Cognitive–Emotional Functioning in Substance Use Disorder: Differences by MoCA-Based Mild Cognitive Impairment

Diego-Oswaldo Camacho-Vega[1], Rosa Linda Martínez Hampl[1], Luis Villalobos-Gallegos[1], María Guadalupe Delgadillo Ramos[1], Salvador Trejo García[1]

[1] Facultad de Medicina y Psicología, Universidad Autónoma de Baja California, Tijuana, México.

RESUMEN

Introducción: la adicción es una condición crónica pero tratable caracterizada por alteraciones en circuitos cerebrales, déficits cognitivos y desregulación emocional, que incrementan el riesgo de recaída y dificultan el tratamiento. El deterioro cognitivo leve (DCL) puede constituir una vulnerabilidad adicional que afecta la coordinación entre el control inhibitorio y los procesos emocionales; sin embargo, su papel conjunto en consumidores crónicos ha sido poco estudiado. **Objetivo:** comparar el control inhibitorio, la interferencia y la regulación emocionales entre consumidores crónicos con y sin DCL, así como analizar asociaciones entre variables cognitivas, emocionales y conductuales. **Método:** estudio transversal comparativo con 80 hombres en tratamiento residencial. Los participantes cumplieron criterios DSM-5 de trastorno por uso de sustancias, reportaron consumo de múltiples sustancias y al menos seis semanas de abstinencia. El estado cognitivo se evaluó con el *Montreal Cognitive Assessment*. El control inhibitorio se midió con una tarea Go/No-Go y la regulación emocional con el Stroop emocional y la Escala de desregulación emocional. Se realizaron comparaciones no paramétricas, correlaciones parciales controlando edad y corrección Tasa de Descubrimientos Falsos. **Resultados:** la edad media fue de 34.1 años (DE = 10) y el 48.8% presentó DCL. No hubo diferencias sociodemográficas entre grupos. El grupo con DCL mostró mayor variabilidad en el control inhibitorio y asociaciones más débiles e inconsistentes entre desempeño cognitivo e interferencia emocional. El grupo sin DCL presentó patrones más estables e integrados. No hubo diferencias en regulación emocional autorreportada. **Discusión y conclusiones:** el DCL se asocia menos con déficits globales y más con menor estabilidad e integración cognitivo-emocional. Considerar el estado cognitivo puede optimizar intervenciones dirigidas a la coordinación entre control cognitivo y regulación emocional en adicciones.

Palabras clave: deterioro cognitivo leve, control inhibitorio, regulación emocional, trastornos relacionados con el uso de sustancias.

ABSTRACT

Introduction: addiction is a chronic yet treatable condition characterized by alterations in brain circuits, cognitive deficits, and emotional dysregulation, which increase relapse risk and complicate treatment outcomes. Mild cognitive impairment (MCI) may represent an additional vulnerability affecting the coordination of inhibitory control and emotional processes; however, its role in chronic drug users remains understudied. **Objective:** to compare inhibitory control, emotional interference, and emotional regulation between chronic drug users with and without MCI, and to examine associations among cognitive, emotional, and behavioral measures. **Method:** a cross-sectional comparative study was conducted with 80 male drug users recruited from residential treatment centers. Participants met DSM-5 criteria for substance use disorder, reported polysubstance use, and maintained at least six weeks of abstinence. Cognitive status was assessed using the Montreal Cognitive Assessment. Inhibitory control was measured with a Go/No-Go task, and emotional regulation with the Emotional Stroop Test and the Difficulties in Emotion Regulation Scale. Analyses included nonparametric comparisons, partial correlations controlling for age, and False Discovery Rate correction. **Results:** participants had a mean age of 34.1 years (SD = 10), and 48.8% met criteria for MCI. No sociodemographic differences were observed between groups. The MCI group showed greater variability in inhibitory control and weaker, less consistent associations between cognitive performance and emotional interference measures. In contrast, the non-MCI group exhibited more stable and distributed cognitive–emotional associations. No significant differences were found in self-reported emotional regulation. **Discussion and conclusions:** findings suggest that MCI is associated less with global deficits and more with reduced stability and integration of cognitive–emotional functioning. Considering cognitive status may improve interventions targeting coordinated cognitive control and emotional regulation in addiction treatment.

Keywords: mild cognitive impairment, inhibitory control, emotional regulation, substance-related disorders.

Corresponding Author:
Salvador Trejo García. Facultad de Medicina y Psicología, Universidad Autónoma de Baja California. Avenida Universidad 14418, Parque Internacional Industrial Tijuana, C.P. 22390, Tijuana, Baja California, México. E-mail: strejo@uabc.edu.mx
Received on: December 17th, 2025
Accepted on: May 16th, 2026
Web Publication on: June 5th, 2026
doi:10.28931/riiad.2026.424

INTRODUCTION

Addiction is a chronic yet treatable condition (Heilig et al., 2021) characterized by alterations in brain circuits (Volkow et al., 2016) and influenced by genetic and environmental factors (Enoch, 2012). According to the Diagnostic and Statistical Manual for Mental Disorders (DSM-5) and its text revision (DSM-5-TR) (American Psychiatry Association, 2013, 2022) substance use disorders (SUDs) are defined by a pattern of impaired control, social impairment, risky use, and pharmacological criteria (tolerance and withdrawal). DSM-5-TR maintains the diagnostic criteria established in the DSM-5 while incorporating updated descriptive and epidemiological information.

In 2021, the United Nations Office on Drugs and Crime (UNODC) estimated that 275 million people worldwide used drugs, with 36 million developing a substance use disorder. In Mexico, the Encuesta Nacional de Consumo de Drogas, Alcohol y Tabaco (Secretaría de Salud et al., 2017) reported a prevalence of 10.3% of lifetime drug use, with higher rates among men (16.2%) compared to women (4.8%). These data highlight the need for context-specific approaches to understanding and treating SUDs.

