THE ROLE OF EXECUTIVE FUNCTIONS AND EMOTIONAL REGULATION IN SUBSTANCE USE - A SYSTEMATIC REVIEW

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Abstract

Objectives. The aim of the study was to explore the scientific literature on the variability of executive functions and emotional regulation in substance users, and based on it, one can formulate prevention and intervention strategies in order to reduce substance use.
Methodology. Using the APA PsycNet and Scopus platforms, cross-sectional and longitudinal studies investigating executive functions and emotional regulation in illicit drug users aged 18 years and older were searched. From a total of 1073 articles, 64 relevant studies published between 2002-2023 were selected**.**
Results. Use of opioids, cocaine, methamphetamine and cannabis was associated with significant deficits in executive functions and emotional regulation. Opioid users showed major difficulties in decision-making and learning, and cocaine users showed deficits in cognitive control. Cognitive flexibility and working memory were impaired in methamphetamine users, and cannabis use was associated with cognitive and emotional deficits. Targeted interventions, such as Cognitive Remediation Therapy and Dialectical Behavior Therapy, have shown improvements in neurocognitive function and reductions in substance use.
Conclusions. Executive functions and emotional regulation are impaired by drug use with variability influenced by the type of substance used and severely impaired in poly-drug use. Following substance use remission, executive function deficits and difficulties in emotional regulation improved. Personalized interventions that specifically address each individual's cognitive and emotional deficits are needed.

Keywords: emotional regulation, executive functions, drug use, addiction, psychological interventions

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Introduction

Drug use is a major global public health problem with severe consequences for individuals and society (EMCDDA, 2024). From occasional recreational use to the development of addiction, drug use affects various aspects of psychological and behavioural functioning (UNODC, 2023).

Executive functions are a complex set of cognitive skills essential for controlling behaviour and managing thoughts, emotions and actions. Mainly executive functions include the following: planning, organization, working memory, attention, inhibitory control and cognitive flexibility. They are essential for carrying out daily activities, adapting to new situations and are also important for adaptive behaviour, the ability to make correct decisions (Barkley, 2012) for impulse control and assessing the long-term consequences of actions (Inozemtseva & Mejía Núñez, 2019). In drug addiction and relapse, executive dysfunctions related to behavioural inhibition and behavioural control are key determinants that compromise the ability to effectively manage pleasure stimuli (Jarmolowicz et al. 2013, Arias et al., 2016). These can be impaired by drug use, leading to difficulties in impulse control and decision making (Barkley, 2012, Jarmolowicz et al., 2013).

Executive functions are influenced differently depending on the substance. This is largely due to the way opioids influence the brain structures responsible for these functions, such as the prefrontal cortex and hippocampus (Volkow, Fowler, Wang, Swanson & Telang, 2007). These cognitive deficits can persist even after periods of prolonged abstinence, indicating long-term effects on the brain (Goldstein et al., 2004).

Emotional regulation involves the ability to monitor, evaluate and modify emotional responses in an adaptive and effective way. This is essential for maintaining mental health and functional social relationships (Gratz & Roemer, 2003), but individuals who exhibit addictive behaviours have significant difficulties in this area (Stellern et al. 2023, Weiss et al. 2022). Cannabis use has been associated with increased negative affectivity and difficulties in emotional regulation.

These effects may result from cannabis influence on the endocannabinoid system, which plays an important role in modulating emotions and stress (Volkow, Baler, Compton & Weiss, 2014).

Cross-sectional and longitudinal studies have provided different perspectives on the effects of drug use. Longitudinal studies have shown clearer picture of long-term effects, while cross-sectional studies have emphasized the association between concepts presented at a specific point in time (Bell et al., 2020). For example, a 30-year longitudinal study showed that patterns of cannabis use, particularly chronic/intensive use, increasing use, and chronic/occasional use, were associated with emotional dysfunction, nicotine dependence, alcohol dependence/abuse, unconventional behaviours, and sensation-seeking (Benitez, Lauzon, Nietert, McRae-Clark & Sherman, 2020).

The effects of drug use vary depending on the demographics of the populations studied. For example, college students and veterans exhibited different risk profiles and consumption patterns (Bell et al., 2017). Students may use drugs in social contexts, influencing their executive functions and emotional regulation in different ways than veterans, who may use substances to cope with post-traumatic stress (Volkow, Wang, Fowler, Tomasi & Telang, 2011).

Taken into consideration these aspects, the present study aims to highlight the relationship between executive functions and emotional regulation in people who use drugs, with the objective of promoting the development of these skills in order to prevent the use of psychoactive substances.

Aim and objectives of the study

This study aimed to explore the scientific literature on the role of executive functions and emotional regulation and how these psychological variables influence substance use in people aged 18 years and older. The results of this work could prove useful in the formulation of prevention and intervention strategies and guidelines to reduce drug use and its consequences at both socio-economic and individual levels.

The questions that guided this research were the following:

1.How are difficulties in emotional regulation manifested in drug users depending on the substance consumed?

2.Does the type of psychoactive substance used by a drug user influence the degree of executive dysfunction?

3.What type of psychological interventions target both deficits in executive functioning and difficulties in emotional regulation?

Based on these research questions, the following objectives were set:

O1. To examine the difficulties in emotional regulation and deficits in executive functions in relation to the type of drug used.

O2. To conduct a review of psychological intervention methods presented in the specialty literature that target both deficits in executive functioning and difficulties in emotional regulation.

O3. To examine the role of executive functioning and emotional regulation in the prevention of drug use problems.

Methodology

Data source

The search platforms used to identify the specialty literature needed to conduct this systematic literature review were APA PsycNet and Scopus. The search mode consisted of composing specific search phrases that contained keywords related to substance use and executive functions and substance use and emotional regulation. Word linkages were made using Boolean AND and OR commands. These are exemplified in Table 1.

Table 1
Search terms for identifying articles

Concept	Search strings
Drug use	TITLE-ABS-KEY (*substance use disorder; substance related disorder; substance abuse; problem substance use; substance addict; substance dependence; drug use disorder; drug related disorder; drug misuse; drug abuse; drug addict; drug dependence; SUD*) OR ALL (*addiction; dependence; abuse) AND (cocaine; marijuana; cannabis; amphetamine; mdma; heroin; narcotics; opiate; opioid; phencyclidine; ecstasy; salvia; hallucinogens; methadone; cocaine; stimulants; inhalants; benzodiazepines; depressants; sedatives; speed*)
Emotional regulation	TITLE-ABS-KEY (*emotional regulation; emotional dysregulation; affective regulation; emotional control; emotional stability; affective control; affective management; emotion regulation strategies; affective dysregulation; mood regulation*)
Executive function	TITLE-ABS-KEY (*executive function; cognitive control; inhibitory control; cognitive flexibility; decision making; problem solving; planning ability; self-regulation; attention control; impulse control; executive processes*)

Filters available on both platforms were used to select Open Access, in English-language, manuscript-type scientific articles. Further according to the platform specificity, the filtering continued for APA PsycNet with articles in the field of *Substance Abuse and Addiction* by population over 18 years of age. For Scopus the filter for the scientific domain *Psychology* was used, focusing on the study population aged 18 years and over.

