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Assessment of visuospatial memory in drug addicts admitted to the blue cross reception center of Côte d'ivoire

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Abstract
In recent years, being a country of drug trafficking and transit in West Africa, Ivory coast has become a country of drug consumption. Indeed, in 2016, UNODC study established that 12% of the Ivorian population aged between 14 and 64 years old consume drugs. This dramatic situation is at the root of many security problems throughout the country. According to literature, drug use can lead to more or less severe complications on cognitive abilities. This is particularly alarming as the majority of drug users are teenagers, putting their future at risk. The aim of this study was to determine the effects of narcotics on the memory abilities of users admitted for treatment at the Blue Cross reception centre.
To this end, an evaluation of their visuospatial memory was carried out by means of the memory test of 9 images of familiar objects. The naming test consisted of pointing out with the finger in the square frame to the box corresponding to the image presented by the investigatorr. The memory performance of pre-withdrawal patients (Prwp), patients undergoing withdrawal (Puw) and post withdrawal patients (Pwp) was compared with that of controls (patients who were not drug users).
The results showed that Prwp and Puw do not pass the test. They therefore have delayed learning, unlike the pwp and controls. Thus, after withdrawal, a progressive recovery of the memory ability of drug users was observed.

Keywords: Illicit drug, drug addict, withdrawal, visuospatial memory

Introduction

Since time immemorial, human beings have taken up all kinds of substances that could affect the normal functioning of the central nervous system. These compounds have been identified as psychotropic drugs and defined as all chemical substances of natural or artificial origin that are able to alter mental activity. The use of narcotic drugs is of great concern worldwide. Indeed, the International Narcotics Control Board (INCB) estimates that there are between 150 and 300 million users of illicit substances worldwide (UNODC, 2012) [20]. Data from the literature shows that the use of illicit drugs and other psychoactive substances is not without risk: they alter brain structures and functions (Asensio 2010 *et al.*, Garland, 2012) [4, 9], affecting mood (Schlauch *et al.*, 2013), perception (McCann *et al.*, 2011; O'Daly *et al.*, 2012) [15, 17] and consciousness (Koethe *et al.*, 2006) [12]. These changes have psychological, psychosocial effects and can lead to violence and/or legal issues (Loftis and Huckans, 2013) [14]. The WHO (WHO 2010), estimates that the use of psychoactive substances and dependence are responsible for 5.4% of the annual burden of disease worldwide. Over the past decade, the production and demand for illicit drugs dramatically increased, as shown by the seizure of huge quantities of drugs by national and international authorities and the growth of drug addiction. According to the United Nations Office on Drugs and Crime (UNODC, 2012) [20], drug use caused over 253,000 deaths globally. These deaths represent 1.3% of all-cause mortality among people aged 15-64 years old. Some studies also indicate that cannabis is the most widely used drug in the world.
Unfortunately, Africa and West Africa in particular, has become a major destination for transnational organised crime and a hub for drug use and transit in the world. Indeed, according to the United Nations Office on Drugs and Crime (UNODC, 2019) [22] report, drug

use is twice the global average in Nigeria. Cannabis remains the most used illicit drug in this part of the world followed by amphetamine-type stimulants. According to the Ecole Nationale d'Application des Cadres Territoriaux (ENACT, 2019) [7], the quantity of amphetamine, cocaine, opiates and opioids prescribed for non-medical purposes, for West Africans is expected to double by 2050, from about 185 tons in 2018 to 430 tons.

Côte d'Ivoire, which has been in an economic crisis since 1980s, and which has experienced political crises in 2002 and 2010, could not escape this scourge. All sectors are almost affected. In addition of being a country of transit and trafficking, Ivory Coast has become a country of drug consumption (Vagondo *et al*., 2019). In 2016, a UNODC study established that 12% of the Ivorian population aged between 14 and 64 years old use drugs. This dramatic situation is the source of many security problems throughout the country.

According to numerous studies, drug use can lead to more or less serious complications on the memory. This situation is so alarming that the majority of users are teenagers, jeopardizing their future. It was, therefore in this context we dicided to investigate on the effects of psychoactive substances on visuo-spatial memory on this part of the Ivorian population.