Contemporary models conceptualize SUDs as involving impairments in cognitive control and decision-making processes. The Interaction of Person-Affect-Cognition-Execution model (I-PACE) (Brand et al., 2019) proposes that substance use arises from dynamic interactions between affective, cognitive, and executive systems. Within this framework, deficits in attention, memory, inhibitory control, and emotional regulation are central to maladaptive behavior and increased relapse risk (Bechara & Damasio, 2002; Becoña, 2007; Ramey & Regier, 2019).

Mild cognitive impairment (MCI) may exacerbate these deficits, particularly in inhibitory control and emotional regulation—essential processes for maintaining abstinence (Sturm et al., 2013). Moreover, MCI has a high prevalence among individuals undergoing treatment for substance use disorders (Toledo-Fernández et al., 2020), suggesting that cognitive vulnerability may play a key role in treatment outcomes.

Although previous research has documented associations between substance use, cognitive impairment, and emotional dysregulation (Melugin et al., 2021; Stellern et al., 2023), these domains have largely been examined independently. Moreover, most studies are correlational in nature, limiting conclusions about directionality or causality. Consequently, it remains unclear whether cognitive deficits contribute to substance use, emerge because of it, or reflect shared underlying mechanisms.

In this context, the present study does not aim to establish causal relationships but rather to examine whether patterns of cognitive control and emotional regulation differ between individuals with SUDs who present with MCI and those who do not. This group-comparative approach allows for the characterization of cognitive–emotional functioning within a clinically relevant population without assuming directionality between variables.

The present study, therefore, aims to examine differences in inhibitory control and emotional regulation, using both objective and subjective measures, between individuals with and without MCI undergoing residential treatment for substance use. We hypothesized that participants with MCI would exhibit poorer inhibitory control, greater emotional interference, and higher levels of self-reported emotional dysregulation compared to those without MCI.

METHOD

Design

A quantitative, non-experimental, cross-sectional, and comparative design was used to examine differences between individuals with SUD with and without MCI.

Participants

The sample consisted of 80 male participants receiving residential treatment for substance use in Tijuana, Mexico, recruited through convenience sampling. Inclusion criteria were: age ≥ 18 years; at least 12 months of substance use; reported use of at least two different substances, and a minimum of six weeks of abstinence to reduce the influence of withdrawal symptoms.

Participants met diagnostic criteria for substance use disorder according to the DSM-5 (which does not differ from DSM-5-TR). Clinical characterization was obtained through a structured clinical interview administered by trained evaluators and complemented with available clinical records. Information collected included substance use history, age of onset, number of substances used, duration of abstinence, and prior treatment.

Participants ranged aged from 18 to 62 years (M = 34.11, SD = 10.00). Most were single, and the most frequently reported educational level was secondary school (see Table 1). Participants reported polysubstance use, with marijuana, methamphetamine, and heroin being the most reported substances.

Participants were classified into two groups based on cognitive screening using the Montreal Cognitive Assessment (MoCA): MCI group (MoCA < 26; *n* = 39, 48.8%) and non-MCI group (MoCA ≥ 26; *n* = 41, 51.2%). This classification reflects screening-level cognitive impairment rather than a clinical diagnosis. MoCA scores were adjusted for years of education according to standard guidelines.

Participants with diagnosed neurological disorders, severe psychiatric conditions, or acute intoxication at the time of assessment were excluded to reduce potential confounding effects on cognitive performance. Information regarding pharmacological treatment was recorded during the clinical evaluation.

Detailed sociodemographic and clinical characteristics by group are presented in Table 1.

Instruments

Structured Clinical Interview

The structured clinical interview, designed by the authors, is a comprehensive tool that collects information on the participant's personal and demographic data, patterns of substance use, and prior treatment experiences, along with associated physical, psychological, or social complications. It screens medical conditions across multiple systems and considers cognitive, emotional, and behavioral difficulties, as well as past psychiatric diagnoses and treatments. A familiogram documents family history of health issues, substance dependence, or psychiatric illness, while perinatal, developmental, educational, and occupational histories provide insight into early milestones, learning or behavioral difficulties, school performance, and work experiences.

Montreal Cognitive Assessment

The MoCA was used as a screening tool for cognitive impairment (Nasreddine et al., 2005). This brief instrument assesses multiple cognitive domains, including visuospatial and executive functioning, naming, memory, attention, language, abstraction, delayed recall, and orientation. Total scores range from 0 to 30, with scores below 26 commonly used to indicate possible cognitive impairment at the screening level. Following the standard administration guidelines, one additional point is typically added for individuals with ≤ 12 years of formal education (Nasreddine et al., 2005). Thus, in the present study the MoCA classification was used to identify participants with screening-level indicators of mild cognitive impairment rather than to establish a clinical diagnosis of MCI. In Mexican populations, the MoCA has demonstrated strong internal consistency (α = .891) (Aguilar-Navarro et al., 2018).

Go/No-Go Task

To assess inhibitory control, participants completed a computerized Go/No-Go task from the Psychological Test Battery (PEBL) (Mueller & Piper, 2014). This version involves two conditions: P-Go and R-Go. In each condition, participants viewed a sequential presentation of letters ("P" or "R") displayed within a 2 × 2 array of stars on a computer screen. Each stimulus appeared for 500 milliseconds (ms) with an interstimulus interval (ISI) of 1,500 ms. Participants were instructed to press the right shift key in response to the designated "Go" stimulus and to withhold responses to the "No-Go" stimulus.

In the P-Go condition, "P" served as the target (Go) and "R" as the nontarget (No-Go); in the R-Go condition, the assignments were reversed. Each condition consisted of 160 trials, with "Go" stimuli presented in 80% of trials and "No-Go" stimuli in 20%, yielding a total of 320 experimental trials plus a brief practice phase. Stimuli were presented randomly across trials.

