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REVIEW

Five Challenges in Implementing Cognitive Remediation for Patients with Substance Use Disorders in Clinical Settings

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Abstract

Many patients with substance use disorders (SUDs) present cognitive deficits, which are associated with clinical outcomes. Neuropsychological remediation might help rehabilitate cognitive functions in these populations, hence improving treatment effectiveness. Nardo and colleagues (*Neuropsychology Review*, *32*, 161–191, 2022) reviewed 32 studies applying cognitive remediation for patients with SUDs. They underlined the heterogeneity and lack of quality of studies in this research field but concluded that cognitive remediation remains a promising tool for addictive disorders. We capitalize on the insights of this review to identify the key barriers that currently hinder the practical implementation of cognitive remediation in clinical settings. We outline five issues to be addressed, namely, (1) the integration of cognitive remediation in clinical practices; (2) the selection criteria and individual factors to consider; (3) the timing to be followed; (4) the priority across trained cognitive functions; and (5) the generalization of the improvements obtained. We finally propose that cognitive remediation should not be limited to classical cognitive functions but should also be extended toward substance-related biases and social cognition, two categories of processes that are also involved in the emergence and persistence of SUDs.

Keywords Cognitive remediation · Substance use disorder · Neuropsychology · Cognitive therapy

Introduction

Substance use disorders (SUDs) are characterized by the chronic loss of control over the consumption of a psychoactive substance, causing functional impairments as well as having harmful consequences on health and interpersonal relationships (Volkow et al., 2016). While their extent varies across individuals and substances, these impairments frequently encompass cognitive deficits that potentially cover perceptive, motor, and attentional abilities as well as memory and executive functions (e.g., Bruijnen et al., 2019; Melugin et al., 2021). These deficits, which only partly recover with abstinence, play a role in the emergence and maintenance of SUDs, as they are associated with increased consumption, reduced treatment adherence, and greater relapse risk (Czapla et al., 2016). Targeting impaired cognitive functions might thus improve treatment outcomes, directly by reinforcing the cognitive abilities needed to maintain abstinence (Sliedrecht et al., 2019) and indirectly by increasing the cognitive abilities and motivation to adhere to medical and psychological treatments (Contardo et al., 2009).

In recent years, cognitive remediation has emerged as a complementary treatment to psychotherapeutic and

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pharmacotherapeutic approaches for individuals with SUDs. It involves therapeutic interventions, including neuropsychological training, aimed at restoring or boosting cognitive abilities to improve psychosocial functioning (Wykes et al., 2011). Remediation interventions can be general (e.g., targeting global cognitive strategies) or focused on specific cognitive functions (e.g., inhibition, memory, attention). Nardo and colleagues (2022) conducted the first systematic review of 32 studies directly testing the usefulness of remediation interventions to reduce cognitive deficits in patients with alcohol, cannabis, stimulant, and/or opioid use disorders. Their review provides a comprehensive evaluation of the available evidence, including effect sizes, bias risk, and methodological quality of the studies. This rigorous evaluation offers to researchers and practitioners a very useful and much needed overview of the current state of the art in this blooming field. The authors identified some positive outcomes, notably significant improvements in trained cognitive functions and the potential benefits of targeting a range of cognitive functions rather than focusing on specific ones. However, this systematic review also showed that the available literature has limited methodological value, with very few studies presenting high quality and many having a high risk of bias (notably related to high dropout rates). They also claimed that this research field presents large heterogeneity across studies, encompassing the population selected, the cognitive functions targeted, the remediation tools used, the efficacy criteria chosen, and the practical implementation. These mixed findings could discourage practitioners to implement cognitive remediation as long as the conditions of its efficacy in patients with SUDs have not been further established by more reliable experimental work. However, the authors also conclude that cognitive remediation remains a promising tool to improve treatment outcomes in patients with SUDs, which is consistent with previous review papers (e.g., Bates et al., 2013; Rolland et al., 2019; Verdejo-Garcia et al., 2023). Such conclusions might generate an ambiguous message to researchers and clinicians, namely that the promises held by cognitive remediation in SUDs are high but not yet confirmed. They also leave those who already consider applying cognitive remediation in therapeutic settings without recommendations to identify the practical issues that should be addressed to do so.