Material and Methods

Material

Patients

The study was carried out on eighty (80) patients, sixty (60) were drug users and twenty (20) controls (No drug users). Among the drug-using patients, twenty (20) were at their first contact with the Blue Cross and therefore had not undergone any withdrawal treatment (Prwp), twenty (20) patients had been in withdrawal for at least two weeks (Puw) and twenty (20) had been weaned (Pwp). Only patients using illicit drugs were included in this study. Patients'age ranged between 17 and 50 years of old (mean age, 21 years old), of both sexes and were all admitted to the Blue Cross reception center. For this study, only male patients were taken into account. The hormonal changes caused by the menstrual cycle do not allow to draw effective conclusions in the case of intergroup comparisons (in Yao, 2011) [32]. Therefore, it was necessary to put patients under the same psychological conditions during the test. All participants signed their informed consent.

Technical Equipment

Material was basically composed of

- A memory test of nine images of familiar objects (a key, a traditional clothing, a pig, a cutlass, a bicycle, a drum, a mango, a mask, a pot) (figures 1 and 2), to assess the visuospatial memory (FOUILLOT and Thunnin 1993; Yao *et al*., 2011) [8, 32].
- and a software (STATISTICA 10.0) for data processing.

Methods

The visuospatial memory test consists of studying the arrangement, naming and evocation of images during a spatial reasoning test. The patient must memorise the arrangement of nine images of familiar objects (a traditional clothing, a pig, a mango, a key, a bicycle, a pot, a mask, a cutlass and a drum) arranged on nine equal sides of a square frame (40 cm on each side) set before him. The delay between the images'presentation and the recall is fixed to thirty (30) seconds in which the patient underwent a simple interference task (mental calculation or conversation). For each type of test, the criterion for spatial reasoning is set to three successive tests without error.

In case of failure, the test is stopped after ten trials. During tests, correct answers are confirmed by the investigator and errors are reported to the patient.

During the presentation that precedes each naming or evocation, the spatial arrangement of images should not change; each image always occupies the same place on the frame. However, the order of images' presentation does not follow an obvious spatial organisation and should vary from one trial to the next.

The layout of each image is successively shown for five seconds to the patient, who is instructed to remember the place of the image in the frame. During the presentation tests that precede the namings or evocations, the patient must not see the overall arrangement of the nine images on the nine sides of the frame, meaning that each image is removed before the presentation of the following one.

For each type of test, the criterion for spatial reasoning is set to three successive tests without error. In case of failure, the test is stopped after ten trials. During tests, correct answers are confirmed by the investigator and errors are reported to the patient. For this study,only the naming test was performed.

The patient was instructed to point out the box corresponding to the image shown by the investigator. The naming of the nine boxes is also a trial that can be successful or not.

Data analysis

The sample is a series of trials which can reach a maximum of ten, when learning comes late or has not been established. The character studied is the number of errors per test. Since the learning of the spatial layout was focused on nine images of common objects, the maximum number of errors was nine. For each type of test, the results were presented in a single entry table with two columns, the first column was used for the number of trials and the second for the percentage of errors. However, for a proper interpretation of data they will be graphically expressed.

The percentage of errors was determined as followed:

$$\frac{\text{Number of errors for the test}}{\text{Maximum nimber of errors}} \times 100$$

That is to say

$$\frac{\text{Number of errors for the test}}{9} \times 100$$

In addition, in each series of experiments, the memory performances of four groups of patients were compared: control patients, drug-dependent patients who have not yet started their treatment (Pre-Withdrawal Patients (Prwp), patients still in withdrawal (Puw) and ex-drug-dependent patients who have completed their treatment (Weaned Patients (Pwp). The aim is to analyse the overall behaviour

of each group through their performance and to compare these results with the other groups.
Thus, it was necessary to check the significance of the likely differences observed between the mean error obtained in each group, i.e. whether for each test the difference in performance between two given groups was significant or not.

One way (ANOVA) using Statistica 10.0 software was used to make these comparisons. The probability (p) of 0.05 was considered as the limit value of significance. Thus, if "p" is less than or equal to 0.05, then the difference between the variables compared is significant. On the other hand, if "p" is greater than 0.05, then the difference between the two variables being compared is not significant.