The primary outcome measures were response accuracy (RA), defined as the proportion of correct responses to the Go stimuli, and mean reaction time (RT) for correct Go trials, which together reflect response execution and attentional control during the task (Makmee & Wongupparaj, 2022). The task lasted approximately 8 minutes.

Emotional Stroop Task

Emotional regulation was evaluated using both objective and subjective measures. For the objective measure, the Stroop Color-Word Test was applied. This task assesses attention, sustained focus, and inhibitory control. It consists of three subscales of 100 items each, with phases lasting approximately 45 seconds. The paradigm was administered using Inquisit Lab software. Participants were asked to identify the ink color of words, which never matched their semantic content (e.g., the word yellow printed in blue ink). In addition to neutral words, affective words such as anger, sadness, failure, joy, war, and love were included to examine the interference of emotionally salient content (Williams et al., 1996).

The stimulus set was adapted from English to Spanish through a translation–back translation procedure: initial translation by a native English speaker followed by independent back-translation into English by a native Spanish speaker, with subsequent reconciliation. This approach is consistent with recommended cross-cultural adaptation procedures for psychological instruments (Brislin, 1970; Beaton et al., 2000).

Two types of indices were derived from the task. First, RTs for correct responses were computed as an indicator of processing speed and inhibitory control, and were used as an operational measure of impulsivity, with faster responses reflecting a more impulsive response style. Second, interference was operationalized through bias scores, calculated for each condition (color, aggressive, negative, and positive words) by subtracting the mean RT for neutral words from the mean RT for each respective condition. These bias scores represent the degree of attentional interference elicited by emotionally and semantically salient stimuli relative to a neutral baseline (Isaac et al., 2012; Smith & Waterman, 2003).

In Mexican samples, the Stroop Task has demonstrated acceptable reliability (α = .767) (Eliorriaga-Santiago et al., 2017), consistent with evidence of adequate test–retest reliability reported in prior studies (Strauss et al., 2005).

Difficulties in Emotion Regulation Scale

For the subjective measure of emotional regulation, we used the Difficulties in Emotion Regulation Scale (DERS-E) (Lavender et al., 2017), adapted into Spanish (Carranza-Plancarte et al., 2022). This version consists of 28 items across five subscales: emotional dysregulation, daily interference, emotional inattention, emotional confusion, and emotional rejection. Responses are rated on a five-point Likert scale (1 = almost never; 5 = almost always), with lower scores reflecting fewer difficulties. Cronbach's alpha values range from .63: .88 across subscales.

Procedure

Participants were evaluated individually in a quiet room within the treatment facility. After providing informed consent, all assessments were conducted in a single session per participant, due to access restrictions during the COVID-19 pandemic.

The session followed a fixed administration order. First, participants completed a structured clinical interview to collect demographic and clinical information. Cognitive status was then assessed using the MoCA, and participants were subsequently classified into MCI and non-MCI groups based on screening criteria.

Following classification, participants completed the experimental tasks in the same order: (1) Go/No-Go task, (2) Emotional Stroop Task, and (3) the self-report measure of emotional regulation (DERS-E). This standardized sequence was maintained across all participants to ensure consistency of administration.

Data Analysis

The analysis was conducted in two stages. First, differences between participants with and without mild cognitive impairment were examined. Second, within-group associations among cognitive, emotional, and behavioral variables were explored separately for each group.

Data was analyzed using available cases. Participant characteristics were summarized using descriptive statistics: quantitative variables as means and standard deviations or medians, and categorical variables as percentages. Due to the non-normal distribution of numerical variables (assessed using the Kolmogorov–Smirnov test); between-group comparisons (MCI vs. non-MCI) were performed using the Mann–Whitney U test for continuous variables and the chi-square (χ^2) test for categorical variables. Within-group analyses were conducted using Spearman rank-order correlations, examining associations among variables separately in the MCI and non-MCI groups.

Associations between variables were examined using partial correlations, controlling for age to account for its potential confounding influence and isolating age-independent relationships. Group differences were initially evaluated using the Mann–Whitney U test. To further account for age as a covariate, Quade's nonparametric analysis of covariance was applied as an alternative to ANCOVA (Rae, 1985), allowing for the assessment of group differences after adjusting for age-related effects.

Given the number of correlations and comparisons conducted, analyses were considered exploratory in nature, aimed at identifying potential patterns of association between cognitive, emotional, and behavioral measures. Therefore, results should be interpreted as preliminary. In this context, to address the increased risk of Type I error (rejecting the null hypothesis when it is true), false discovery rate (FDR) correction (Benjamini & Hochberg, 1995) was applied within each family of analyses. Specifically, FDR adjustments were conducted separately by group (MCI and non-MCI) and by analytical domain (e.g., cognitive, emotional, and behavioral constructs), thereby controlling multiple comparisons within each set of related tests. Additionally, effect sizes are reported to aid interpretation beyond statistical significance, and were interpreted following Ferguson criteria (2009).

Ethical Considerations

This study was approved by the Bioethics and Research Committee (approval number 725/2020-2), from Facultad de Medicina y Psicología of the Universidad Autónoma de Baja California. Each participant provided with an informed consent document, and those who agreed to participate gave their signed authorization.

RESULTS

Clinical Profiles

No significant differences were found between participants with and without mild cognitive impairment in sociodemographic or clinical variables; including age, age of substance use onset, number of substances used, and duration of abstinence (see Table 1).

Table 1
Clinical and sociodemographic characteristics of the groups.