This search strategy yielded 1073 articles published between 1984-2024 that were retrieved from the two platforms in July 2024.

Table 2 presents the inclusion and exclusion criteria for the studies.

Table 2

Inclusion and exclusion criteria used in the study selection process

Inclusion criteria	Exclusion criteria
The title, abstract, or keywords of the article contained at least one of the terms emotional regulation or executive function; The mean age of participants was over 18 years; Studies based on field data analysis; Results focused on the impact of executive functions and emotional regulation as predictors of substance use or consequences of substance use.	The title, abstract, or keywords of the article did not include any terms related to drug use or executive functions/emotional regulation; Cross-sectional studies with a mean participant age below 18 years; Systematic reviews or meta-analysis studies.

Data analysis and extraction

All resulting elements were archived using the free bibliographic management program, Zotero (Corporation for Digital Scholarship, n.ed.). This software facilitated alphabetizing the papers, archiving them separately and identifying duplicate items. Zotero also made it possible to view essential information (title, authors, publication name, volume, pages, etc.) about each selected record and to read the abstract of each paper without opening a separate file. This made it possible to track both the initial number of papers and the number remaining after applying the exclusion criteria, by automatically generating the number of records in each title collection (file). Then, after all papers were saved, duplicate records (62) were deleted. Further, 46 meta-analyses and systematic reviews were removed.

The first sorting was based on searching for the terms executive functions and emotional regulation in all the files and folder labels in which the remaining 965 unique articles were archived. Articles whose title, abstract, or labels contained at least one of these terms were extracted (438). Of these, 212 articles were removed because their subject was exclusively legal drugs such as nicotine or alcohol.

For the 226 articles, a detailed analysis of the titles and abstracts was used, excluding 114 articles for reasons such as those given in Table 3.

The 112 articles whose abstracts were selected were then subjected to an in-depth textual analysis, whether the investigations on executive functions and emotional regulation were direct or indirect. Additional information of interest to the study resulting from the full text analysis of each article was extracted separately.

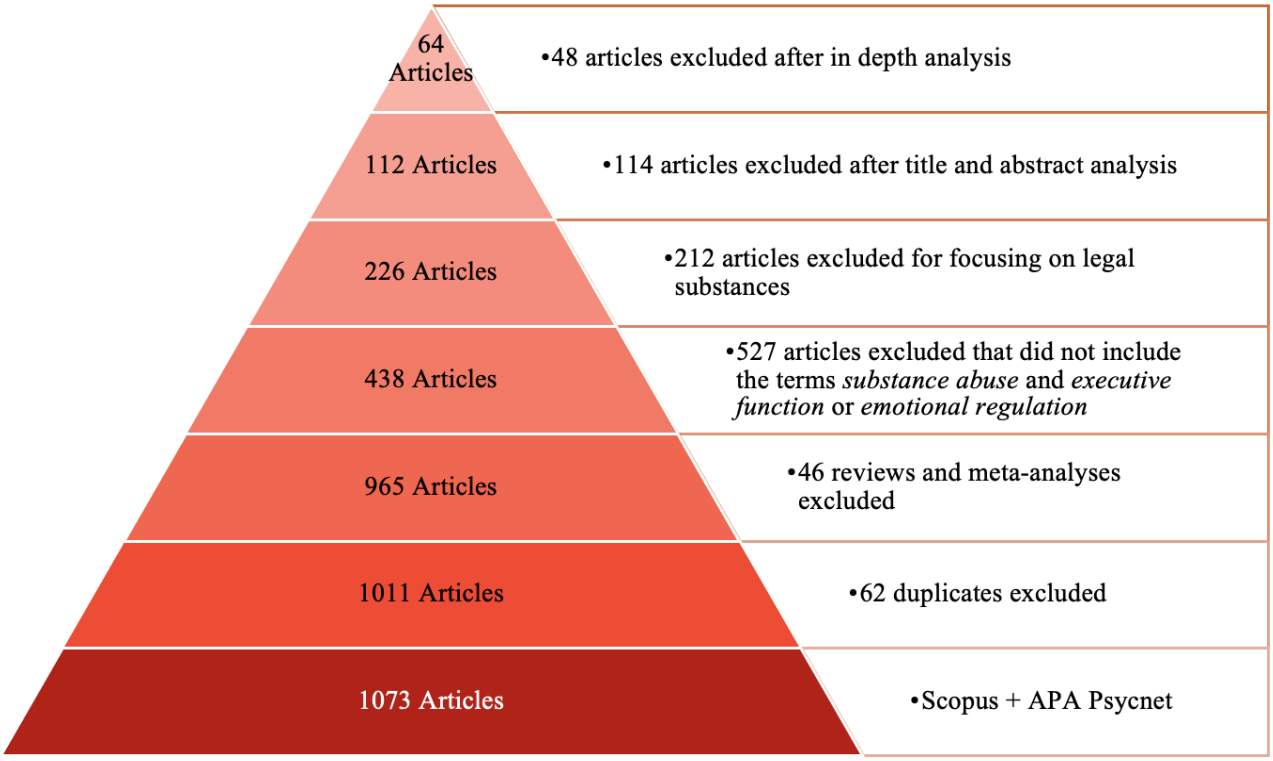
Another 48 studies were removed after checking the inclusion criteria in the full article. In the majority of cases, the reasons for exclusion were the small number of participants, exceeding the range set for the average age, and lack of information necessary for this analysis (number of participants, investigation and measurement of executive functions and emotional regulation, proportion of participants by sex and research site).

Table 3
Phase 1, 2 and 3 of exclusion

Phase 1
Studies exclusively focused on the use of legal substances (e.g., nicotine, alcohol) were excluded.
Phase 2
Characteristics of the sample
Studies conducted on other species, such as mice, were excluded. Studies with fewer than 20 participants were excluded. Cross-sectional studies with participants under 18 years of age were excluded.
Phase 3
Investigation characteristics
Studies investigating parental executive functions or substance use and their impact on children were excluded. Studies analyzing neurocognitive functions from a medical perspective rather than a psychological perspective were excluded.

Also retained were those papers which, although they did not provide exact data on the substances used, had among the selection criteria for the participants the fulfilment of the conditions for the diagnosis of mental and behavioural disorders due to psychoactive substances. In the end, 64 articles were left on which the results of this work are based. The entire process of systematic review of articles is summarized in Figure 1.