Fig 1: The square frame with the 9 images of familiar objects used for the visuospatial memory test.

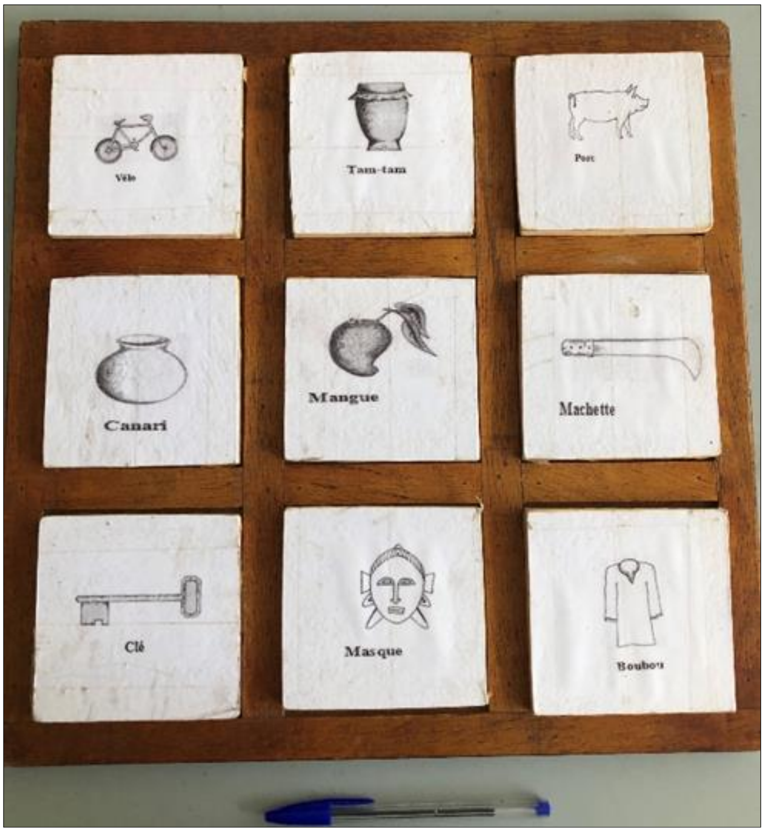

Fig 2: Overall picture of the device for the visuospatial memory test

Results

Comparison of performance between controls and pre-withdrawal patients (Prwp)

The percentages of errors on all tests for pre-withdrawal drug users were higher than for controls (Figure 1). The difference of performance between controls and pre-withdrawal patients (Prwp) was significant (chi2 = 5.57 > 4 and p = 0.0183 < 0.05). The percentage of errors for controls decreases from 37.77% for the first test to 0% from the 5th to the 10th test, whereas that of the pre-withdrawal patients (from 55.55% to 8.88%), even though it decreases, does not nullify during these ten tests. The comparison of patients' performance with that of control patients showed a highly significant difference from the 2nd test to the 9th (test 2: F(1,8) = 12.500 and p= 0.00767; test 3: F(1.8) = 27.563 and p = 0.000777; test 4: F(1. 8) = 22.857 and p = 0.00139; test 5: F(1.8) = 51.200 and p = 0.00010; test 6: F(1.8) = 14.696 and p = 0.00499; trial 7: F(1.8) = 90.0 and p = 0.0001; test 8: F(1.8) = 11.0 and p = 0.01; test 9: F(1.8) = 13.500 and p = 0.00627). The 1st and 10th tests are not significant (test 1: F (1.8) = 3.3684 and p=0.10379; test 10: F (1.8) =2.6667 and p= 0.14111);

Comparison of performance between controls and patients undergoing withdrawal

The percentages of errors (46.66%) of patients undergoing withdrawal were higher than the controls (37.77%) for the first test (Figure 2).

These values progressively decreased to zero by the 5th test for the control patients. For the weaning patients, the percentage of errors decreased significantly over ten tests but did not nullify. This result was not significant since chi2 =2.66 < 4 and p= 0.1032 > 0.05. The comparison of performance between control and withdrawal patients during the different tests showed that tests 2; 3; 4; 6 and 7 were highly significant with respective values F (1. 8)=4.6286 and p=0.06364; F (1.8)=8.333 and p=0.02030; F (1.8)=8.3404 and p=0.02026; F (1.8)=9.5294 and p=0.01496; F (1.8)=5.0625 and p=0.05457.