	Non-MCI		MCI		
Clinical history	*Mean*	*SD*	*Mean*	*SD*	*U*
Age	32.46	9.7	35.85	10.1	642
Age at onset of use	16.22	5.9	15.15	2.92	704
Number of drugs used	3.65	1.33	3.89	1.41	739.5
Duration of abstinence	24.41	15.7	21	11.9	749
		%		%	χ^2
Marital status:	Single	73.2		61.5	3.98
Educational level:	High school	46.3		46.2	5.14
Place of birth:	Tijuana	51.2		46.2	16.85
Type of delivery:	Vaginal	78.0		74.4	.15
Cried at birth		68.3		69.2	.35
Head injuries		24.4		38.5	1.84
Family mental disorder		9.8		15.4	.58
Participant mental disorder		2.4		10.3	2.09

Note: χ^2 = Chi-square; Non-MCI = non-mild cognitive impairment; MCI = mild cognitive impairment; $p < .05$, ** $p < .01$, *** $p < .001$.

Across both groups, abstinence duration was negatively associated with memory retrieval, indicating a consistent relationship between clinical history and cognitive performance. When controlling for age, this association remained significant only in the non-MCI group. In the non-MCI group, additional associations were observed: identification was negatively correlated with trauma, recovery was positively associated with age, and trauma was positively correlated with language performance.

However, none of these associations remained significant after correction for multiple comparisons. Similarly, the negative correlation between trauma and identification in the MCI group did not survive correction for multiple comparisons (see supplementary material Table 1s).

Go/No-Go Task

Initial analyses suggested group differences in inhibitory control variability (in P and R conditions), with participants with mild cognitive impairment exhibiting greater reaction time variability during the first round, indicative of less consistent inhibitory processing. However, these differences did not remain significant after controlling multiple comparisons using the FDR procedure. It is important to note that the statistical power for these comparisons was modest ($1 - \beta = .69$), which may have limited the ability to detect effects after correction. Moreover, the observed effect sizes (rank-biserial correlations ranging from −.31 to −.26) fall within the range considered small but meaningful according to Ferguson's criteria, suggesting that the observed differences may still reflect potentially relevant effects despite the lack of statistical significance after adjustment. The association remained significant after adjusting for age using Quade's nonparametric ANCOVA for variability in P condition ($p = .018$) but not for the R condition ($p = .068$). Interestingly, in both cases the effect size was equivalent. Therefore, these findings should be interpreted with caution as preliminary evidence, warranting further investigation with larger samples (see Table 2).

Table 2
Comparisons of the GO-NO/GO task on MCI and Non-MCI.

Measure	*MCI (n = 39) M (SD)*	*Non-MCI (n = 41) M (SD)*	*U*	*rb*
Accuracy (proportion correct responses)				
First round – P condition	.95 (.16)	.98 (.05)	666.00	.17
First round – R condition	.71 (.21)	.73 (.19)	759.50	.05
Second round – P condition	.71 (.19)	.72 (.21)	763.50	.05
Second round – R condition	.98 (.30)	.98 (.04)	663.50	.17
Variability in accuracy (SD)				
First round – P condition	.12 (.10)	.10 (.11)	701.50	-.12
First round – R condition	.39 (.10)	.38 (.12)	776.50	-.03

Table 2
(Continuation)

Measure	*MCI (n = 39) M (SD)*	*Non-MCI (n = 41) M (SD)*	*U*	*rb*
Second round – P condition	.39 (.12)	.38 (.13)	753.00	-.06
Second round – R condition	.12 (.09)	.10 (.10)	665.00	-.17
Reaction time (ms)				
First round – P condition	502.70 (5.10)	497.20 (75.51)	659.00	-.15
First round – R condition	427.42 (46.16)	423.89 (48.01)	704.00	-.07
Second round – P condition	440.10 (73.34)	420.30 (52.11)	608.00	-.18
Second round – R condition	512.50 (92.55)	493.79 (71.63)	658.00	-.16
Reaction time variability (SD)				
First round – P condition	110.78 (29.92)	99.47 (32.92)	535.00*	-.31
First round – R condition	68.17 (40.14)	53.51 (33.95)	562.50*	-.26
Second round – P condition	78.97 (75.83)	57.77 (48.28)	588.00	-.21
Second round – R condition	108.03 (33.23)	100.49 (31.36)	671.00	-.14

Note: MCI = mild cognitive impairment, Non-MCI = non-mild cognitive impairment; U = Mann–Whitney U test; M = mean, SD = standard deviation. rb = rank-biserial correlation (effect size); ms = milliseconds. * $p < .05$; ** $p < .01$; *** $p < .001$.

Within-group analyses revealed that in participants without mild cognitive impairment, cognitive performance (MoCA) in memory recovery was positively associated with task accuracy ($r = .39$, $p < .05$). These associations did not survive FDR correction (see supplementary material Table 2s).

Stroop Task Performance

Differences between groups were observed in response times to emotional stimuli. Participants with mild cognitive impairment showed slower responses to color and positive words, whereas those without mild cognitive impairment showed slower responses to negative words. After correction for multiple comparisons, only the difference in response times to color words remained significant (see Table 3). This effect remained significant after adjusting for age using Quade's nonparametric ANCOVA ($p = .01$), with a small but significant effect size ($r_s = .32$).

In the non-MCI group, several associations between Stroop performance and cognitive domains were observed prior to correction for multiple comparisons, particularly for visuospatial abilities, language, and memory retrieval. Based on Ferguson's criteria, these correlations were mostly small but meaningful, with some reaching near-moderate magnitude. However, none remained significant after correction for multiple comparisons. Accordingly, these findings should be regarded as tentative, particularly considering the limited statistical power of the analyses ($1 - \beta = .60$). In contrast, the MCI group showed no significant associations, and the overall pattern of correlations was weaker and less consistent across domains (see supplementary material Table 3s).

Table 3
Comparisons of the Stroop task on MCI and Non-MCI.

