INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH AND INNOVATIVE STUDIES
IJSRIS journal
ISSN: 2820-7157
Advancing Knowledge, Inspiring Innovation
www.ijsrisjournal.com
INDEXED JOURNAL
PEER REVIEWED Rigorous & Transparent
DOI: CROSSREF Member
OPEN ACCESS For Global Visibility
BI-MONTHLY Timely Publication
WIDE READERSHIP High Impact & Visibility
AUTHOR FRIENDLY Fast | Supportive | Reliable
RECEIVED 17 September
ACCEPTED 09 October
PUBLISHED 1 November 2026
September 2026
Volume 5
Number 6
Pages from 08 to 15

Memory Function in Substance Use Disorders: A Comparative Neuropsychological Study at the Psychiatry Department of Hassan II University Hospital in Fez

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Crossref doi
PREFIX : 10.63883
IJSRIS JOURNAL
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ABSTRACT

The study of memory functions in individuals with addictive behaviors is a clinical priority for cognitive assessment and the adaptation of care. Objective: To compare episodic memory and working memory performance between patients receiving addiction treatment and controls, and to examine their association with scores on the Drug Use Disorders Identification Test (DUDIT). Methods: A comparative cross-sectional study conducted at the Fez Addiction Treatment Center involving 100 men, divided into 50 patients and 50 controls. Participants were assessed using a two-story recall task and direct and reverse digit span tests; the DUDIT was administered to the clinical group. Analyses included between-group comparisons, effect sizes, correlations, and analyses adjusted for age and educational level. Results: The mean episodic memory score was 22.46 ± 5.32/60 among patients, compared with 42.54 ± 6.63/60 among controls; the alternative working memory score was 8.04 ± 0.92/16 versus 12.66 ± 1.65/16 ($p < 0.001$ for both comparisons). The differences persisted after adjustment. No, statistically significant correlation was found between the DUDIT and cognitive scores in the clinical group. Conclusion: In this male clinical sample characterized by frequent poly-substance use, performance on memory tests was lower than that of the control group. The cross-sectional nature of the study and the lack of control for several confounding factors preclude any causal interpretation

Key words: addictive behaviors, neuropsychological assessment, working memory, episodic memory

1. INTRODUCTION

Addictive behaviors constitute a public health problem whose consequences extend beyond the medical realm: they affect mental health as well as family, professional, and social life. Beyond these impacts, chronic use of psychoactive substances impairs cognitive functioning. International meta-analyses, particularly those on cocaine, report at least moderate deficits in attention, episodic memory, and working memory [6], [9].

Episodic memory allows us to recall events experienced within a specific context of time and place. Working memory allows us to temporarily hold and manipulate information. These two functions are essential for adhering to treatment: understanding instructions, remembering appointments, and following therapeutic advice. Their impairment can therefore limit the effectiveness of treatment.

In Morocco, published studies in the field of addiction primarily focus on the clinical profile and psychiatric comorbidities of patients [4], [1]. We have not identified any comparable study on the memory performance of patients with substance use disorders. Our study aims to partially address this gap.

Primary objective: to compare episodic memory and working memory performance between 50 patients with addictive behaviors and 50 controls without addictive behaviors.

Secondary objectives: to describe the sociodemographic and clinical profiles of the patients; to examine the relationship between the severity of addiction (DUDIT) and cognitive performance; to verify whether the difference between the groups persists after controlling for age and educational level.

Hypotheses: (1) patients will score lower than controls on both tests; (2) the severity of addiction is negatively associated with performance.

The significance of this comparison also lies in its clinical implications: memory difficulties can complicate the recall of information received during consultations, the understanding of instructions, and the continuity of care. Nevertheless, an observed association between clinical status and performance does not prove that substance use alone is the cause of the difference. Premorbid characteristics, comorbidities, and testing conditions must be considered in the interpretation.

2. METHODOLOGY

2.1 Study Design and Population

This is a cross-sectional, descriptive, and comparative study conducted at the Fez Addiction Treatment Center (GST Fez-Meknes). It involved 100 participants divided into two groups of 50: a clinical group (patients with addictive behaviors) and a control group.