We acknowledge that no sound and integrated neuropsychological program is currently available to propose optimal cognitive remediation in patients with SUDs. However, in view of the persistently high relapse rates in this population (Brandon et al., 2007) and of the established efficacy of cognitive remediation for other psychiatric or neurodevelopmental disorders such as schizophrenia or autism spectrum disorder (e.g., Bowie et al., 2020; Dandil et al., 2020), we believe that the more efficient programs identified by Nardo and colleagues [e.g., Cogpack software (Rupp et al., 2012) or strategy-based approaches (Rezapour et al., 2019)] could be implemented in clinical settings because they will renew clinical practices and favor improved treatment outcomes. In addition to the choice of the tool, the practical conditions of the implementation of cognitive remediation should be optimized to maximize its efficiency. Indeed, even a neuropsychological program with strongly established validity would lose its clinical usefulness if applied at the wrong time, for the wrong patients, or on the wrong cognitive function. Here, we thus propose a discussion on five key challenges, each related to an issue that should be addressed before starting individual cognitive remediation in a patient with a SUD to optimize its efficacy. These issues are related to (1) the *integration* of cognitive remediation in current practice and the *information* of the patients/colleagues/relatives interested in such remediation; (2) the *selection criteria* needed to increase the success rates of cognitive remediation and the *individual factors* to consider when implementing cognitive remediation; (3) the *timing* to follow when applying cognitive remediation; (4) the *priority/hierarchy* to propose across the trained cognitive functions; and (5) the factors to consider for ensuring the *generalization* of the improvements generated by cognitive remediation to everyday life and the fulfillment of the more global *therapeutic objectives*.

First Challenge: Ensuring Integration and Information

Cognitive remediation should be considered a complementary tool to integrate into classical treatments (Eack, 2012; Hill et al., 2016). Before implementing it, clinicians should first carefully think about the ways it will be introduced not only to patients and their relatives but also to other practitioners. Neuropsychological exercises can be quite complex and repetitive, and thus require persistent motivation from the patient. Precise explanations of the aims and expected outcomes of cognitive remediation, through "neuropsychological psychoeducation" (Caplain et al., 2019), can enhance patient's motivation. For example, explaining the concept of inhibition and how impaired inhibition can reduce one's ability to control consumption can be beneficial. Motivational interviewing (Di Clemente et al., 2017; Rubak et al., 2005) and interventions related to theories of behavior change (Webb et al., 2010) are also powerful tools to boost motivation to engage in cognitive remediation (Fiszdon et al., 2016). Regarding clinicians, as neuropsychological tools remain little used in clinical settings, many practitioners might still consider cognitive remediation as ineffective or even harmful; this is especially true for computer-based therapy that can be seen as dehumanizing patients and reducing clinical alliance. The initiation of cognitive remediation should thus be prefaced by informing other clinicians about

its efficacy and showing how it can be combined with more classical approaches (e.g., cognitive behavioral therapy or metacognitive training, Bechdolf et al., 2012; Chan et al., 2020; Julien et al., 2023; Lee et al., 2022), leading to mutual benefits.

For example, the effectiveness of cognitive remediation (through goal management training) is increased when combined with mindfulness therapy, leading to an enhanced impact on decreasing impulsivity and optimizing decision-making in patients with SUDs (Anderson et al., 2021). Providing a rationale and clear objectives for the cognitive remediation process to all stakeholders before starting it could increase participation and motivation, as well as foster the development of integrated programs that merge the principles of cognitive remediation with more classical therapeutic approaches (e.g., Action-Based Cognitive Remediation, Bowie, 2019; Bowie et al., 2017).