Measure	*MCI (n = 39) M (SD)*	*Non-MCI (n = 41) M (SD)*	*U*	*rb*
Reaction time (ms)				
Neutral words	1370.20 (598.00)	1166.00 (601.46)	605.00	.24
Aggressive words	1408.00 (634.40)	1197.00 (627.47)	643.00	.20
Color words	1553.00 (879.20)	1200.50 (746.82)	514.00***	.36
Negative words	1424.00 (670.96)	1166.50 (554.53)	580.00*	.28
Positive words	1468.00 (764.40)	1215.80 (629.79)	577.00	.28
Emotional interference (bias scores)				
Aggressive words	42.37 (286.30)	31.35 (186.10)	773.00	-.03
Color words	182.70 (529.10)	100.38 (284.50)	712.00	.11
Negative words	54.20 (289.40)	-1.87 (186.90)	693.00	.13
Positive words	99.50 (324.00)	-69.70 (846.70)	795.00	.01

Note: MCI = mild cognitive impairment, Non-MCI = non-mild cognitive impairment; U = Mann–Whitney U test; rb = rank-biserial correlation (effect size); M = mean, SD = standard deviation. ms = milliseconds. * $p < .05$; ** $p < .01$; *** $p < .001$.

Thus, although the individual correlations in the non-MCI group cannot be considered robust, the overall configuration of effect sizes suggests a potentially more coherent organization of cognitive–emotional relationships relative to the MCI group. This interpretation remains preliminary and requires replication in larger samples.

Difficulties in Emotion Regulation Scale No significant differences were found between groups in self-reported emotional regulation (see Table 4).

Within-group analyses suggested associations between emotional regulation and cognitive or behavioral measures; however, these effects did not remain significant after FDR correction and should be interpreted with caution (Table 4s)

Table 4
Comparisons of DERS on MCI and Non-MCI.

Measure	*MCI (n = 39) M (SD)*	*Non-MCI (n = 41) M (SD)*	*U*	*rb*
Emotional dysregulation	2.07 (1.06)	1.73 (0.87)	618.00	.23
Emotional rejection	2.17 (0.90)	1.93 (0.87)	648.50	.19
Emotional interference	2.19 (1.04)	2.04 (1.09)	719.50	.10
Emotional inattention	3.67 (1.14)	3.98 (1.08)	678.00	.15
Emotional confusion	2.44 (0.75)	2.32 (0.59)	744.00	.07

Note: MCI = mild cognitive impairment, Non-MCI = non-mild cognitive impairment; U = Mann–Whitney U test; rb = rank-biserial correlation (effect size); M = mean, SD = standard deviation. * $p < .05$; ** $p < .01$; *** $p < .001$.

Cognitive–Emotional Tasks Integration

Several correlations reached moderate to large effect sizes according to Ferguson's criteria in the MCI group, particularly for accuracy in the first Go/No-Go condition (MRC1R [P]), where associations with Stroop measures ranged from moderate to near-large magnitude (e.g., $r \approx -.50$ to $-.73$; see Table 5). However, these effects were largely restricted to this specific condition and were not consistently observed across other task parameters, suggesting a lack of stability in the overall pattern of associations.

In contrast, the non-MCI group showed a more consistent pattern of correlations, particularly for reaction time measures (RTM), with several associations reaching small-to-moderate and moderate effect sizes ($r \approx .30$–$.52$). These effects were distributed across multiple conditions and cognitive domains, indicating a more coherent and reproducible pattern.

Although some associations did not remain significant after correction for multiple comparisons, and statistical power was modest ($1-\beta \approx .60$), the overall configuration of effect sizes suggests qualitatively different organizational patterns between groups. Specifically, the MCI group appears to exhibit stronger but context-dependent associations, whereas the non-MCI group shows more stable and systematically distributed cognitive–emotional relationships.

DISCUSSION AND CONCLUSIONS

This study examined whether individuals with SUDs who present with MCI differ from those without MCI in inhibitory control and emotional regulation during abstinence. Framed within contemporary models of addiction, particularly those emphasizing the interaction between executive, cognitive, and affective systems, the findings suggest that MCI in

Table 5
Correlation between the Stroop Test and the Go-No-Go Task.

	MRPN	*MRPA*	*MRPC*	*MRPNE*	*MRPP*	*IRPA*	*IRPC*	*IRPN*	*IRPP*
					MCI				
MRC1R (P)	-0.33*	-0.41*	-0.66**	-0.52**	-0.51**	-0.22	-0.73**	-0.52**	-0.58**
MRC1R (R)	0.13	0.03	0.18	0.12	0.12	-0.2	0.15	0.02	0.04
MRC2R (P)	0.08	-0.03	0.04	0.09	0.04	-0.21	-0.02	0.05	-0.06
MRC2R (R)	-0.23	-0.27	-0.25	-0.32	-0.23	-0.11	-0.16	-0.26	-0.1
MTR1R (P)	0.24	0.13	0.2	0.22	0.23	-0.22	-0.02	-0.04	0.04
MTR1R (R)	0.34*	0.34*	0.31	0.35*	0.34*	-0.01	0.01	0.01	0.09
MTR2R (P)	0.12	0.19	0.17	0.19	0.12	0.16	0.14	0.2	0.06
MTR2R (R)	0.02	0	0.05	0.07	0.03	-0.04	0.06	0.12	0.02
					Non-MCI				
MRC1R (P)	-0.2	-0.25	-0.22	-0.17	-0.15	-0.19	-0.21	0.14	-0.04
MRC1R (R)	0.16	0.21	0.23	0.22	0.11	0.2	0.16	0.14	-0.05
MRC2R (P)	0.17	0.19	0.19	0.2	0.11	0.08	0.16	0.02	-0.15
MRC2R (R)	-0.19	-0.22	-0.26	-0.15	-0.14	-0.12	-0.15	0.18	-0.05
MTR1R (P)	0.40**	0.52**	0.46**	0.43**	0.26	0.46**	0.25	-0.01	-0.03
MTR1R (R)	0.27	0.32*	0.34*	0.31	0.22	0.2	0.18	0.04	-0.04
MTR2R (P)	0.37*	0.34*	0.33*	0.35*	0.31	-0.03	0.04	-0.12	-0.14
MTR2R (R)	0.37*	0.47**	0.42**	0.37*	0.25	0.37*	0.19	-0.10	0.02