Figure 1
Article selection process



Results

In Tables 4 and 5 information relevant to this review has been extracted from each included article. Data such as the type of drug on which the study was conducted, the number, gender and characteristics of the participants and the concepts drawn from the study.

In terms of substances tracked in the collected studies most were conducted on cocaine use (COC) (26) followed by opioids (OPI) (14), cannabis (18), polydrug use (4), amphetamine/methamphetamine (17), MDMA (13), benzodiazepines (BZD) (6). It is worth mentioning that some of the collected studies were conducted on more than one drug (28), and other studies were conducted on drug use disorders but not specified (6).

Most studies (48) were conducted in the USA, but it is important to note that research also covered other countries. Data from the UK were analysed in 5 studies, while Spain and Norway were analysed in 3 studies each. Data from China, France, Ireland, the Netherlands, France, Ireland and Iran were included in 1 study each.

Study group sizes ranged from 26 to 14768 participants. In terms of gender, although the majority of participants were men, in most of the studies a balanced ratio of women to men was maintained. In 5 of the studies data collected only from men and in one study only from women were analysed.

Most of the studies were cross-sectional (51), while only 13 were longitudinal studies lasting between 3 months and up to 30 years. The cross-sectional studies had average ages ranging from 18.6 to 58.1 years. In the longitudinal research, the youngest participants at the time of the first measurement were new-borns, and the oldest participants at the last time of data collection had an average age of 52.5 years.

Results on executive functions and emotional regulation were grouped as follows.

Executive Functions (43): executive dysfunction, learning, working memory/attention, cognitive flexibility, inhibitory control, motor functioning, verbal fluency, verbal and visual working memory, processing speed, problem solving, impulsivity, attention switching, decision making, cognitive remediation, measurement of inhibition, self-monitoring, action initiation, planning, monitoring ongoing task performance, and organizational capacity.

Emotional regulation (23): attachment, coping strategies, negative affect, emotional dysregulation, negative emotionality and emotional arousal, cognitive reappraisal and emotional suppression, impulsivity, engagement in goal-directed activities, emotional self-regulation, affective dysregulation, stress, stigma, emotional distress, emotional response non-acceptance, difficulties in impulse control, limited access to emotion regulation strategies.

Executive function deficits

Opioid-dependent individuals have been found to have significant neurocognitive deficits, particularly in learning and memory, as well as difficulties in planning, organizing, and maintaining a job (Dolan, Bechara, & Nathan, 2008; Kalapatapu, Lewis, Vinogradov, Batki, & Winhusen, 2013). Impulse control was impaired, but not attention or cognitive flexibility (Pau, Lee, & Chan, 2002). In multiple substance users, executive dysfunction has been correlated with social adjustment problems and behaviour characterized by illegal activities (Hagen et al, 2016; Hagen et al., 2017).

Long-term cannabis use influenced executive function and attention in older adults, but these effects were not evident in those over 50 years of age with psychiatric comorbidities (Benitez et al., 2020; Fitton, Bates, Hayes, & Fazel, 2018). Chronic methamphetamine use has been associated with executive dysfunction and reduced cognitive reserve, especially in the presence of major depression (Casaletto et al., 2015; Winhusen et al., 2013).

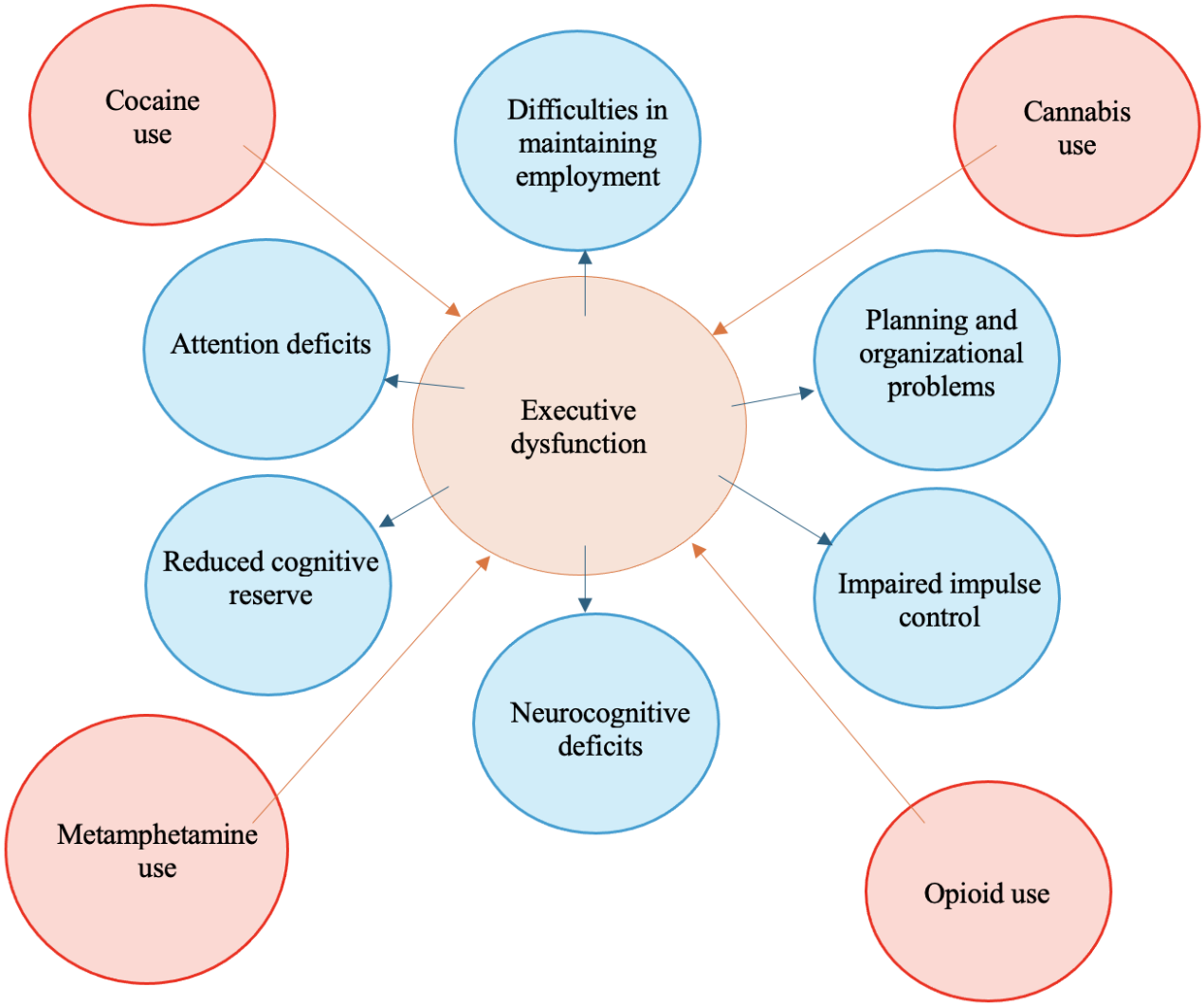
Cocaine use has been associated with disruptions in cognitive control, particularly in those with intense cravings (DiGirolamo, Smelson, & Guevremont, 2015; Sokhadze, Stewart,

Hollifield, & Tasman, 2008). Addicted individuals may process information about risks and consequences differently (Fukunaga, Bogg, Finn, & Brown, 2013). Poorer performance on executive function tasks has been associated with poorer recognition of problematic substance use and poorer retention in treatment (Severtson, von Thomsen, Hedden, & Latimer, 2010; Worhunsky et al., 2013).