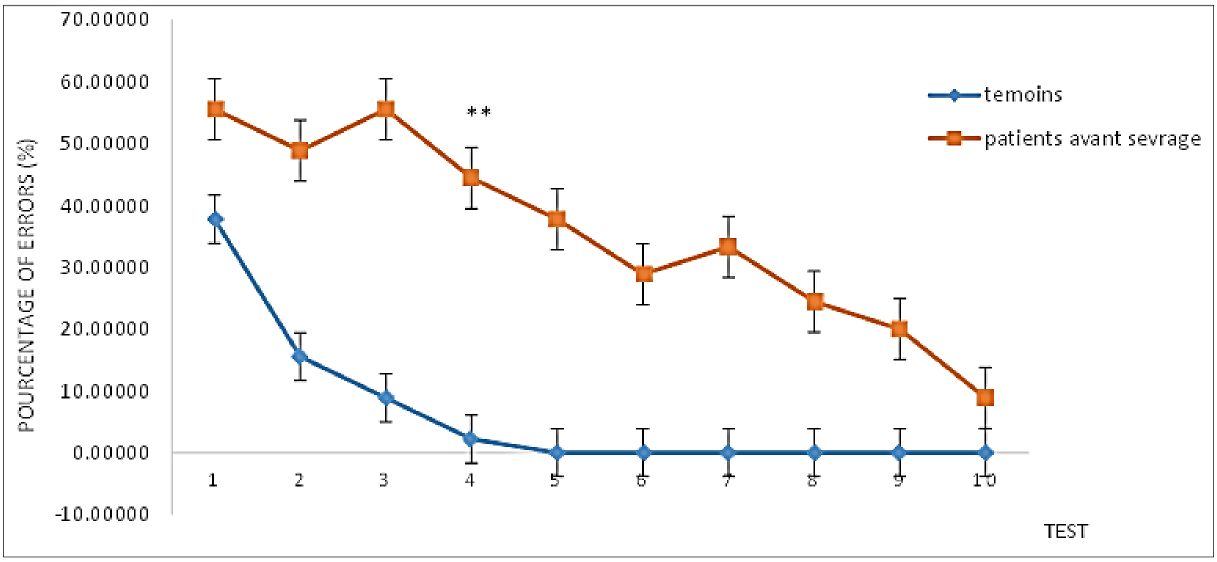

Fig 3: Performance of pre-withdrawal patients (Prwp)

Control: person who has never used illicit drugs (narcotics)
Pre-withdrawal patient: drug-using patient who has not yet started treatment

**: very significant
Prwp makes more errors than controls throughout the tests.

The difference in performance was highly significant. Also, Prwp did not pass the test after 10 tests. The learning process for the latter was delayed. The irregular (inconsistent) course of Prwp curve could indicate a difficulty in concentration.