Second Challenge: Selecting Patients and Considering Individual Factors

Given the time-consuming nature of cognitive remediation for patients and clinicians, it should not be proposed to all in- or outpatients with SUDs. *Selection criteria* should be applied to focus the intervention on patients who could benefit from it, hence increasing its success rate. This relates to at least two issues. First, cognitive remediation requires to maintain high personal involvement through long and repetitive sessions over weeks. Clinicians should thus increase the motivational resources of each patient (e.g., through the development of a sound therapeutic alliance) to avoid early drop-out (frequent in previous cognitive remediation studies, e.g., Brooks et al., 2016; Hendershot et al., 2018; Rass et al., 2015). Second, while cognitive remediation is by essence dedicated to improving cognitive function in patients with impairments, successful neuropsychological remediation requires a sufficient level of cognitive resources to understand the instructions, maintain attention, and effectively engage in training. In SUD, cognitive deficits present major inter-individual differences during the detoxification phase (Ihara et al., 2000; Schmid et al., 2021). If the cognitive level at the start of the intervention is too low, the success rate may be compromised, as patients may struggle to complete the program correctly (e.g., Stephens et al., 2015).

At the very least, clinicians should check the presence of minimal cognitive resources through cognitive screening tests (e.g., BEARNI, Ritz et al., 2015; or MoCA, Nasreddine et al., 2005) and set thresholds under which the patient will not be directly included in the program. Such individuals might nevertheless benefit from other interventions (e.g., psychoeducation, programs improving quality of life through sleep or diet interventions) and could be included later, after the spontaneous recovery of the needed cognitive resources. Ideally, a complete neuropsychological evaluation (e.g., Kwako et al., 2016; Rochat et al., 2019) should be performed for each patient before inclusion to identify their specific cognitive profile and hence adapt the program. The presence of comorbid psychiatric, neurological, or somatic disorders should also be evaluated, as they might increase neurocognitive impairments (Cody & Vance, 2016; D'Hondt et al., 2018). We thus propose that cognitive remediation should not be applied blindly to all patients but rather as a priority to individuals presenting greater chances of benefitting from it. This selection will spare and optimize the often-limited material and human resources available in clinical settings and will also reduce the failure rates of the intervention, such failure lowering self-efficacy feelings and self-esteem among patients.

A complementary question regarding the selection of patients is their consumption status when starting cognitive remediation. Only two studies (Stanger et al., 2020; Sweeney et al., 2018), which explored the effect of cognitive remediation among young outpatients with cannabis use disorder, included participants with current substance consumption. All other previous articles on cognitive remediation in SUDs reviewed by Nardo and colleagues (2022) only included detoxified patients, with a large range of abstinence duration (from a few days (e.g., Bell et al., 2016; Marceau et al., 2017) to several months (e.g., Steingass et al., 1994)). This emphasis on sober participants is justified by two main reasons: (a) neuropsychological testing, which evaluates baseline cognitive abilities before cognitive remediation, must be conducted in detoxified patients not to be biased by recent or current consumption; (b) the high levels of motivation, engagement, and cognitive resources required during cognitive remediation may be incompatible with ongoing substance consumption. However, a recent expert consensus study (Verdejo-Garcia et al., 2023) proposed that cognitive remediation could be integrated into both abstinence-oriented and harm reduction programs, suggesting that it might be applied to patients with ongoing moderate consumption. The necessity for abstinence throughout cognitive remediation and the appropriate course of action when patients relapse during this process (i.e., continuing cognitive remediation as planned or requesting a new detoxification stay before proceeding) thus remain matters of debate.

Third Challenge: Setting the Intervention Timing

Recent guidelines (Verdejo-Garcia et al., 2023) suggest that cognitive training should be implemented several times a week for a duration of more than 3 months. In line with these recommendations, many previous studies applying

cognitive remediation in SUDs implemented programs spanning beyond the detoxification stay through ambulatory interventions or long-term rehabilitation stays (Nardo et al., 2022). As detoxification stays are usually short, lasting less than a month (Bates et al., 2002), they should be considered as a starting point to initiate longer cognitive rehabilitation programs lasting for several weeks or months. Indeed, the first 7–10 days of detoxification are most often focused on managing withdrawal symptoms, and patients potentially receive high doses of psychotropic drugs (e.g., benzodiazepines) during this period. This withdrawal phase, along with the frequently associated pharmacological treatment, hinders the accurate assessment of cognitive deficits and the safe implementation of cognitive remediation. A neuropsychological assessment preceding cognitive remediation should thus be performed when withdrawal symptoms are no longer present and when psychiatric medication is lowered.