Abstinence from methamphetamine led to partial recovery in executive functioning and affective distress after one year of abstinence (Iudicello et al., 2010). Executive functioning has been identified as a predictor of treatment success for substance use disorders (Rezapour et al., 2021; Kiluk et al., 2017; Li, Palka & Brown, 2020).

Figure 2

The link between substance use and executive dysfunction



Difficulties in emotional regulation

Difficulty with emotional regulation has been identified as a mediator between negative affectivity and substance use, including opioids and cannabis. According to Bakhshaie et al. (2019) negative affectivity has been associated with non-medical opioid use being influenced by emotional regulation. Similarly, Buckner, Zvolensky, Farris, & Hogan (2014) reported a significant positive correlation between negative affectivity, emotional dysregulation, and cannabis use as a coping mechanism for managing negative emotions. Tull, Berghoff, Wheeless, Cohen & Gratz (2018) identified emotional dysregulation as an important mediator in the

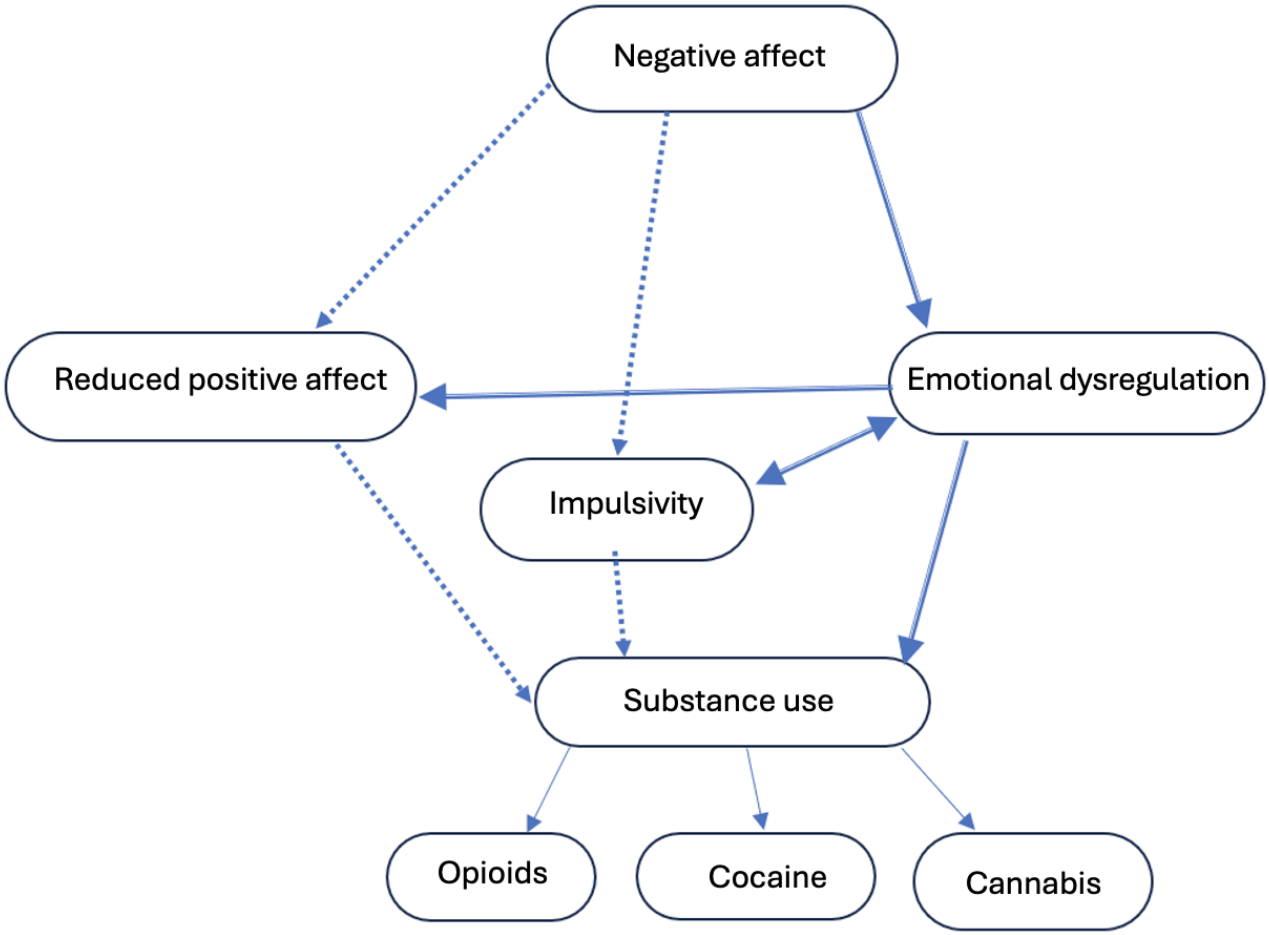
relationship between the severity of post-traumatic stress disorder symptoms and psychoactive substance use. Peckham, McHugh, Kneeland, Björgvinsson & Beard (2020) highlighted a less explored aspect of emotion regulation - the deliberate reduction of positive emotions. The finding that the attenuation of positive affect can be a predictor of substance use, particularly in individuals with higher pre-treatment substance use, suggested that difficulties managing positive emotions may exacerbate the risk of relapse or continued substance use.

Different emotional regulation strategies influenced substance use outcomes differently. For example, Decker, Morie, Hunkele, Babuscio & Carroll (2016) showed that cognitive reappraisal was not associated with cocaine abstinence, whereas emotional suppression might serve as an adaptive strategy for some cocaine-dependent individuals.

Impulsivity, often linked to emotional dysregulation, exacerbated substance use problems, especially cannabis (Simons & Carey, 2002; Thames, Arbid &Sayegh, 2014). Similarly, Claudat et al. (2020) observed greater impulsivity and difficulty engaging in goal-directed activities among individuals with eating and substance use disorders.

Figure 3

Negative affect as a mediator of substance use



Interventions for substance use disorders that integrate emotional regulation and executive functions.

Bell et al. (2017) examined the combined effects of Cognitive Remediation Therapy and Work-Based Therapy in U.S. veterans in early recovery from substance use disorders. The study found significant improvements in neurocognitive functioning and reduction in substance use compared to the control group, while results also showed sustained improvements in real-life functioning after 12 months (Bell et al., 2020).