Note: MRPN = Mean response rate for neutral words; MRPA = Mean number of correct responses for aggressive words; MRPC = Mean response rate for color words; MRPNE = Mean response rate for negative words; MRPP = Mean response rate for positive words; IRPA = Response impulsivity for aggressive words; IRPC = Response impulsivity for color words; IRPN = Response impulsivity for negative words; IRPP = Response impulsivity for positive words; MRC1R = Mean number of correct responses in the first round; MRC2R = Mean number of correct responses in the second round; MTR1R = Mean response time in the first round; MTR2R = Mean response time in the second round. * $p < .05$; ** $p < .01$; *** $p < .001$.

this population may be expressed less as a uniform deficit in performance and more as a disruption in the stability and coordination of cognitive–emotional functioning.

This interpretation is broadly consistent with current conceptualizations of addiction as a chronic condition involving alterations in neural systems that support decision-making, behavioral regulation, and affective processing (Heilig et al., 2021; Volkow et al., 2016). The I-PACE model, for example, proposes that addictive behaviors emerge from dynamic interactions among executive control, emotional reactivity, and cognitive biases (Brand et al., 2019).

From this perspective, the present findings suggest that when MCI is also present these already vulnerable systems may become less efficiently coordinated, which could compromise the individual's capacity to regulate behavior under cognitively or emotionally demanding conditions.

Regarding inhibitory control, the lack of robust group differences after correction for multiple comparisons suggests that MCI in individuals with SUDs may not necessarily manifest as a straightforward inhibitory deficit. Instead, the tendency toward greater variability in behavioral performance points to reduced consistency in cognitive control. This is clinically meaningful because, in SUDs, failures of control do not always appear as chronically poor performance, but often as fluctuations in the ability to maintain stable, goal-directed responding across time and context. Thus, rather than contradicting prior literature on executive dysfunction in addiction (Bechara & Damasio, 2002; Becoña, 2007; Ramey & Regier, 2019), these findings may refine it by suggesting that in abstinent individuals with MCI, impairment is better understood in terms of instability than simple mean-level deterioration.

A similar interpretation applies to the emotional interference findings. Although the evidence did not support a generalized alteration across all emotional Stroop conditions, it did suggest selective inefficiencies in situations requiring attention to task-relevant features while ignoring competing stimulus information. This pattern fits with the notion that emotional regulation in SUD is closely linked to executive functioning rather than being an isolated affective process (Bandeira et al., 2021). In other words, the difficulty may not lie in emotion per se, but in the ability to maintain inhibition or attentional goals when emotionally or perceptually competing information is present. This is compatible with theoretical perspectives that view relapsing vulnerability as partly arising from altered coordination between affective salience and cognitive control systems (Brand et al., 2019).

The present study also responds to a gap identified in the literature. As noted in the Introduction, inhibitory control, emotional regulation, and cognitive impairment have often been examined separately in SUD research, despite theoretical models suggesting that they are functionally intertwined. In this study, the most informative differences between groups did not emerge from self-report scores or from broad mean comparisons alone, but from the pattern of relationships across objective cognitive–emotional tasks. Participants without MCI showed a more coherent and distributed pattern of associations, suggesting that cognitive control and emotional processing remained more functionally integrated.

In contrast, participants with MCI displayed a more irregular pattern, with associations that appeared stronger in specific contexts but less stable overall. This supports the idea that MCI may exacerbate not only isolated cognitive weaknesses, but the broader disorganization of the cognitive–affective architecture already implicated in SUD.

This point is especially relevant considering prior studies reporting associations among substance use, emotional dysregulation, and cognitive impairment (Melugin et al., 2021; Stellern et al., 2023), while leaving unresolved how these domains relate within individuals. Our findings do not establish causality, nor were they intended to do so. They do suggest, however, that comparing individuals with SUDs as a function of MCI status can reveal meaningful differences in the way cognitive and emotional processes are organized. In this sense, the present study contributes to the literature not by showing unequivocal deficits in every domain, but by indicating that MCI may alter the functional integration of systems that are already central to SUDs vulnerability and recovery.

The lack of significant differences in self-reported emotional regulation also deserves consideration. This finding suggests that subjective measures may be insufficient to capture subtle difficulties in individuals with cognitive compromise. Since self-report depends on introspection, self-monitoring, and accurate appraisal of one's own functioning, its sensitivity may be reduced in people with MCI (Gao et al., 2026). This may help explain why objective task-based indicators revealed more differentiated patterns than self-perceived emotional regulation. In clinical terms, this underscores the importance of complementing self-report tools with behavioral assessment when working with cognitively vulnerable SUD populations.

Taken together, these findings support the view that MCI represents a clinically relevant vulnerability in people undergoing treatment for SUDs. As previous work has shown, MCI is relatively prevalent in this population (Toledo-Fernández et al., 2020), and the present results suggest that its relevance may lie not only in overall cognitive difficulty, but in the less efficient coordination of executive and affective processes that are essential for sustained abstinence. This has practical implications for treatment: individuals with MCI may benefit from interventions that reduce cognitive load, increase external structure, and scaffold the regulation of emotionally salient situations, rather than relying heavily on intact self-monitoring or spontaneous executive control. Mild cognitive impairment in individuals with SUDs may be better understood not as a generalized reduction in performance, but as a disruption in the coordination of cognitive–emotional systems that are critical for adaptive regulation and sustained abstinence.