Given the very limited time remaining during the hospital stay (i.e., most often 1 or 2 weeks), the detoxification period constitutes a first step during which cognitive remediation can be either (1) *prepared*, among patients with massive impairments, by developing the therapeutic alliance, increasing their motivation and insight with neuropsychological psychoeducation, and allowing them (through spontaneous recovery or specific cognitive training) to get ready to fully benefit from cognitive remediation; or (2) *initiated*, among patients with already sufficient resources, by stating the objectives of the remediation, familiarizing patients with cognitive exercises, reinforcing motivation as well as therapeutic alliance, and beginning the rehabilitation program under the supervision of clinical staff. This initiation phase can be implemented among inpatients during the detoxification stay but also among outpatients or in various treatment settings and should be further developed in post-detoxification centers, long-term rehabilitation settings, sober homes, or through ambulatory sessions in daycare hospitals. Reconceptualizing the initial detoxification stay or first therapy sessions as key moments to initiate a neuropsychological program could enhance the motivation of both patients and clinicians to take full advantage of this period, paving the way for long-lasting and effective interventions, as proposed in other psychiatric conditions (Bowie et al., 2013; Hill et al., 2016; Tchanturia et al., 2013).

This issue related to the intervention timing also raises the question of the health professionals that should be mobilized and the services that should be developed to conduct cognitive remediation. Among the 32 studies reviewed by Nardo and colleagues (2022), 26 concerned inpatients, where cognitive remediation was performed by the clinical or research staff of the hospital/service. For the 6 studies involving outpatients, cognitive remediation was mostly based on computerized programs (e.g., Cogmed; Brain Fitness, Insight) or standardized neuropsychological tests, with a supervision made either by the clinical staff of the service where patients were treated (e.g., work therapy service, Bell et al., 2016, 2017) or research assistants (e.g., Rass et al., 2015; Stanger et al., 2020; Sweeney et al., 2018). As the detoxification stay only constitutes the first step for cognitive remediation, which should be performed for months after detoxification (Verdejo-Garcia et al., 2023), there is a need to develop new structures and train professionals (particularly neuropsychologists) able to propose this remediation in the long run through follow-up sessions. Additionally, generalization sessions focusing on the everyday life application of cognitive improvements should be developed to extend the benefits of cognitive remediation to real behaviors (Bowie et al., 2020). As it stands, these interventions are not fully covered by medical insurance in most countries, and very few specialized structures exist to perform cognitive remediation in populations presenting SUDs. While we propose that the most realistic places to start cognitive remediation are the detoxification or post-detoxification structures, the extension and generalization of cognitive remediation will require the development of specific services where interventions can take place in the long run under the supervision of trained (neuro)psychologists (Harvey et al., 2018).

Fourth Challenge: Determining the Priority/Hierarchy Across Cognitive Functions

As it is impossible to train patients regarding every cognitive function in the time allocated to neuropsychological interventions, a clear *priority* should be proposed to focus remediation on the most pertinent cognitive functions. A decisional algorithm to help clinicians select these targeted abilities has recently been proposed (Rolland et al., 2019). We reason that cognitive remediation should be focused on cognitive functions that are as follows:

(a) *Significantly impaired when remediation is initiated.* It might appear obvious to avoid intervention for unimpaired cognitive functions, but neuropsychological programs are often administered for all patients without previous neuropsychological evaluation, thus uselessly providing training for preserved abilities. Conducting an individualized cognitive evaluation, such as the comprehensive and theory-grounded neuroclinical assessment proposed by Kwako and colleagues (2016), can prevent such pitfalls by allowing remediation to be focused on the abilities specifically impaired for each patient. This is particularly important since cognitive deficits are characterized by a wide inter-individual variability in patients with SUDs, from patients presenting no impairment at all to those presenting a generalized deficit across all cognitive functions (Rochat & Khazaal, 2019);