The selection criteria for the control group were the absence of addictive behavior; age, sex, and educational level comparable to those of the clinical group; and the absence of any major neurological or psychiatric disorder likely to affect memory.

Recruitment involved a single-center clinical sample and a control group of equal sizes. The available information indicates that controls were selected for comparability in age, sex, and educational level, without demonstrating individual matching. The specific recruitment period, sampling method, inclusion criteria for the clinical group, and procedures for verifying the absence of addictive behavior among the controls are not documented in this submission and must be clarified based on the initial protocol prior to submission.

2.2 Measurement Tools

DUDIT (Drug Use Disorders Identification Test): an 11-item questionnaire, scored from 0 to 44, assessing the severity of drug use. We used the Arabic version validated in Morocco [8], which has good reliability (Cronbach's alpha = 0.95).

Episodic memory test: two stories read in succession, followed by a two-minute distractor task, then recall in order. A free recall is worth 2 points, a prompted recall 1 point, and no recall 0 points (total score out of 60: 15–25 low, 26–35 moderate, 36–60 good). This test is an adaptation to the Moroccan context, by Prof. Ali Afrfar, of a test described by Van der Linden (2004).

Working Memory Test: Digit spans in direct and then reverse order,8 levels with 2 trials each, 1 point per successful level, alternative total out of 16. It is based on the Wechsler scale [14], and instructions are given in the Moroccan dialect.

Details regarding the tests: the forward span primarily assesses the immediate retention of verbal information, whereas the reverse span places greater emphasis on its mental manipulation. These indicators do not, on their own, constitute a comprehensive assessment of working memory. For the two tests adapted to the Moroccan linguistic context, the exact scoring rules, categorical thresholds, reliability and validity data, and any ceiling/floor effects require additional documentation prior to submission. The reported classification of episodic memory (low: 15–25; moderate: 26–35; good: 36–60) does not specify the category for scores below 15.

2.3 Statistical Analysis

Quantitative variables are described by the mean, standard deviation, median, and range; qualitative variables by frequencies and percentages. The two groups were compared using Welch's t-test for independent samples and, due to non-

normal distributions (Shapiro-Wilk test), the Mann-Whitney U test. The magnitude of the differences is expressed by Cohen's d. The relationships between the DUDIT and cognitive scores were examined using Pearson's and Spearman's correlations within the clinical group. An analysis of covariance (ANCOVA) was performed for each score, with group as the factor and educational level and age as covariates; its assumptions (normality of residuals, homogeneity of variances and slopes) were verified and supplemented by a rank-based ANCOVA and robust standard errors (HC3). The significance threshold was set at $p < 0.05$. The analyses were performed using Python (scipy, stats models) and Excel.

Given the observational nature of the study, these procedures describe associations between groups rather than causal effects of exposure to substances. The interpretation of p-values must be considered in conjunction with differences in meaning, effect sizes, and, when available, confidence intervals. The multiplicity of memory indicators, some of which are correlated, must also be considered.

3. RESULTS

3.1 Participant Characteristics

Both groups consisted exclusively of males. The mean age was 32.4 ± 8.9 years among patients and 33.0 ± 8.6 years among controls ($p = 0.733$). Educational level did not differ significantly between the groups ($p = 0.662$). However, patients were more likely to be unemployed (58% versus 10%) (Table 1).

Table 1: Sociodemographic characteristics of the two groups

Characteristic	Patients (n = 50)	Controls (n = 50)
Male	50 (100%)	50 (100%)
Age, mean ± SE (years)	32.4 ± 8.9	33.0 ± 8.6
Age 18–29	18 (36%)	19 (38%)
Age 30–49	30 (60%)	30 (60%)
Age ≥ 50	2 (4%)	1 (2%)
Education level: elementary school	14 (28%)	9 (18%)
Level of education: middle school	11 (22%)	14 (28%)
Level of education: high school	12 (24%)	12 (24%)
Level of education: college	13 (26%)	15 (30%)
Occupation: employee	16 (32%)	38 (76%)
Occupation: unemployed	29 (58%)	5 (10%)
Occupation: student	2 (4%)	7 (14%)
Urban area	47 (94%)	50 (100%)

Age and educational level: individual records. Occupation and residential area: data collection form (occupation missing for 3 patients).

