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Motivational Interviewing combined with chess accelerates improvement in executive functions in cocaine dependent patients: A one-month prospective study

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ABSTRACT

Background: In cocaine-dependent individuals, executive function (EF) deficits are associated with poor treatment outcomes. Psychological interventions and pharmacological approaches have produced only modest effect sizes. To date, studies of this topic have been few and limited. The aim of this study was to examine the effects of a new model of intervention, which integrates chess and Motivational Interviewing, Motivational Chess (MC)
Methods: We evaluated 46 cocaine-dependent inpatients (aged 18–45), in two groups—MC ($n = 26$); and active comparison—AC ($n = 20$). Using neuropsychological tests and an impulsivity scale, we assessed the subjects before and after the study period (one month of abstinence monitored by urine toxicology screening).
Results: The MC and AC groups did not differ at baseline. In the post-intervention assessment (after one month), both groups showed significant improvements in attention, mental flexibility, inhibitory control, abstraction abilities, and decision-making ($p < 0.01$). In addition, the improvement in working memory was more significant in the MC group than in the AC group (group-by-time interaction, $p = 01$).
Conclusions: One month of abstinence was sufficient to improve various attentional and executive domains in cocaine-dependent subjects. The MC intervention was associated with greater improvements in EFs, especially working memory, suggesting that tailored interventions focusing on complex EFs accelerate the process of cognitive recovery during the initial period of abstinence.
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1. Introduction

Cocaine Dependence (CD) is associated with neurobiological changes in the prefrontal cortex (PFC; Tomasi et al., 2007), impulsivity, and executive function (EF) deficits (Cunha et al., 2013; Noël et al., 2013; Cunha et al., 2011; Verdejo-Garcia et al., 2007). Executive functioning is defined as the complex ability of a person to

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respond in an adaptive manner to new situations, depending on a variety of executive domains such as motivation, working memory, and inhibitory control (Lezak et al., 2004). It is therefore unsurprising that EF deficits have a significant negative impact on how an individual functions in daily life (Cunha et al., 2011), as well as on treatment retention in CD patients (Verdejo-Garcia et al., 2012; Aharonovich et al., 2003). Therefore, interventions focusing on the rehabilitation of EF in such individuals are of great interest. Nevertheless, there are few data on the neuropsychological rehabilitation of patients with CD (Sofuoglu et al., 2012).

To the best of our knowledge, there have been only three studies of this topic: two focused on the use of cognitive rehabilitation system computer programs known as PSSCogRehab (Bickel et al., 2011; Fals-Stewart and Lam, 2010); and one combined goal management training with mindfulness meditation (Alfonso et al., 2011). All three of those studies demonstrated some improvement in selective attention, inhibitory control, decision-making, delay discounting, and working memory (Alfonso et al., 2011; Bickel et al., 2011; Fals-Stewart and Lam, 2010). However, abstinence from substance use could not be confirmed, because urine toxicology screening was not used in any of the three studies. In addition, those studies were conducted in different settings and with heterogeneous samples (e.g., including patients with comorbid opioid dependence), thus making it difficult to generalize their findings (Fals-Stewart and Lam, 2010). Furthermore, the lack of an active comparison group might have biased some of the results (Alfonso et al., 2011).

Given the increasing prevalence of cocaine dependence in developing countries (Brazilian Psychiatry Association, 2012), together with the relevance of a neurocognitive system that reinforces drug-related behaviors (Noël et al., 2013), there is a need for treatments involving simple strategies that effectively improve cognition in addicted patients. Therefore, we developed a new intervention to stimulate EF in CD patients, named "Motivational Chess" (MC). MC consists of the combination of Motivational Interviewing (MI) with the game of chess. MI is a psychologically based treatment designed for addicted patients that helps them change their maladaptive behaviors by focusing on the various stages of motivation (Stein et al., 2009; Miller and Rollnick, 2002). From a neuropsychological perspective, motivation plays a crucial role in EF because it is a necessary precondition for behavioral adaptation (Lezak et al., 2004). On the other hand, there is some evidence that playing chess may improve certain cognitive functions, especially EF and planning, which could have an impact on coping abilities as well (Aciego et al., 2012, Unterrainer et al., 2006). In healthy individuals, playing chess has been associated with increased prefrontal cortex activation in areas related to EF (Atherton et al., 2003; Nichelli et al., 1994). Practicing chess for four weeks (ten sessions) has been shown to improve executive function in patients with schizophrenia (Demily et al., 2009). Although it is assumed that chess-related planning abilities are generalizable to other cognitive domains, one study showed that not be the case (Unterrainer et al., 2011), one possible explanation being that the participants in that study (experienced chess players without psychiatric disorders) were not taught how to generalize those abilities to real-life situations. Keeping this in mind, in our study we used MI to focus on: (1) generalization of the learned abilities to daily life (for example: the patient was able to plan a strategy anticipating three moves, the coordinator tried to link these to the steps they need to take to prevent relapse); (2) to enhance participation through facilitating intrinsic motivation and consequently leading to active group participation.