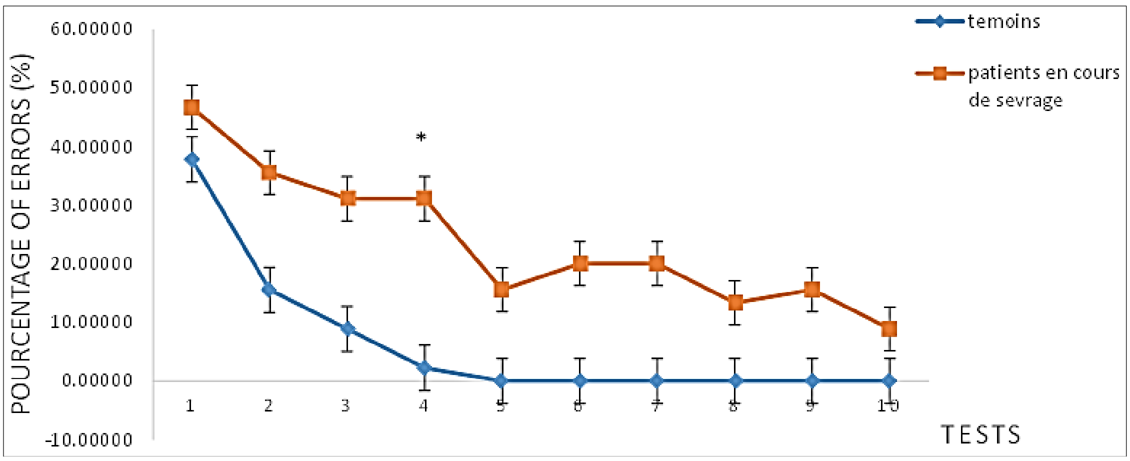

Fig 4: Performance of patients undergoing withdrawal (Puw)

*: significant
Control: person who has never used illicit drugs (narcotics)
Patient undergoing withdrawal (Puw): drug-using patient who has been in treatment for at least 2 weeks
PUW, like PBW, have a delayed learning. Overall, the PUW have significantly lower memory performance than the controls.

Comparison of performance between controls and post-withdrawal patients (Pwp)

According to the naming test, results indicated a decrease in the percentage of errors in both controls and post-withdrawal patients (Figure 5). These error rates decreased from 37.77% on the first test to zero on the fifth test for controls and from 42% to zero on the seventh test for post-withdrawal patients.
The performance of control patients and post-withdrawal patients was not significantly different, (chi2=0.01 and p= 0.9321).

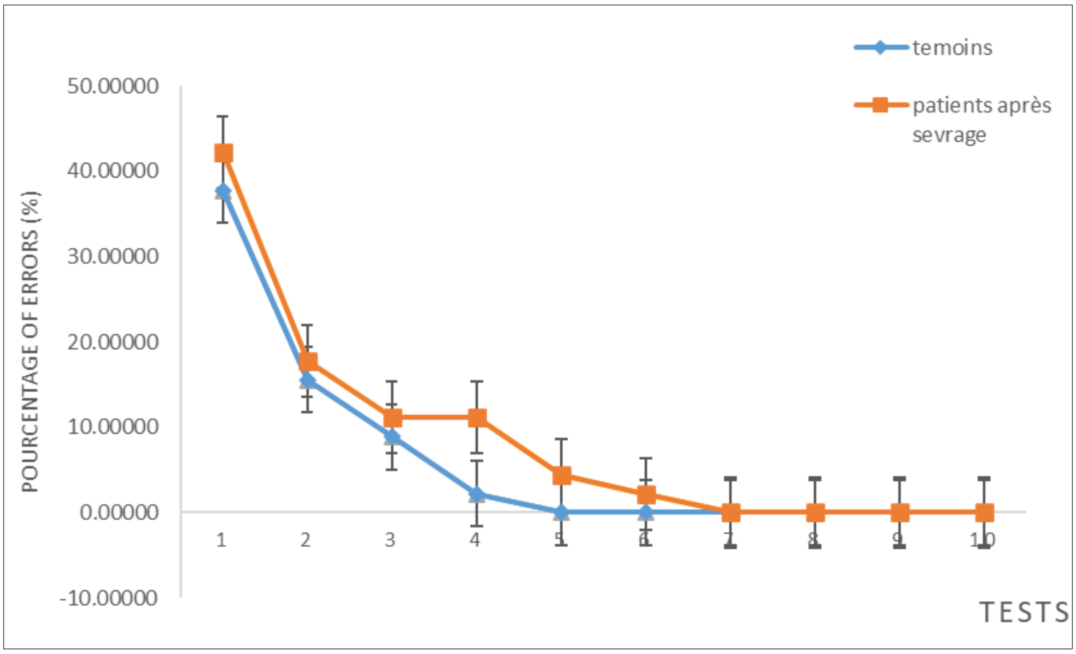

Fig 5: Performance of post withdrawal patients (Pwp)

Control: person who has never used illicit drugs (narcotics)
Post-withdrawal patient (Pwp): drug-addicted patient having completed treatment (withdrawal)
The memory performance of Pwp did not differ significantly from that of the controls. However, these Pwp only passed the test after 2 trials before the controls.