Clinically, all patients have a psychoactive substance use disorder (one patient also has pathological gambling). The most used substances are cocaine (76%), cannabis (54%), tobacco (46%), and crack (46%) (Figure 1). Polydrug use is the norm: 78% of patients use at least two substances. Daily use is reported by 84% of them, and 80% began using before the age of 20 (Table 2). The mean DUDIT score is 35.96 ± 3.84 (median 36, range 26 to 42); all patients exceed the threshold for probable dependence.

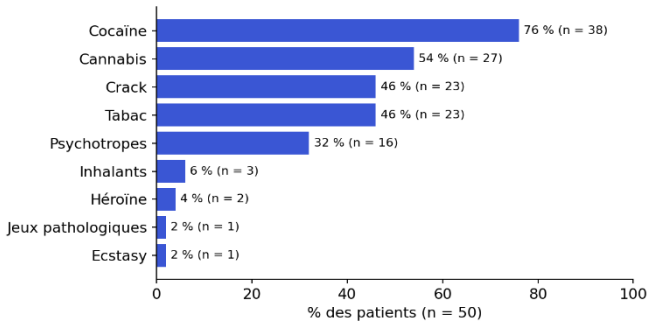


Figure 1: Substances used by patients (multiple responses allowed)

Table 2: Clinical characteristics of patients (n = 50)

Variable	n (%)
Number of substances used	Number of substances used
1 substance	11 (22%)
2 substances	14 (28%)
3 substances	19 (38%)
4 substances	2 (4%)
5 substances	4 (8%)
Age at first use	Age at first use
12 – 16 years	21 (42%)
16–20 years	19 (38%)
≥ 20 years	10 (20%)
Frequency of use	Frequency of use
Daily	42 (84%)
Several times a week	3 (6%)
Weekly	4 (8%)
Occasionally	5 (10%)

Consistency check of descriptive data: The figures in Table 2 for frequency of use (42, 3, 4, and 5) total 54 observations for 50 patients. Since the categories are presented as mutually exclusive, this table must be corrected based on the individual records before submission. Furthermore, the age categories for first use "12–16 years" and "16–20 years «share a common boundary at age 16, which needs to be clarified. The values are retained here as they appear in source data, without arbitrary correction.

3.2 Comparison of Cognitive Performance

Patients scored significantly lower than controls on all measures of working memory and episodic memory ($p < 0.001$), with very large effect sizes (d ranging from 2.1 to 3.5) (Table 3, Figures 2 and 3). On the episodic memory test, 37 out of 50 patients were classified as "poor" and only 1 as "good," compared with 44 out of 50 controls classified as "good" and none as "poor" (Table 4). The decline in performance between the first and second stories was marked among patients (12.5 then 9.9) and absent among controls (21.3 then 21.2).

Table 3: Comparison of scores between patients and controls

Score	Patients mean ± SE	Controls Mean ± SE	Difference	P (Welch)	p (Mann - Whitney)	Cohen's d
MT: alternative total /16	8.04 ± 0.92	12.66 ± 1.65	4.62	< 0.001	< 0.001	3.46
MT: direct span	6.02 ± 0.80	7.74 ± 0.85	1.72	< 0.001	< 0.001	2.09
MT: reverse span	4.10 ± 0.54	6.92 ± 1.03	2.82	< 0.001	< 0.001	3.43
Episodic: history 1/30	12.54 ± 2.97	21.32 ± 4.17	8.78	< 0.001	< 0.001	2.43
Episodic: history 2/30	9.92 ± 3.53	21.22 ± 4.10	11.30	< 0.001	< 0.001	2.95
Episodic: total /60	22.46 ± 5.32	42.54 ± 6.63	20.08	< 0.001	< 0.001	3.34

WM: working memory. Difference = controls − patients.