(b) *Not associated with strong spontaneous recovery during early abstinence*. Cognitive impairments are often extended at the beginning of the detoxification process (Bernardin et al., 2014; Rolland et al., 2019; Stavro et al., 2013). However, spontaneous recovery, namely neuropsychological improvement following abstinence (notably through brain recuperation) in the absence of any specific remediation, plays a role in the improvement of cognitive abilities (Bartsch et al., 2007; Bates et al., 2002). The extent of spontaneous recovery varies across (1) *cognitive abilities*, as some verbal abilities might resolve earlier than visuospatial ones (Angerville et al., 2023; Ioime et al., 2018). Moreover, while some abilities are significantly improved during the first months of abstinence (Angerville et al., 2023; Pitel et al., 2009), some memory subcomponents can take months to recover, and some decision-making impairments (e.g., problem solving or complex executive abilities) appear very little influenced by abstinence (Manning et al., 2008); (2) *the type of substance use disorder* (Schulte et al., 2014), as abstinence appears to be mostly related to improvement in visuospatial and attentional abilities in alcohol use disorder (Loeber et al., 2010), while spontaneous recovery mostly concerns memory and attention in cannabis use disorder (Fried et al., 2005), decision making in opioid use disorder (Zhang et al., 2011), and attention in cocaine use disorder (Pace-Schott et al., 2008). Cognitive remediation should thus be tailored for every substance to focus on the abilities that are the less influenced by spontaneous recovery, while such tailoring can be difficult among patients with polysubstance use or multiple comorbidities. It would indeed make no sense to intervene on cognitive functions that will recover in the first months of abstinence even in the absence of intervention (unless these functions are strongly involved in early relapse occurring before spontaneous recovery). It should however be noted that some impairments, known to recover spontaneously in SUDs, might result from other factors than these disorders in some patients (e.g., comorbidities, previous brain injury). Such impairments will then not recover with abstinence and should be addressed in the tailored cognitive remediation program.

(c) *Subject to improvement through cognitive remediation*. The efficacy of cognitive remediation to improve cognitive abilities varies across functions, with some being far more difficult to rehabilitate (e.g., high-level executive functions such as complex problem solving). Clinicians should thus focus on cognitive functions that can be modified in the timeframe allotted for remediation;

(d) *Important for the patient's involvement in other clinical interventions*. Many psychological, environmental, and structural factors influence the probability for the patient to initiate and maintain its involvement in medical treatment, including sociodemographic variables, living conditions, psychopathological comorbidities, treatment settings, and personal (versus external) decision to initiate detoxification (Krawczyk et al., 2021). Beyond these general factors, cognitive abilities are also essential for patients with SUDs to take an active role in classical psychological and psychiatric treatments. It has notably been demonstrated that higher cognitive abilities at treatment initiation and particularly higher attentional and abstract reasoning performances predict stronger motivation and involvement throughout the detoxification process, as well as higher treatment retention and better expected clinical outcomes (Katz et al., 2005; Rubenis et al., 2018). Cognitive remediation should thus focus on functions that directly enhance the patient's motivation and reduce treatment barriers (Le Berre et al., 2012). By initiating a virtuous cycle where interventions increase motivation toward cognitive remediation, the efficacy of other interventions can be improved, leading to increased treatment engagement (Saperstein & Medalia, 2016). Depending on the therapeutic objectives, cognitive functions directly important for the patient's personal aims (e.g., professional reintegration, improved quality of life) can also be prioritized in remediation to boost intrinsic motivation, which is a central determinant of the persistent involvement in treatment (Brown et al., 2011).

(e) *Strongly involved in re-consumption or relapse*. The main priority in SUD treatment is to avoid relapse, which would hamper the whole therapeutic process. Previous studies (see Rolland et al., 2019 for a review) have identified the involvement of each cognitive ability in relapse risk for each SUD and have shown that some cognitive functions, despite being widely impaired in patients with SUDs, are not significantly involved in relapse. For example, while most SUDs are associated with a massive working memory deficit, this impairment does not seem to increase relapse risk (Domínguez-Salas et al., 2016; Rolland et al., 2019). Focusing on this ability in cognitive remediation, as done by numerous earlier studies, thus appears of limited interest in that perspective: even when successfully improving working memory, such interventions, while they might be beneficial for everyday life, will have no effect to reduce relapse rates. Conversely, impulsivity, which is high (Rolland et al., 2019) and significantly involved in relapse (Sliedrecht et al., 2021) in alcohol use disorder, could be a relevant target in this disorder. As a whole, considering the role played by each cognitive ability in relapse when selecting the targeted functions would thus optimize the clinical impact of cognitive remediation.