Future Directions

These findings highlight the importance of assessing cognitive vulnerability in treatment contexts and suggest that interventions may benefit from emphasizing structured, externally-supported strategies. Future longitudinal research with larger and more diverse samples, as well as more comprehensive cognitive assessments, will be essential to determine whether these patterns predict clinically meaningful outcomes such as treatment adherence, relapse risk, and response to intervention. Subsequent studies with larger samples should incorporate multivariate approaches to examine the robustness of these associations while controlling for relevant covariates such as age, education, abstinence duration, and substance-related variables.

Limitations of the Study

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes causal inferences regarding the relationships between MCI, inhibitory control, and emotional regulation. Thus, it remains unclear whether the observed patterns reflect pre-existing cognitive vulnerability, consequences of substance use, or partially shared underlying mechanisms.

Second, the use of a convenience sample composed exclusively of male participants recruited from residential treatment settings limits the generalizability of the findings to women, outpatient populations, or individuals at different stages of recovery. Third, although objective behavioral tasks were included, MCI was identified using a screening instrument (MoCA) rather than a comprehensive neuropsychological battery, which may have introduced some degree of misclassification. Additionally, aspects of substance use history relied on self-report, which may be subject to recall bias.

From an analytical perspective, the relatively modest sample size resulted in limited statistical power, particularly for within-group and correlational analyses. This is especially relevant given that several effects did not remain significant after correction for multiple comparisons, suggesting that some findings should be considered preliminary. In line with the exploratory nature of the study, multivariable models were not conducted; instead, the focus was placed on identifying bivariate patterns that could inform future hypothesis-driven research.

Despite these limitations, the present study provides a clinically relevant characterization of cognitive–emotional functioning in individuals with SUDs undergoing treatment. Rather than identifying broad and consistent deficits, the findings suggest that MCI is associated with alterations in the stability and integration of cognitive and emotional processes. This interpretation is consistent with contemporary models of addiction, such as the I-PACE framework, which emphasizes the dynamic interaction between executive control and affective systems.

FUNDING

No funding was received for the conduct of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest. During the preparation of this document, the authors used ChatGPT with the purpose of to improve the manuscript English writing. After using this tool or service, the authors edited and reviewed the generated content. If necessary, the authors take full responsibility for the content of the manuscript.

AUTHORS CONTRIBUTION

Diego-Oswaldo Camacho-Vega: conceptualization, methodology, formal analysis, investigation, writing of the original draft.
Rosa Linda Martínez Hampl: conceptualization, methodology, formal analysis, investigation, writing of the original draft.
Luis Villalobos-Gallegos: writing of the original

draft, review & editing.
María Guadalupe Delgadillo Ramos: writing of the original draft, review & editing.
Salvador Trejo García: conceptualization, methodology, formal analysis, investigation, writing of the original draft, review & editing.

REFERENCES

Aguilar-Navarro, S. G., Mimenza-Alvarado, A. J., Palacios-García, A. A., Samudio-Cruz, A., Gutiérrez-Gutiérrez, L. A., & Ávila-Funes, J. A. (2018). Validez y confiabilidad del MoCA (Montreal Cognitive Assessment) para el tamizaje del deterioro cognoscitivo en méxico. *Revista Colombiana de Psiquiatría*, *47*(4), 237–243. https://doi.org/10.1016/j.rcp.2017.05.003

American Psychiatric Association (Ed.). (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (5th ed.). American Psychiatric Association.

American Psychiatric Association (Ed.). (2022). *Diagnostic and statistical manual of mental disorders: DSM-5-TRTM* (5th ed., text revision). American Psychiatric Association Publishing.

Bandeira, M., Cavalcanti, M. K., Cordeiro, S., Soares, J. W. J., & Duarte, M. (2021). Executive functions and emotion regulation in substance use disorder. *Jornal Brasileiro De Psiquiatria*, *70*(3), 236–244. https://doi.org/10.1590/0047-2085000000331

Bechara, A., & Damasio, H. (2002). Decision-making and addiction (part I): impaired activation of somatic states in substance dependent individuals when pondering decisions with negative future consequences. *Neuropsychologia*, *40*(10), 1675–1689. https://doi.org/10.1016/S0028-3932(02)00015-5

Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B.. (2000) Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine*, *25*, 3186–3191. https://doi.org/10.1097/00007632-200012150-00014

Becoña, E. (2007). Bases psicológicas de la prevención del consumo de drogas. *Papeles del Psicólogo*, *28*(1), 11–20. https://www.papelesdelpsicologo.es/pdf/1424.pdf

Benjamini, Y., & Hochberg, Y. (1995). Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. *Journal of the Royal Statistical Society: Series B (Methodological)*, *57*(1), 289–300. https://doi.org/10.1111/j.2517-6161.1995.tb02031.x

Brand, M., Wegmann, E., Stark, R., Müller, A., Wölfling, K., Robbins, T. W., & Potenza, M. N. (2019). The Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors: Update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. *Neuroscience & Biobehavioral Reviews*, *104*, 1–10. https://doi.org/10.1016/j.neubiorev.2019.06.032

Brislin, R. W.. (1970). Back-translation for cross-cultural research. *Journal of Cross-Cultural Psychology*, *1*, 185–216. https://doi.org/10.1177/135910457000100301

Carranza-Plancarte, J., Navarro-Contreras, G., Correa-Romero, F., & González-Torres, M. (2022). Validación psicométrica de la escala de dificultades en la regulación emocional DERS para adultos michoacanos. *Revista de Educación y Desarrollo*, *61*, 39–48. https://www.cucs.udg.mx/revistas/edu_desarrollo/anteriores/61/61_Carranza.pdf

Eliorriaga-Santiago, S., Montes-Rojas, J., Medina-Gutierrez, M., & Ortiz-Becerra, A. (2017). *Estandarización Mexicana del Test Stroop*: Datos Normativos. Universidad Latinoamericana.