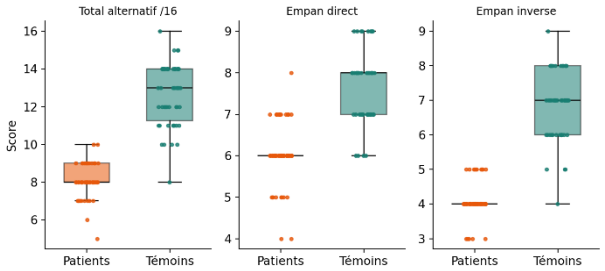


Figure 2: Working memory scores of patients and controls

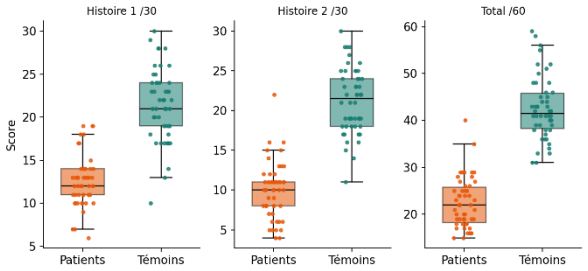


Figure 3: Episodic memory core

Table 4: Ranking of episodic memory performance (total /60)

Group	Low (15–25)	Moderate (26–35)	Good (36–60)
Patients (n = 50)	37 (74%)	12 (24%)	1 (2%)
Controls (n = 50)	0 (0%)	6 (12%)	44 (88%)

3.3 Analysis of Covariance

To verify that the difference between the groups was not due to age or educational level, an ANCOVA was performed for each score, with group as the factor and these two variables as covariates. After adjustment, the difference between patients

and controls remained highly significant for all six scores ($p < 0.001$), and the adjusted means were nearly identical to the unadjusted means (Table 5). Educational level was not associated with any of the scores (p values ranging from 0.107 to 0.742); age was associated only with recall of the second story ($p = 0.006$). The results were identical when using rank-based ANCOVA and robust standard errors (HC3). Finally, the comparison at comparable educational levels (low levels: elementary and middle school; high levels: high school and college) shows the same difference in both strata ($p < 0.001$).

Table 5: ANCOVA: effect of group on educational level and age

Score	Mean patients	Mean controls	Difference [95% CI]	p (group)	Partial η^2	p (level of education)	p for age
MT: alternative total /16	8.05	12.68	4.63 [4.09; 5.17]	< 0.001	0.76	0.429	**0.429**
MT: direct span	6.02	7.76	1.74 [1.41; 2.07]	< 0.001	0.54	0.281	**0.929**
MT: reverse span	4.11	6.93	2.82 [2.49; 3.15]	< 0.001	0.75	0.718	**0.292**
Episodic: history 1/30	12.47	21.46	9.00 [7.57; 10.43]	< 0.001	0.62	0.107	**0.864**
Episodic: history 2/30	9.99	21.12	11.13 [9.63; 12.63]	< 0.001	0.70	0.729	**0.006**
Episodic: total /60	22.46	42.59	20.13 [17.74; 22.51]	< 0.001	0.75	0.742	**0.062**

3.4 Relationship Between Dependence Severity (DUDIT) and Performance

No, statistically significant association was found between the DUDIT score and working memory or episodic memory performance in this clinical group (Table 6, Figure 4). This finding does not rule out the possibility of a weak association.

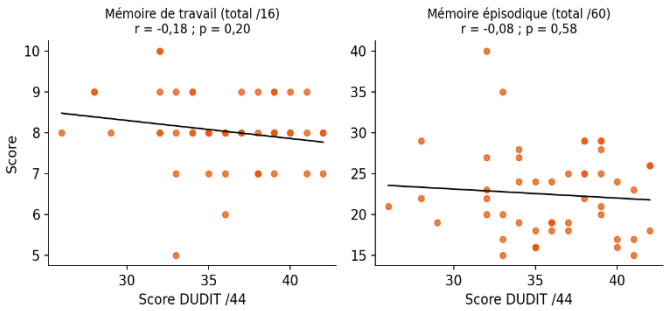


Figure 4: Relationship between the DUDIT score and cognitive performance in patients

Table 6: Correlations between the DUDIT and cognitive scores (patients, n = 50)

Pearson	Pearson's r	p	Spearman's rho	p
Working memory: total /16	-0.18	0.202	-0.21	0.135
Direct span	-0.09	0.550	-0.08	0.601
Reverse span	-0.13	0.350	-0.15	0.300
Episodic memory: total /60	-0.08	0.580	-0.04	0.800