Flynn et al. (2019) investigated the effectiveness of the Dialectical Behaviour Therapy (DBT) skills training program for individuals with dual disorders (substance dependence and mental health diagnoses) with positive outcomes in the management of co-occurring symptoms.

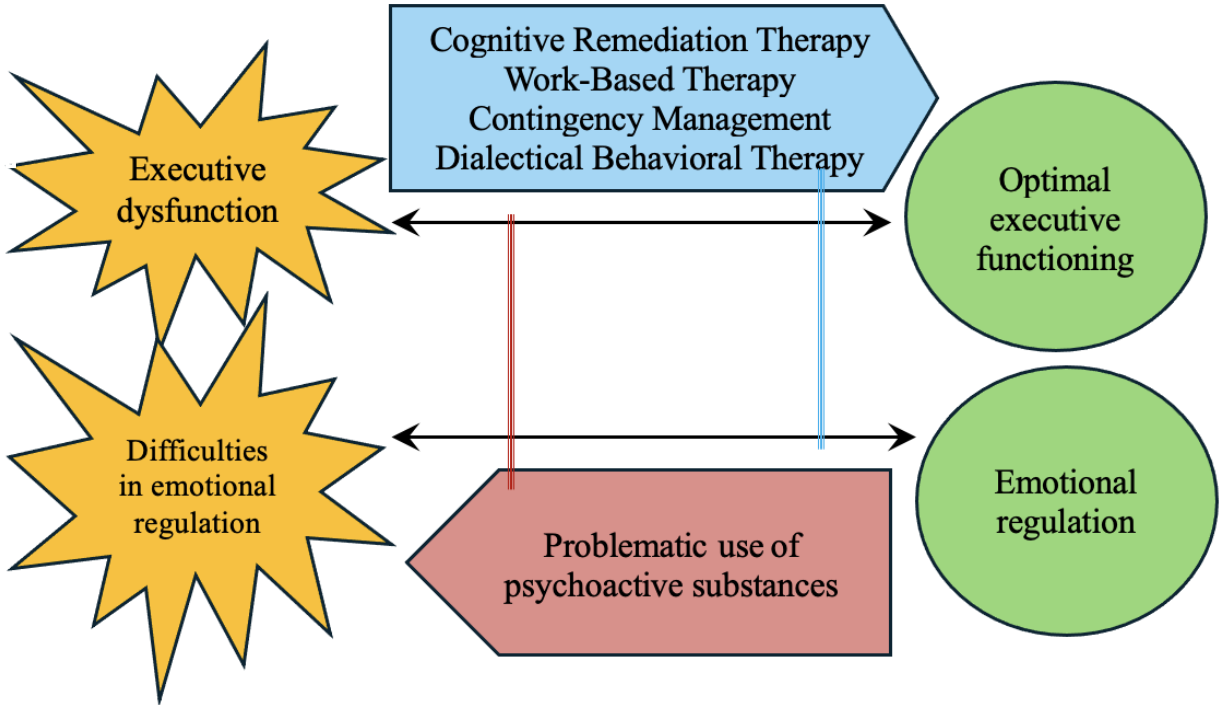
Kiluk et al. (2017) explored cognitive remediation (CR) training utilizing contingency management (CM) techniques in outpatients treatment for substance use disorders. The study supported the feasibility of using CM techniques to enhance patient engagement and showed improvements in neurocognitive function.

Berry, Haddock, Barrowclough, & Gregg (2022) investigated the relationship between attachment styles, coping mechanisms, and substance use in participants with substance dependence diagnoses and schizophrenia or psychosis. The study indicated that anxious-insecure attachment was significantly associated with problematic substance use mediated by dysfunctional coping styles (Berry et al., 2022).

Rezapour et al. (2021) studied cognitive rehabilitation in patients with opioid use disorder newly admitted to methadone treatment and suggested that working memory and inhibitory control might be predictors of treatment response.

Figure 4

Intervention strategies for substance use disorders including emotional regulation and executive functions



Variability of cognitive deficits by substance use

Adults dependent on opioids, cocaine, methamphetamine, MDMA, and cannabis have been identified with significant deficits in executive functions and emotional regulation, but these deficits vary by substance. Opioid users showed extensive neurocognitive deficits, including major difficulties in decision-making and learning. Alcohol and cocaine dependence exacerbated these problems, leading to more pronounced neurocognitive impairment (Arias et al., 2016; Bell et al., 2017; Bell et al., 2020).

In contrast, cocaine users particularly exhibited deficits in cognitive control and executive functioning, with major difficulties in responding to craving cues and maintaining

abstinence. They have been identified as susceptible to relapse due to impaired cognitive control (Devito et al., 2017; DiGirolamo et al., 2015).

Methamphetamine (MA) users showed significant deficits in cognitive flexibility and working memory. Chronic MA use impaired daily functioning and was associated with high affective distress and poor emotional regulation strategies (Casaletto et al., 2015; Casaletto et al., 2015; Iudicello et al., 2010; Huckans et al., 2021).

MDMA use was associated with significant challenges in inhibition, self-monitoring, and working memory, and emotional dysregulation was identified as a major problem. They showed high levels of affective distress and negative affectivity, contributing to substance use to cope with negative emotions (Hadjiefthyvoulou, Fisk, Montgomery & Bridges, 2012; Montgomery, Fisk, Newcombe, Wareing & Murphy, 2005; Flynn et al., 2019).

Chronic cannabis use has been associated with cognitive deficits, including problems in executive functions and attention. Emotional dysregulation has also been identified as significant, negatively influencing substance use and related problems (Benitez et al., 2020; Crook et al., 2021).

Discussions

Functional consequences

Although research has indicated cognitive and emotional deficits in people with substance use disorders, these findings do not apply universally. Arias et al. (2016) have shown that not all opioid-dependent adults exhibit deficits in executive functions, and the severity of these deficits may be influenced by co-occurring disorders such as alcohol or cocaine dependence.

Similarly, emotional dysregulation may not be a universal mechanism underlying non-medical opioid use. Some individuals with high negative affectivity have been able to effectively use coping strategies and emotion regulation interventions to reduce their non-medical opioid use (Bakhshaie et al., 2019). The relationship between cognitive and emotional processes and substance use behaviours may be complex and heterogeneous in this population (Bonnet, Bréjard, & Pedinielli, 2013).

Thus, the importance of avoiding generalizations and recognizing individual variability in the manifestation and impact of executive dysfunction and emotional dysregulation in individuals with substance use disorders has been emphasized (Buckner, Walukevich, Zvolensky & Gallagher, 2017). It has been recommended that therapeutic approaches should be personalized, considering the specific characteristics and needs of each individual, to optimize the effectiveness of interventions in this population.