Enoch, M.-A. (2012). The Influence of Gene–Environment Interactions on the Development of Alcoholism and Drug Dependence. *Current Psychiatry Reports*, *14*(2), 150–158. https://doi.org/10.1007/s11920-011-0252-9

Ferguson, C. J. (2009). An Effect Size Primer: A Guide for Clinicians and Researchers. *Professional Psychology: Research and Practice*, *40*(5), 532–538. https://doi.org/10.1037/a0015808

Gao, Y., Zaninotto, P., & Steptoe, A. (2026). Associations of self- and informant-reported functional impairment with cognitive performance and incident dementia. *The Journal of Prevention of Alzheimer's Disease*, *13*(3). https://doi.org/10.1016/j.tjpad.2026.100482

Heilig, M., MacKillop, J., Martinez, D., Rehm, J., Leggio, L., & Vanderschuren, L. J. M. J. (2021). Addiction as a brain disease revised: why it still matters, and the need for consilience. *Neuropsychopharmacology*, *46*(10), 1715–1723. https://doi.org/10.1038/s41386-020-00950-y

Isaac, L., Vrijsen, J. N., Eling, P., Van Oostrom, I., Speckens, A., & Becker, E. S. (2012). Verbal and facial-emotional Stroop tasks reveal specific attentional interferences in sad mood. *Brain and Behavior*, *2*(1), 74–83. https://doi.org/10.1002/brb3.38

Lavender, J. M., Tull, M. T., DiLillo, D., Messman-Moore, T., & Gratz, K. L. (2017). Development and Validation of a State-Based Measure of Emotion Dysregulation: The State Difficulties in Emotion Regulation Scale (S-DERS). *Assessment*, *24*(2), 197–209. https://doi.org/10.1177/1073191115601218

Makmee, P., & Wongupparaj, P. (2022). Virtual Reality-based Cognitive Intervention for Enhancing Executive Functions in Community-dwelling Older Adults. *Psychosocial Intervention*, *31*(3), 133–144. https://doi.org/10.5093/pi2022a10

Melugin, P. R., Nolan, S. O., & Siciliano, C. A. (2021). Bidirectional causality between addiction and cognitive deficits. *International Review of Neurobiology*, *157*, 371–407. https://doi.org/10.1016/bs.irn.2020.11.001

Mueller, S. T., & Piper, B. J. (2014). The Psychology Experiment Building Language (PEBL) and PEBL Test Battery. *Journal of Neuroscience Methods*, *222*, 250–259. https://doi.org/10.1016/j.jneumeth.2013.10.024

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J. L., & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A Brief Screening Tool For Mild Cognitive Impairment. *Journal of the American Geriatrics Society*, *53*(4), 695–699. https://doi.org/10.1111/j.1532-5415.2005.53221.x

Rae, G. (1985). Quade's nonparametric analysis of covariance by matching. *Behavior Research Methods, Instruments, & Computers*, *17*(3), 421–422. https://doi.org/10.3758/BF03200959

Ramey, T., & Regier, P. S. (2019). Cognitive impairment in substance use disorders. *CNS Spectrums*, *24*(1), 102–113. https://doi.org/10.1017/S1092852918001426

Secretaría de Salud, Comisión Nacional contra las Adicciones, & Instituto Nacional de Psiquiatría Ramón de la Fuente Muñiz. (2017). *Encuesta Nacional de Consumo de Drogas, Alcohol y Tabaco 2016–2017: Reporte de drogas*. Secretaría de Salud. https://encuestas.insp.mx/repositorio/encuestas/ENCODAT2016/

doctos/informes/reporte_encodat_drogas_2016_2017.pdf

Smith, P. M., & Waterman, M. (2003). Processing bias for aggression words in forensic and nonforensic samples. *Cognition & Emotion*, *17*, 751–765. https://doi.org/10.1080/02699930302281

Stellern, J., Xiao, K. B., Grennell, E., Sanches, M., Gowin, J. L., & Sloan, M. E. (2022). Emotion regulation in substance use disorders: a systematic review and meta-analysis. *Addiction*, *118*(1), 30–47. https://doi.org/10.1111/add.16001

Strauss, G. P., Allen, D. N., Jorgensen, M. L., & Cramer, S. L. (2005). Test-Retest Reliability of Standard and Emotional Stroop Tasks: An Investigation of Color-Word and Picture-Word Versions. *Assessment*, *12*(3), 330–337. https://doi.org/10.1177/1073191105276375

Sturm, V. E., Yokoyama, J. S., Seeley, W. W., Kramer, J. H., Miller, B. L., & Rankin, K. P. (2013). Heightened emotional contagion in mild cognitive impairment and Alzheimer's disease is associated with temporal lobe degeneration. *Proceedings of the National Academy of Sciences*, *110*(24), 9944–9949. https://doi.org/10.1073/pnas.1301119110

Toledo-Fernández, A., Marín-Navarrete, R., Villalobos-Gallegos, L., Salvador-Cruz, J., Benjet, C., & Roncero, C. (2020). Exploring the prevalence of substance-induced neurocognitive disorder among polysubstance users, adding subjective and objective evidence of cognitive impairment. *Psychiatry Research*, *288*. https://doi.org/10.1016/j.psychres.2020.112944

Volkow, N. D., Koob, G. F., & McLellan, A. T. (2016). Neurobiologic Advances from the Brain Disease Model of Addiction. *New England Journal of Medicine*, *374*(4), 363–371. https://doi.org/10.1056/NEJMra1511480

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin*, *120*(1), 3–24. https://doi.org/10.1037/0033-2909.120.1.3

SUPPLEMENTARY INFORMATION

The authors of this article provided supplementary materialresulting from the literature review

https://riiad.org/index.php/riiad/article/view/424/529

Also the attached QR will take you directly to this material.