4. DISCUSSION

4.1 Participant Profile

Our sample consists exclusively of young men (mean age of 32 years). This male predominance is comparable to that found in Moroccan addiction treatment centers, such as in Oujda, where 89% of 100 patients were men [4]. The substance use profile, however, is distinctive: cocaine (76%) and crack (46%) predominate, ahead of cannabis (54%), whereas the two available Moroccan studies report cannabis as the primary illicit substance (74% in both cases), following tobacco [4], [1]. This discrepancy may be due to the recruitment method and limits direct comparison with these studies.

Polydrug use (78%), daily use (84%), and early onset (80% before age 20) characterize our group. Adolescence is a period of prefrontal cortex maturation during which early use could have more pronounced cognitive consequences [5]. This profile is the one in which the most pronounced cognitive impairments are expected.

4.2 Working Memory

The working memory deficit observed in our patients is consistent with the international literature on cocaine. A meta-analysis of 46 studies (1,452 users and 1,411 controls) reports at least moderate deficits in attention, episodic memory, and working memory [6]. A review concludes that chronic cocaine use is associated with global cognitive impairment rather than an isolated deficit [9]. A meta-analysis comparing cocaine and methamphetamine indicates that cocaine is more strongly associated with impairments in working memory [3]. Among French patients with cocaine dependence both current users and those in abstinence working memory and episodic memory were also impaired [10]. Among abstinent poly-drug users, clinically significant deficits have also been described in executive functions, including working memory updating [12].

In our series, the difference is more pronounced for the reverse span (d = 3.4) than for the forward span (d = 2.1). This dissociation is consistent with the idea that the reverse task requires more active manipulation of information—and thus greater involvement of the central administrator—than simple short-term memory retention. This interpretation remains to be confirmed by specific tests.

4.3 Episodic Memory

Patients scored approximately half as high as controls (22.5/60 vs. 42.5/60), which is consistent with studies showing impairments in episodic memory among dependent cocaine users [13], [6], [10]. This result contrasts with data on cannabis alone, for which a meta-analysis of adolescents and young adults found only weak effects of uncertain clinical significance that diminish after more than 72 hours of abstinence [7]. The magnitude of the deficit in our sample, where cocaine and crack are common, suggests that cannabis alone is not sufficient to explain it, although it is not possible to distinguish the contribution of each substance among poly-drug users.

The decline in scores between the first and second assessments among patients which was not observed in the control group could indicate a vulnerability in consolidation or recovery. This descriptive observation is based solely on our data and will need to be explored through a specific analysis.

Analysis of covariates reduces the likelihood that the observed differences are entirely attributable to differences in age and educational level alone. However, it does not account for other unmeasured variables, particularly social conditions, psychiatric status, and recent substance exposure.

4.4 Role of Educational Level and Age

Educational level and age typically influence performance on memory tests, and an imbalance between the groups could have explained part of the difference. This is not the case here: the two groups are comparable in terms of gender, age, and educational level, and the ANCOVA shows that the difference persists, virtually unchanged. In our sample, educational level is not associated with scores. The observed difference cannot therefore be explained by these two factors, which reinforces the validity of the comparison.

However, the observed effect sizes (d ranging from 2.1 to 3.5) remain significantly higher than the moderate magnitude reported by meta-analysis. Other uncontrolled factors may contribute to this: recruitment of heavy-use patients in a clinical setting, poly-substance use, the time interval between the last dose and assessment, comorbidities (depression, anxiety), the effect of medications, occupation (58% of patients were unemployed compared with 10% in the control group), and assessment by an examiner who was aware of the group assignment. The magnitude of the difference should therefore be interpreted with caution.