Discussion

In this study, the memory capacities of drug addicts admitted for treatment at the Blue Cross reception centre was evaluated. This revealed that learning (memorization) was delayed in patients who did not yet started their treatment (Prwp) and those in the process of withdrawal (Puw). Frequent use of drugs impaired their visuospatial memory.
The nervous system must optimally analyse all the information it receives and which is linked to the assign task. This can only be done if the overall activity of the brain is optimal. Below this optimal activity, the stimuli will be less well analysed and performance will be poorer (Adou *et al.*, 2012) [2]. It is obvious that drug alters the normal functioning of the nervous system.
According to Alain *et al.* (2014) [3], chronic use of cannabis (once a week for a minimum period of three years) is significantly associated with cognitive disorders, such as concentration, working memory, prospective and episodic memory disorders with alterations in the encoding, storage and recall of information as well as disorders in the processing of information necessary for decision making.

These factors could explain the significant difference in performance between control patients and drug addicts. These results confirm the hypothesis according to which memory function is a complex function involving sensory, cognitive and motor capacities with vast cerebral neuronal networks (GISQUET, 2006) [10]. This inability to memorise new facts and to learn could suggest a dysfunction of structures (Papez circuit, hippocampus) involved in the stabilisation of messages according to a spatial temporal relationship (Adou *et al.*, 2012) [2]. The test used in this study also calls upon working memory (Adou, 1999) [1]. This memory assumes that the patient not only records successive events, but also records them in the order in which they occur and uses them selectively later. At the physiological level, the neuronal support of working memory consists of a sustained activation of neuronal circuits that keep cortical neurons active, particularly in the prefrontal cortex, after the initial sensory stimulation (LAROCHE, 2004) [13].
This impairment of working memory due to regular drug use could explain some of the failures. moreover, the work of Salthouse (2011; 2013) [25, 24] pointed out the vulnerability of young people's brains, as they continue to develop to the age of majority, when they reach the peak of their capacities at the age of 22/25 years. Thus, any disturbance before the end of this period could lead to cognitive and behavioural problems. The results obtained with patients undergoing detoxification (Pud), indicate a significant difference with controls, but to a lesser degree compared to untreated drug-using patients. The damage created by the use of

psychoactive substances seen above has not yet been fully restored. Furthermore, there are some cases of recidivism during the withdrawal process. They are related to the lack" of insight" (i.e. the patient's perception of the psychological illness). This parameter was mentioned by Droulout *et al*. (2003) [6]. According to these authors "the insight" of patients influences their capacity for therapeutic alliance. Indeed, a patient who does not consider himself ill will not see the need to be on medication that may have been imposed on him by the doctor (Kande, 2020) [11].

The difficulties observed during the naming test suggest that there is always a difficulty in the information collection process. According to Tako (1995) [29], damage to the mammillary bodies indirectly induces dysfunction of the cingulate cortex, which results in an inability to actively reconstruct or order memories.

The comparison of performance between post withdrawal patients and controls revealed that there was no significant difference between both groups. This suggests a partial recovery of this cognitive function, especially since the ESPs passed the test two trials after the controls. These same observations were made by Tait *et al*. (2011) [28] and Schweinsburg *et al*. (2008) [27].

Their work indicates that users who have stopped using have better immediate memory performance than those who continue. It has also been shown that attentional and working memory impairments in adults frequently consuming cannabis tend to disappear within a month after stopping its use (in Alain *et al*., 2014) [3]. In teenagers, behavioural, verbal memory and planning problems could persist longer, four to six weeks after withdrawal. This has also been verified by the work of Meiner *et al*. (2012) [16], which states that users who used cannabis before the age of 18 do not fully recover their cognitive functions after they have stopped using it for at least a year.

Conclusion

From this study, it appears that the visuospatial memory of regular users of illicit drugs is significantly disturbed. However, with appropriate treatment (detoxification), this important cognitive function can be gradually recovered. However, after withdrawal, there remains a small gap between the memory performance of ex-drug users and that of non users of drugs. This indicates the irreversible nature of some brain lesions caused by the regular use of these psychoactive substances.

In order to protect the population, it could be necessary to raise the awareness of this phenomenon, for them to be informed about narcotics mode of action and their consequences on brain activity. Though, it is difficult to act on the production and distribution of these additive substances, it is however possible and easier to target the population and especially "our children.

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