Fifth Challenge: Clarifying Therapeutic Objectives and Generalizing Improvements to Everyday Life

The treatment outcomes targeted varied widely across previous cognitive remediation studies. This is a crucial issue when proposing specific, measurable, achievable, realistic/relevant, and timed *therapeutic objectives* (i.e., the SMART method, Bovend'Eerdt et al., 2009) in clinical interventions. The aim of cognitive remediation should bet to improve the targeted cognitive functions but also to generalize this progress to other cognitive abilities and real-life situations (Vance et al., 2017). Most previous studies succeeded in improving retrained cognitive functions, but none of them directly tested the real impact of this improvement on everyday life behaviors. This could explain the inconsistent results obtained for treatment outcomes, which mostly relied on this transfer to practical situations. Clinicians should bear in mind that the ultimate goal of cognitive remediation in SUDs is to restore efficient cognitive functioning outside the clinical context, notably to maintain abstinence. Beyond the question pertaining to the direct efficacy of the intervention (i.e., is cognitive remediation improving performance in the trained tasks?), clinicians should also address three questions: will the cognitive improvements obtained through neuropsychological training (1) be transferred to other cognitive abilities and to everyday life behaviors?; (2) persist in time, at least long enough to help the patient in the early stages of abstinence or consumption reduction?; and (3) have a real impact on clinical involvement (e.g., by increasing patient's motivation or treatment adherence) and/or on targeted therapeutic outcomes (e.g., reducing craving, limiting consumption or maintaining abstinence)? In other words, cognitive remediation should be conceptualized as a way to achieve clinical outcomes rather than as an objective per se. For example, beyond wondering whether the patient's performance is increased during an inhibition task after training, we should wonder whether the training increased the patient's ability to exert cognitive control to refrain from urges when confronted with the substance (Sofuoglu et al., 2013). Such questions are relevant when choosing the type of neuropsychological approach, even before selecting the cognitive functions targeted. The most often used approach in experimental studies exploring the efficacy of cognitive remediation in SUDs is the "drill and practice approach" (i.e., repeated training on exercises focused on a specific cognitive function, Nardo et al., 2022). While this approach appears to be effective in improving cognitive abilities and is easily implementable, particularly for patients with severe cognitive impairments or psychopathological comorbidities, its transferability to real life and subsequent treatment outcomes may be limited compared to internal or external strategy-based approaches (Lambez & Vakil, 2021; Porter et al., 2013). Complementing cognitive remediation with interventions (e.g., metacognitive training, Caselli et al., 2018) could also favor such a transfer by increasing patients' abilities to gain a more global perspective and to apply the improved cognitive abilities to other contexts.

Discussion

We pointed out five key questions that each researcher and clinician should reflect on when implementing cognitive remediation, beyond the selection of the more efficient tools (which can be conducted on the basis of the review proposed by Nardo and colleagues). The objective of this paper was neither to propose turnkey practical guidelines to implement cognitive remediation in SUDs, nor to present a gold-standard and comprehensive neuropsychological tool, which appears premature in view of the available literature. We rather aimed at providing researchers and clinicians with a clear identification of the main issues to be addressed in order to bridge the gap between current experimental evidence and actual clinical practice. In line with what has been conducted in other psychiatric disorders (e.g., Kim et al., 2018; Vander Zwalmen et al., 2022), we offer the first insights regarding the conditions in which cognitive remediation might be useful in SUDs, namely how it could be integrated in the overall treatment scheme and therapeutic objectives related to these disorders, to which patients it may benefit, and with which timing and hierarchy across cognitive functions it should be built. As cognitive remediation has been used for decades in other psychiatric or neurological conditions, clinicians and researchers interested in its implementation in SUDs could benefit from the recent guidelines and recommendations developed in these neighboring fields (e.g., Bowie et al., 2020; Julien et al., 2023; Vita et al., 2022).