4.5 No Association with Severity as Measured by the DUDIT

We found no significant correlation between DUDIT and performance ($r = -0.18$ for working memory, $r = -0.08$ for episodic memory). Several factors call for caution. The variability of the DUDIT is low: all patients are classified as having probable dependence (scores ranging from 26 to 42), which automatically reduces the correlations. With 50 subjects, only correlations of approximately 0.39 or higher could be detected with 80% power; a modest association cannot therefore be ruled out. Finally, the literature is mixed: among cocaine users, deficits already exist at a non-dependent recreational level of use, with age of onset, craving, and ADHD symptoms modulating performance [13], while other studies have shown that greater severity of use predicted poorer working memory updating performance [12]. The DUDIT measures recent use and associated problems; it likely reflects cumulative exposure less well than the duration or quantity of use.

The absence of a statistically significant correlation should not be equated with proof of a lack of association. The relatively narrow range of DUDIT scores among patients may reduce explanatory variability; furthermore, a questionnaire focusing on use and associated problems does not directly quantify cumulative exposure, abstinence, or immediate pharmacological effects.

4.6 Strengths and Limitations

Among the study's strengths are the comparison with a control group of equal size that was comparable in terms of sex, age, and educational level; the use of a questionnaire validated in Arabic in Morocco (DUDIT) and tests adapted to the Moroccan context; and the verification of the robustness of the results using several statistical methods.

Several limitations should be noted. The cross-sectional design does not allow for distinguishing deficits that predate substances use from its consequences: a preexisting prefrontal dysfunction could contribute to early initiation of use [5]. Poly-substance use makes it impossible to attribute deficits to a specific substance. The groups differ in occupation and residential setting. The time since last use, psychiatric comorbidities (common in Moroccan addiction populations: 71–80% according to Jelti et al., 2022, and Bensalah et al., 2024), and depression were not considered. The exclusively male sample, recruited from a single center, limits the generalizability of the results. Finally, the tests used differ from those in international studies (versions, scoring scales, populations); we therefore compare the direction and magnitude of the differences, rather than the raw scores.

Additional concerns include a possible selection bias in the control group, a significant difference in employment status between groups (58% of patients were unemployed compared with 10% of controls), the lack of detailed documentation regarding test standardization, and a possible influence from the examiner knowing the group. The exceptionally high effect sizes warrant verification of individual scores, scoring rules, and the comparability of testing conditions. The decline in performance between the two trials may reflect several factors (order of presentation, attention, fatigue, interference, or recall) and does not, on its own, allow us to infer a specific consolidation deficit.

CONCLUSION

This study shows that patients being treated for addictive behaviors—most of whom are poly-substance users of cocaine, cannabis, and crack—perform significantly worse than controls on episodic memory and working memory tasks. The difference remains highly significant after controlling educational level and age. However, the severity of dependence as measured by the DUDIT is not associated with performance in this sample, whose scores are very little.

From a clinical perspective, these results suggest several avenues for further evaluation rather than interventions whose efficacy would be demonstrated by this study:

Consider targeted screening for cognitive difficulties at admission, using tools whose validity in the Moroccan context has been established.

Examine the feasibility of simplified, bilingual (Arabic and French) informational materials, assessing their acceptability and potential impact on understanding and adherence to care.

Examine the value of cognitive remediation interventions for patients with objectively identified difficulties, ideally within a controlled protocol.

Conduct multicenter longitudinal studies that include women, characterizing substances and their use, abstinence status, treatments, and psychiatric comorbidities.

In conclusion, the differences observed on memory tests constitute an important clinical indicator in this sample. However, generalizing these findings and attributing them to addictive behaviors requires better-documented neuropsychological measures and research that account for confounding factors.

METHODOLOGICAL AND EDITORIAL INFORMATION TO BE COMPLETED BEFORE SUBMISSION

Research ethics: mention the opinion or authorization of the relevant committee, the consent procedures, and the confidentiality measures implemented; this information is not included in the source document.

Data Traceability: Confirm the dates of data collection, participants' diagnostic criteria, testing conditions, time since last use, and data on treatments and comorbidities when such information was collected.

Statistical Checks Before Submission: Verify the data in Table 2, the formulas for the Empan scores, the model assumptions, the confidence intervals, the consistency of the figures, and the reported figures. These checks require access to the individual data file.

Manuscript preparation: Provide the final list of authors, their affiliations, and the corresponding author; format references according to the target journal's guidelines. Any missing data, permissions, or information were not reconstructed.

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