56 ± 26.43 | 1.53 | 0.465 |
| | Total time | 252.62 ± 116.58 | 312.03 ± 176.32 | 312.21 ± 129.47 | 3.08 | 0.213 |

CDP-C: group of crack cocaine; CDP-I: group of inhaled cocaine; KW: Kruskal-Wallis. [a] $p < 0.05$ (detailed only for the contrasts that have proved significant).

prolonging periods of abstinence with in the process of addiction.

These cognitive changes following drug use serve to provide a theoretical framework of addiction and also lead to the development and identification of biomarkers. The biomarkers, may be used to predict risk of development into addiction, relapse and possibly also to improve treatment. These have a high potential for more effective addiction risk assessment and would ultimately lead to more effective treatment in the future [46].

It is relevant to point out that there were also seemingly unaltered functions found which may be related with the phase of abstinence in which they were and possibly to the characteristics of this sample. The consumers had an acceptable academic level, with a socioeconomic situation although low in comparison with the control group but that allowed them to maintain their addiction, besides emphasizing the degree of interest towards themselves to participate voluntarily in these types of studies.

This study, although useful, is not without limitations. First, it is a cross-sectional study, which means that we cannot relate possible changes. It is necessary to continue doing longitudinal research to compare the results and better understand the

issues involved in them. An attempt was made to balance the education level of the groups, however, due to the characteristics of the population, the maximum control could not be achieved.

On the other hand, further research should incorporate other types of consumption and in different times of abstinence. Among the issues that remain to be assessed is application of the similar instruments, for the purpose of making performance comparisons. It would also be interesting to get the performance off different age groups and with comorbid personality disorders.

In conclusion, it should be noted that this research certainly opens the possibility of conducting future studies to analyze in greater depth the impulsivity, craving and principality the executive functions in Mexican cocaine and crack users. As is well known, cocaine addiction is a growing problem with an increasing proportion of persons at risk that require improved and more sustainable prevention efforts.

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## Funcionamiento cognitivo en sujetos con trastorno de dependencia a cocaína y crack durante la abstinencia temprana

**Introducción.** Los efectos cognitivos causados por el consumo de cocaína y crack, especialmente los déficits de las funciones ejecutivas, aumentan la probabilidad de un comportamiento de búsqueda de drogas e interfieren en la capacidad de los usuarios de asimilar y participar en los programas de rehabilitación.

**Objetivo.** Determinar en la abstinencia temprana el estado de las funciones ejecutivas, la impulsividad y la ansiedad (*craving*) en consumidores de cocaína y crack.

**Sujetos y métodos.** Este estudio transversal tuvo una muestra de 60 hombres, con una edad media de 31,38 ± 7,26 años, distribuidos en tres grupos: usuarios que inhalan cocaína (CDP-I; *n* = 15), con una edad de inicio de consumo de 23,13 ± 7,2 años; consumidores de cocaína en crack (CDP-C; *n* = 26), con una edad de inicio de consumo de 20,81 ± 4,21 años, y un grupo control de sujetos sin adicción (*n* = 19). Se aplicaron evaluaciones sociodemográficas, clínicas y cognitivas.

**Resultados.** Los datos mostraron diferencias significativas en las puntuaciones del nivel socioeconómico e impulsividad. Los grupos de consumidores tienen puntuaciones más bajas con respecto al grupo control. El grupo CDP-C mostró rendimientos pobres en comparación con el grupo CDP-I y el grupo control en las pruebas de Berg, torre de Londres, números en orden y sustracción directos. El grupo CDP-I mostró una menor puntuación en la planificación comparada con los otros dos grupos.

**Conclusiones.** En la abstinencia temprana, los consumidores de crack manifiestan mayor número de déficits, principalmente en la memoria de trabajo, la planificación y la flexibilidad cognitiva.

**Palabras clave.** Abstinencia temprana. Cocaína. Crack. *Craving.* Evaluación. Función ejecutiva.