Before concluding, three major perspectives are worth mentioning. First, the vast majority of the studies reviewed by Nardo and colleagues focused on inpatients. SUDs treatment is obviously not limited to hospital contexts, and the issues identified in the present paper are applicable to other treatment settings (e.g., daycare centers, ambulatory psychological or psychiatric care). Moreover, despite the current lack of available evidence regarding the use of cognitive remediation among other populations presenting SUDs, neuropsychological tools might be of interest beyond the populations targeted by most previous studies (i.e., recently detoxified inpatients). Cognitive remediation could notably be proposed as a prophylactic intervention for at-risk groups (e.g., adolescents with excessive substance use, because starting cognitive remediation as early as possible

in the disorder's course increases its efficacy (Bellani et al., 2019)), as an outreaching program (e.g., in non-treatment seeking individuals with long-term excessive and chronic use), or as a follow-up approach (e.g., in long-term abstinent individuals with remaining cognitive impairments). The questions raised and proposed approaches discussed here are also relevant for practitioners working outside hospital contexts, even though data are currently lacking in SUDs to definitely state how, when, and for whom cognitive remediation would maximize its efficacy on clinical outcomes. The efficacy conditions may also vary according to the substance used, as the currently limited evidence suggests that cognitive remediation would have higher impact on relapse in opioid and polysubstance use disorders (e.g., Fals-Stewart & Lam, 2010; Rezapour et al., 2019) than among cannabis or ketamine users (e.g., Man, 2020; Rass et al., 2015; Stanger et al., 2020).

Second, Nardo and colleagues only mentioned studies using classical neuropsychological approaches (i.e., paper-and-pencil or computerized behavioral tasks). However, other tools to improve cognitive abilities in patients with SUDs have recently emerged. These include pharmacological treatments (Sofuoglu et al., 2013), physical activity (Cabé et al., 2021), mindfulness (Witkiewitz et al., 2014), and neuromodulation approaches (Franken & van de Wetering, 2015), which increase cerebral functioning and hence boost the related cognitive abilities. Importantly, it has been suggested that neuromodulation techniques could optimize the efficiency of cognitive remediation (e.g., Bollen et al., 2022a), which raises new perspectives for combined interventions.

Third, Nardo and colleagues focused their review on studies exploring the remediation of classical cognitive functions. However, influential frameworks (e.g., the Addictions Neuroclinical Assessment; Kwako et al., 2016) underlined that SUDs are also characterized by impairments in two other key functional domains, namely (1) the *incentive salience system*, which is related to craving and the preferential processing of substance-related stimuli (attentional/approach biases, e.g., Coskunpinar & Cyders, 2013); and (2) the *negative emotionality system*, which relates to negative affective responses and psychopathological comorbidities (e.g., depressive or anxious symptomatology), but also to impaired social cognition, defined as the efficient perceptions, interpretations, and reactions to social signals, a key faculty for efficient and positive interpersonal relations (Pabst et al., 2022). Cognitive remediation approaches have also been developed for these two other systems (e.g., Verdejo-Garcia et al., 2023) and should be considered by clinicians, notably because of the central role played by these deficits in SUDs (e.g., Bollen et al., 2022b; Sliedrecht et al., 2019).

We thus believe that cognitive remediation, encompassing classical cognitive functions as well as incentive salience and negative emotionality systems, still holds promise to improve SUD treatment. Future studies should explore the extent and conditions of the efficacy of cognitive remediation, which may be included in gold-standard neuropsychological programs (potentially combined with neuroscience tools) targeting key cognitive functions to improve treatment outcomes. Nevertheless, the most important claim of our paper is that practitioners should not wait for these ideal programs to emerge before applying cognitive remediation for patients with SUDs. In a more proactive approach, we believe practitioners can already apply the imperfect existing tools, providing that they first take up the five challenges we presented by addressing the practical issues to ensure coherent implementation and optimal efficacy.

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