Comorbidities

Data suggest that substance use has often been identified comorbid with other mental and behavioural health disorders, including depression, post-traumatic stress disorder, personality disorders (NIDA, 2020; Schuckit, 2006) but also somatic conditions such as HIV and various forms of negative affectivity and executive dysfunction (Hardy, Fani, Jovanovic & Michopoulos, 2018; Nigg et al., 2017; Janssen, Van Aken, De Mey, Witteman & Egger, 2014). These conditions need to be considered when treating patients with substance dependence, especially given that the problems are primarily comorbid with each other. For example, in opioid use, Arias et al. (2016) identified comorbidities such as alcohol and cocaine dependence. Also, Mackesy-Amiti, Boodram & Donenberg, (2020), Mackesy-Amiti & Donenberg (2020) and Weiss, Tull, Viana, Anestis & Gratz (2012) reported affective and negative impulsivity among opioid-dependent individuals

HIV infection has been mentioned as a common co-morbidity among cannabis users but also among injecting drug users (Crook et al., 2021; Thames, Mahmood, Burggren, Karimian & Kuhn, 2016; Golub, Starks, Kowalczyk, Thompson & Parsons 2012).

Executive functions - analysed as a unit

Although executive functions have been described in the literature together with its component elements such as attention, decision making, cognitive flexibility, inhibitory control (Diamond, 2013; Ferland & Hurd, 2020; Tipps, Raybuck, Buck & Lattal, 2014) in many of the studies reviewed in this study the concept of executive functions has been used in a more general way, including a broader domain of higher cognitive aspects, without clearly distinguishing between the listed components.

This general approach may limit a deep understanding of how each component of executive functions contributes to emotional regulation and other cognitive aspects in the context of substance use disorders. For example, cognitive flexibility, which refers to the ability to shift perspectives or strategies in response to environmental changes, may have a different impact on substance use behaviours compared to inhibitory control, which involves suppressing impulsive or inappropriate responses (Domínguez-Salas, Díaz-Batanero, Lozano-Rojas & Verdejo-García, 2016).

Links between executive functions and emotional regulation

Even though the concepts of emotional regulation and executive functions were used separately for this systematic review, it is important to note that they are often closely related and influence each other (Schmeichel & Tang, 2014).

Executive functions, which include attention, decision making, cognitive flexibility, and inhibitory control, have been identified as essential for adapting behaviours and regulating emotional responses to different situations (Diamond, 2013). Emotional regulation involves the processes by which individuals influence the emotions they experience, when and how they experience them, and how they express them (Gross, 2014).

A better understanding of how these cognitive and emotional processes interact could provide important insights for developing more effective therapeutic interventions for people with substance use disorders. The indirect link between deficient emotional regulation and executive impairments observed in drug users has been described by some authors (Blume & Marlatt, 2009; Punzi, 2015; Foroozandeh, 2017) but more studies are needed to investigate these relationships directly and to be able to establish the precise mechanisms by which deficient emotional regulation contributes to executive impairments observed in drug users, as the issue of the complexity and interdependence of these cognitive and emotional processes needs to be considered

Poly-drug use and new psychoactive substance

Poly-substance users of psychoactive substances constitute a distinct category in which deficits in executive functions were even more pronounced, manifesting in poorer performance on tasks involving cognitive flexibility, working memory, and set-shifting ability (Van Der Plas, Crone, Van Den Wildenberg, Tranel & Bechara, 2009; Schmidt, Pennington, Cardoos, Durazzo & Meyerhoff, 2017; Arias et al., 2016). These deficits have been exacerbated by dangerous combinations of substances used (Iudici, Castelnuovo & Faccio, 2015). Sustained abstinence for one year showed significant improvements in executive functions, increased life satisfaction, and reduced psychological distress, thus highlighting the potential for cognitive recovery through prolonged abstinence (Hagen et al., 2017).

New psychoactive substances, introduced to the drug market in 2009, have seen a rapid increase from 27 substances to 950 substances (EMCDDA, 2024). Their use has been associated with a range of social and health harms through syndromes of toxicity and dependence that are recognized for the difficulties caused in primary care, emergency departments, psychiatric hospitals and community care settings (Shafi, Berry, Sumnall, Wood & Tracy, 2020). Therapeutic approaches to substance-induced disorders are a current challenge in the drug addiction phenomenon and require investigation for adequate representation in the literature for effective interventions.

Gender differences

There are also significant gender differences in the effects of drug use on executive functions and emotional regulation. Women were more likely to develop affective disorders such as anxiety and depression in the context of substance abuse, influenced by biological and hormonal factors. In contrast, men showed a predisposition to impulsive and aggressive behaviours, increasing the risk of engaging in risky behaviours and experiencing problems with the law and social problems (Li et al., 2007; Becker & Hu, 2008; Nolen-Hoeksema, 2012; McHugh, Votaw, Sugarman & Greenfield, 2018).

These differences have highlighted the need for gender-specific therapeutic interventions: interventions for women should focus on reducing affective symptoms and enhancing social support, whereas for men, interventions should aim at managing impulsivity and aggression, as well as developing behavioural and emotional control (Nolen-Hoeksema, 2012; Fox & Sinha, 2009).

Cultural and socio-economic differences

Most of the studies reviewed were conducted in the US and did not account for cultural and contextual differences in the populations investigated, which may influence both executive functions and emotional regulation and should be addressed in future research. Socioeconomic inequalities have been identified to influence physical health and emotional well-being (Alvarez, Rudolph, Cohen & Muscatell, 2022).

Although the field of drug use and misuse has been intensively studied on a large scale (Prendergast, Podus, Chang, & Urada, 2002; Zhu, Racine, Devereux, Hodgins, & Madigan, 2023; Sakulsriprasert, Thawornwutichat, Phukao, & Guadamuz, 2023) over the last 30 years, few papers have presented the specific situation of youth and adults in Romania (Baciu, 2018). Most existing studies have focused on general populations from other regions, which do not always reflect the accuracy and complexity of the real issues in the Romanian space. Given the significant socio-economic differences between Romania and countries such as the USA or Western European countries, as highlighted in the European Commission reports (2024), it is essential that these contextual issues are carefully considered and addressed in future studies. In Romania, illicit drug use has increased significantly: 3.9% of people aged 15-64 have used drugs in the last month, 2.2 times more than in the 2016 study (ANA, 2022).

Conclusions

The literature review revealed that few studies have investigated executive functions and emotional regulation in illicit drug users simultaneously, but they have emphasized the complexity and variability in how different psychoactive substances influence these cognitive and emotional functions. Substances such as cocaine, opioids, methamphetamines, cannabis and MDMA have profound but different impacts on executive functions and emotional regulation, highlighting the need for more nuanced theoretical and methodological approaches.