The objective of the present study was to examine cognitive functions during one month of monitored abstinence, and also to investigate the additional effect of our new intervention (MC) in cocaine-dependent subjects.

2. Methods

2.1. Participants and ethical aspects

Forty-six cocaine-dependent subjects (37 men and 9 women) were included in this study between April, 2011 and January, 2014. Participants were recruited from among patients enrolled in a four-week standard inpatient program for the treatment of cocaine dependence, which requires hospitalization on the impulsive behavior ward of the Psychiatry Institute at the University of São Paulo School of Medicine *Hospital das Clínicas*, in the city of São Paulo, Brazil. We applied the following inclusion criteria: having received a diagnosis of cocaine dependence; being between 18 and 45 years of age; and having had a minimum of four years of formal education. The diagnosis of cocaine dependence was established through the use of the structured clinical interview for Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Axis I disorders, together with a semi-structured interview (the sixth version of the Addiction Severity Index). We excluded subjects diagnosed with an Axis I psychiatric disorder, including schizophrenia, dementia, major depressive disorder, and bipolar disorder, as well as those with a history of head trauma (loss of consciousness for more than 1 h) or other neurological problems, those with an estimated intelligence quotient < 70, and those with any medical condition that impairs the central nervous system. Additional participant characteristics are provided in Table 1. The study was approved by the local Research Ethics Committee, and it was registered in ClinicalTrials.gov NCT01914835. All participants were volunteers and gave written informed consent.

2.2. Study protocols

Urine toxicology screening was used as an objective measure of recent cocaine use and abstinence. At enrollment, all participants tested positive for the cocaine metabolite benzoylecgonine in urine samples. After the urine test became negative for cocaine metabolites (mean time in days: 9.00 ± 2.99), we performed the pre-assessment (T0), using a battery of cognitive tests (see Section 2.3). Subjects were assigned to engage in monitored chess practice (MC group) or in active comparison (AC group). The participants underwent 10 sessions of group intervention (MC or AC) for approximately three weeks, 90 min each [total 15 h = 10 h of monitored chess practice (MC) or recreational activities (AC) + 5 h of MI for both MC and AC]. At the end of the intervention (approximately one month after enrollment), if the urine test remained negative (100% of all subjects), we performed the post assessment (T1) using the same battery of cognitive tests applied at pre-assessment. There were four different periods in which we decided to alternate the types of intervention (MC or AC), starting with MC intervention, then the Active Control group, the MC intervention again and the Active Control group (MC–AC–MC–AC).

2.3. Instruments

In the pre and post-intervention assessments, we employed the following neuropsychological instruments, in order to assess the various cognitive domains: the Trail Making Test, part B (selective attention; Cunha et al., 2004; Lezak et al., 2004); the Stroop Color-Word Test (inhibitory control; Cunha et al., 2010; Lezak et al., 2004; Stroop, 1935); the Wechsler Memory Scale-third edition (WMS-III) Digit Span Backward task (verbal working memory; Wechsler, 1997); the Wisconsin Card Sorting Test (abstract reasoning; Cunha et al., 2010; Heaton et al., 2005); the Iowa Gambling Task (decision making; Cunha et al., 2011; Bechara et al., 1994); and the Barratt Impulsiveness Scale, version 11 (Malloy-Diniz et al., 2010; Patton et al., 1995).

2.4. Motivational Chess (MC group)

This intervention consisted of two parts. The first part consisted of a "training or practice session", followed by the second part, characterized by the inclusion of "Motivational Interviewing".

2.4.1. Training or practice session which consisted of 1h of monitored chess-practice see author instruction. At the beginning of each monitored chess practice session, the coordinator (a therapist) divided the MC group participants into pairs (typically three to four pairs). Each participant was given a sheet listing the rules of the game, which served as a memory aid. During the practice session, the coordinator considered subject knowledge regarding the rules of chess, ability to follow those rules, and visual perception of the pieces, in order to steer the participants toward goal-directed behaviors. For example, the coordinator encouraged the participants to "stop and think" before making a decision, analyzing the short- and long-term consequences of a given move. In addition, the coordinator used empathic communication to help subjects deal with their own resistance to change in order to adapt to new and challenging situations. It is of note that, throughout the rehabilitation process, the subjects were encouraged to change partners periodically, in order to promote cognitive flexibility.

2.4.2. Motivational Interviewing. In the last 30 min, the coordinator focused on teaching subjects the skills needed in order to generalize the newly learned abilities to their daily lives (e.g., subjects were able to plan a given strategy thinking three moves ahead, and the coordinator tried to link those moves to the steps

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