The normal development of executive functions has been shown to be a potential protective factor against drug use, pointing to skills such as inhibitory control, working memory and planning as essential for healthy decision-making and avoidance of impulsive behaviours. Psychological interventions that improve these executive functions have also been shown to be effective in alleviating drug use problems, facilitating both abstinence maintenance and social reintegration.

Emotional regulation also plays a key role, acting as a protective factor in preventing the development of substance use problems. People who effectively manage their negative emotions are less likely to turn to drugs as a coping mechanism. Psychological interventions that enhance emotional regulation strategies, such as dialectical behaviour therapy, have been shown to be effective in reducing emotional distress and promoting abstinence.

Gender differences also play an important role in how substance use affects executive functions and emotional regulation. Women are more prone to affective disorders such as anxiety and depression, while men show a higher susceptibility to impulsive and aggressive behaviours, highlighting the need for gender-tailored therapeutic interventions.

Although existing interventions, such as Cognitive Remediation Therapy and Dialectical Behaviour Therapy, have demonstrated efficacy in reducing substance use and ameliorating neurocognitive and emotional dysfunction, the literature indicates a further need to explore more specific and personalized methods for developing executive functions, including non-invasive neuropsychological techniques.

This analysis suggests that personalized interventions, tailored to both the type of substance as well as the demographic and gender characteristics of patients, could be essential in the effective prevention and treatment of drug use problems.

Limitations

The range of elements and concepts associated with executive dysfunction and emotional dysregulation in illicit psychoactive substance use may be broader than that obtained by conducting this systematic review, as many of the studies referred to executive function as a general concept and did not detail the component elements.

Although the databases used are recognized clinical and social science databases, this review did not include additional databases, for example medical databases.

Also, the assessment of executive functions has been carried out using a variety of methods ranging from functional MRI to the completion of questionnaires, the lack of a unified way of assessing them may be a limitation of this review and it is noted that further research in this direction is needed. A unitary method of assessment was also not used for emotional regulation and thus this heterogeneity may limit the ability to draw general conclusions. Another limitation is the lack of studies in Central and Eastern Europe, with most of the selected articles being from the USA. It should be noted that no studies have been identified on new psychoactive substances, also known as ethnobotanicals and which generates the need for a tailored response in terms of prevention and intervention to mitigate the social and economic impact of the phenomenon recognized at European level (EMCDDA, 2024).

Table 4
Presentation of studies included in the systematic analysis, focused on executive functions (EF) and type of drug

Authors and year	Drug	N	Male gender	Characteristics of the sample
Arias et al. (2016)	OPI, COC, BZD, Cannabis	38	69.0%	Adults dependent on opioids seeking buprenorphine treatment
Executive functions (EF)*: motor functioning, attention/working memory, verbal fluency*				
Bell et al. (2020)	Alcohol, COC, OPI	48	93.7%	U.S. veterans in Veterans Administration substance abuse programs
EF*: visual and verbal working memory, attention, processing speed*				
Bell et al. (2017)	Alcohol, COC, OPI	48	93.7%	U.S. veterans in Veterans Administration substance abuse programs
EF*: visual and verbal working memory, attention, processing speed*				
Benitez et al. (2020)	Cannabis	14678	55.0%	Non-institutionalized U.S. population divided into never/former/current users
EF*: attention*				
Casaletto et al. (2015)	MA	390	72.8%	195 MA+ users and 195 non-users (MA-) matched by NIDA
EF*: working memory, cognitive flexibility, problem-solving*				
Crook et al. (2021)	Cannabis	138	73.0%	HIV-positive adults
EF*: working memory/attention, verbal fluency*				
Devito et al. (2017)	COC	26	61.5%	Adults diagnosed with cocaine use disorder in outpatient settings
EF*: cognitive control*				
DiGirolamo et al. (2015)	COC	30	76.6%	Adults with cocaine use disorder in inpatient addiction centers
EF*: cognitive control*				
Dolan et al. (2008)	Alcohol, stimulants	68	44.1%	MECCA (Mid-Eastern Council on Chemical Abuse) participants
EF*: impulsivity, cognitive flexibility, set-shifting*				
Fitton et al. (2018)	Unspecified	32	100.0%	Adults aged 50+ in Thames Valley probation services, England
EF*: verbal fluency*				
Fukunaga et al. (2013)	Multiple drugs	47	50.0%	Substance users and control group
EF*: decision-making*				
Gjini et al. (2014)	COC	81	88.9%	Abstinent cocaine-dependent individuals and control group
EF – *undifferentiated*				
Golub et al. (2012)	Multiple drugs	104	100.0%	Gay and bisexual HIV-negative male substance users
EF*: decision-making, set-shifting*				
Hadjiefthyvoulou	MDMA	110	33.6%	MDMA/poly-drug users, abstinent MDMA/poly-

Authors and year	Drug	N	Male gender	Characteristics of the sample
et al. (2012)				drug users (6 months), and non-user students.
EF*: inhibition, self-monitoring, action initiation, working memory, planning, performance monitoring, organizational capacity*				
Hagen et al. (2016)	Polydrug use	158	54.0%	Polydrug users and control group
EF*: inhibitory control, cognitive flexibility, planning, working memory, decision-making*				
Hagen et al. (2017)	Polydrug use	149	61.0%	Polydrug users and control group
EF*: inhibitory control, cognitive flexibility, planning, working memory, decision-making*				
Hagen et al. (2019)	Polydrug use	104	61.5%	Polydrug users and control group
EF*: inhibitory control, cognitive flexibility, planning, working memory*				
Henry et al. (2010)	MA	30	76.6%	MA users in treatment centers
EF*: EF: cognitive flexibility, set-shifting*				
Huckans et al. (2021)	MA	147	60.0%	Active MA users, abstinent individuals, and non-users
EF*: motivation, impulse control, strategic planning*				
Iudicello et al. (2010)	MA	83	87.0%	MA-dependent individuals in remission and control group, treatment center
EF*: working memory, affective distress*				
Janssen et al. (2014)	Unspecified	406	58.4%	Individuals with mental disorders, including substance use disorders
EF*: working memory, set-shifting*				
Jones et al. (2013)	COC	120	51.0%	Cocaine-dependent individuals and control group
EF*: cognitive control, context processing*				
Kalapatapu et al. (2013)	stimulants	183	31.7%	Adults from six community substance abuse programs across the country
EF*: decision-making, verbal learning/memory, executive functioning, set-shifting*				
Kiluk et al. (2017)	Alcohol, COC, cannabis	40	50.0%	Outpatients with mild cognitive impairment and ≥30 days of abstinence from alcohol and drugs
EF*: attention, working memory, cognitive remediation*				
Li et al. (2020)	COC	373	62.7%	Patients with bipolar affective disorder
EF*: cognitive flexibility, set-shifting*				
Madoz-Gúrpide et al. (2011)	COC	51	79.2%	Participants in cocaine detoxification programs in Spain and control group
EF*: cognitive flexibility, set-shifting, working memory*				
Montgomery et al. (2005)	MDMA	48	50.0%	MDMA users and control group
EF*: working memory, verbal fluency*				
Nigg et al. (2017)	Unspecified	641	49.5%	Two community adult samples: one ADHD study, one substance use study
EF*: cognitive flexibility, set-shifting*				

Authors and year	Drug	N	Male gender	Characteristics of the sample
Pau et al. (2002)	OPI	55	100.0%	Individuals in group treatment centers for heroin addiction
EF*: impulse control, mental flexibility/abstract reasoning*				
Rezapour et al. (2021)	OPI	113	100.0%	Participants with opioid use disorders in mandatory methadone maintenance treatment
EF*: working memory, inhibitory control*				
Roberts et al. (2013)	MDMA	40	42.5%	MDMA users and control group of other substance users.
EF*: cognitive flexibility, set-shifting*				
Salo et al. (2011)	MA	52	57.7%	Currently abstinent MA users and control group
EF*: distraction vulnerability (attention)*				
Schmidt et al. (2017)	Polydrug use	105	81.9%	Polydrug users and individuals with alcohol use disorders in San Francisco treatment programs
EF*: cognitive efficiency, working memory, self-reported impulsivity*				
Severtson et al. (2010)	OPI, COC, BZD, Cannabis	258	67.8%	Heroin and/or cocaine users at the Baltimore treatment center
EF *and cognitive impairments*				
Sokhadze et al. (2008)	COC	34	55.9%	Cocaine users and control group
EF*: inhibitory control*				
Thames et al. (2014)	Cannabis	158	33.0%	Active cannabis users, former users, and control group
EF*: decision-making, impulsivity, impaired judgment*				
Thames et al. (2016)	Cannabis	89	75.6%	HIV+ and HIV- patients (non-users, light users, and moderate-to-heavy users), treatment center
EF*: attention, working memory, decision-making*				
Van Der Plas et al. (2009)	MA, COC, alcohol	134	44.7%	Individuals dependent on MA, alcohol, and control group
EF*: working memory, decision-making, cognitive flexibility*				
Vergara-Moragues et al. (2023)	COC	324	60.2%	162 Colombian adults consuming coca paste and 162 control group adults
EF*: working memory, decision-making, cognitive flexibility*				
Vicario et al. (2020)	COC	60	87.5%	Outpatients in Ayuda detox program (n=40) and healthy control group (n=20)
EF*: cognitive reserve, decision-making*				
Winhusen et al. (2013)	COC, MA	165	28.0%	Stimulant-dependent individuals in treatment centers
EF*: working memory/attention, problem-solving*				
Wilens et al. (2017)	stimulants	298	44.0%	College students (18–28 years) misusing prescription stimulants for ADHD
EF*: inhibition, shifting, emotional control, self-regulation, initiation, working memory, planning/organization, task monitoring, material organization*				

Authors and year	Drug	N	Male gender	Characteristics of the sample
Worhunsky et al. (2013)	COC	40	60.0%	Cocaine users and control group
EF*: cognitive control*				

Table 5

Presentation of studies included in the systematic analysis, focused on emotional regulation (ER) and type of drug

Authors and year	Drug	N	Male gender	Characteristics of the sample
Bakhshaie et al. (2019)	OPI	2080	21.3%	Students
Emotional regulation (ER*): negative affect*				
Berry et al. (2022)	Alcohol, cannabis, amphetamine, COC, MDMA	70	87.1%	MIDAS (Motivational Interventions for Drug and Alcohol Misuse in Schizophrenia) study with diagnosed substance dependence or abuse
ER*: Attachment, coping strategies*				
Bonnet et al. (2013)	Alcohol, cannabis	256	37.9%	Students enrolled at two universities in southern France
ER*: Negative emotionality, emotional activation*				
Brook et al. (2016)	Cannabis	548	51.0%	Randomly sampled residential community
Difficulties in ER				
Buckner et al. (2014)	Cannabis	103	68.0%	Current cannabis users
ER*: Negative affectivity, experiential avoidance*				
Buckner et al. (2017)	Cannabis	79	57.0%	Adults with anxiety disorders seeking outpatient treatment for cannabis use disorders
ER*: Coping strategies*				
Claudat et al. (2020)	BZD, cannabis, stimulant, OPI	98	10.4%	Adults with eating behavior disorders and substance use from a partial hospitalization program
ER*: Impulsivity, goal-directed activities*				
Decker et al. (2016)	COC	72	47.2%	Adults in methadone maintenance treatment with cocaine use disorder
ER strategies: cognitive reappraisal and emotional suppression				
Dvorak&Day (2014)	Cannabis	817	34.5%	General population
ER*: Stress tolerance, negative affect, emotional instability*				
Emery&Simons (2017)	Cannabis	2270	36.0%	Young adults, students
Difficulties in ER				
English et al. (2018)	Unspecified	170	100.0%	Black and Latino gay and bisexual men
Difficulties in ER caused by stress, stigma				

Authors and year	Drug	N	Male gender	Characteristics of the sample
Flynn et al. (2019)	Multiple drugs	64	38.1%	Adults with dual diagnoses attending community-based public addiction services with mental health and addiction diagnoses
Difficulties in ER				
Gold et al. (2020)	OPI	68	48.6%	Opioid use disorder participants in methadone maintenance treatment
ER*: Non-acceptance of emotional responses, difficulties in impulse control, limited access to emotion regulation strategies*				
Hardy et al. (2018)	Unspecified	229	0.0%	Women in hospital waiting rooms
Difficulties in ER				
Mackesy-Amiti et al. (2020)	OPI	163	68.1%	Participants aged 18–35 in syringe exchange programs in Chicago
ER*: Negative affect, affect-related impulsivity*				
Mackesy-Amiti & Donenberg (2020)	OPI	161	68.3%	Participants aged 18–35 in syringe exchange programs in Chicago
Difficulties in ER *and affect negative*				
Morie et al. (2020)	COC	57	50.8%	Young adults with prenatal cocaine exposure and control group, longitudinal cohort
ER strategies, traumatic experiences, alexithymia				
Peckham et al. (2020)	Multiple drugs	120	43.0%	Adults with risky substance use
ER*: Reducing affective effects*				
Simons& Carey (2002)	Cannabis	592	39.0%	First- and second-year students at a large private university
ER*: Impulsivity, affective lability*				
Tull et al. (2018)	Multiple drugs	133	55.7%	Substance use disorder patients with trauma in a treatment institution
ER*: Negative affect, emotion avoidance*				
Weiss et al. (2012)	Unspecified	206	63.0%	Residential treatment center for substance use disorders, Mississippi
Difficulties in ER				

Competing interests

The authors declare no competing interests.

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