Drug and Alcohol Dependence 178 (2017) 150–158

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Full length article

Cognitive remediation improves executive functions, self-regulation and quality of life in residents of a substance use disorder therapeutic community

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ARTICLE INFO

Keywords:
Cognitive remediation
Executive functions
Self-regulation
Substance use disorder
Therapeutic community

ABSTRACT

Background: Executive dysfunction is common in substance use disorder (SUD) populations and hinders treatment. We previously found that 50% of residents in SUD therapeutic communities had been hospitalized for head injuries; this was a significant determinant of cognitive impairment. The current study aimed to establish whether cognitive remediation improves executive functions (EFs) and self-regulation in an ecologically valid sample of female residents attending SUD therapeutic community treatment, including those with past head injuries and psychiatric comorbidities.

Methods: Controlled sequential groups design with residents (N = 33, all female) receiving treatment as usual (TAU). The intervention group (n = 16) completed four weeks of cognitive remediation (CR) and the control, TAU only (n = 17). Outcome measures assessed pre- and post-intervention included both performance- and inventory-based measures of EFs, and self-reported self-regulation and quality of life.

Results: CR relative to TAU significantly improved performance-based assessment of inhibition (Color-Word Interference Test; F = 4.29, p = 0.047), inventory-based assessment of EFs (Behavior Rating Inventory of Executive Function – Adult Version: Global Executive Composite; F = 6.38, p = 0.017), impulsivity (Barratt Impulsiveness Scale; F = 4.61, p = 0.040), self-control (Brief Self-Control Scale; F = 5.53, p = 0.026), and quality of life (Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form; F = 7.68, p = 0.010).

Conclusions: Findings suggest that CR improves EFs in a heterogeneous sample of female residents in therapeutic community SUD treatment. Future research may explore the possibility of tailoring CR interventions for various SUD subgroups.

1. Introduction

Self-regulation is a protective factor in ameliorating many social and mental health problems and is understood as the capacity "to make plans, choose from alternatives, control impulses, inhibit unwanted thoughts and regulate social behavior" (Heatherton and Wagner, 2011). Individuals in residential rehabilitation treatment for substance use disorders (SUDs) must possess some capacity for self-regulation in order to meaningfully engage in treatment and ultimately change their behavior. This is particularly true of therapeutic community treatment (Vanderplasschen et al., 2013), which entails significant social participation and shared responsibility for activities of daily life.

Cognitive deficits are one of the four biggest risk factors for dropout from SUD treatment (Brorson et al., 2013), and executive function (EF) impairment is commonly observed in individuals experiencing SUDs (Fernández-Serrano et al., 2010; Hester et al., 2010). Diverse definitions of EFs exist (Friedman and Miyake, 2017) but they are broadly understood as "those capacities that enable a person to engage successfully in independent, purposive, self-directed, and self-serving behavior" (Lezak et al., 2012). An influential threefold model of EFs includes 'working memory', 'inhibition', and 'shifting' (Miyake et al., 2000). Working memory refers to the capacity to monitor and alter information held in mind temporarily, inhibition involves overriding an unwanted distraction to maintain task-focus, and shifting pertains to flexibly switching attention between tasks or mental sets (Hofmann et al., 2012). These basic EFs are intricately linked to and may subserve effective self-regulation (Hofmann et al., 2012).

Individuals in residential treatment for SUDs often have psychiatric

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http://dx.doi.org/10.1016/j.drugalcdep.2017.04.023
Received 27 September 2016; Received in revised form 11 April 2017; Accepted 16 April 2017
Available online 16 June 2017
0376-8716/

and medical comorbidities, including history of head injury. For example, we previously found that 67.2% of residents in SUD therapeutic community treatment (70.3% male) had sustained one or more head injuries, while 50% required hospitalisation following a head injury (Marceau et al., 2016). History of head injury was a significant determinant of cognitive impairment and was associated with higher levels of psychological distress. Psychiatric comorbidities are also frequently observed in SUD populations and add further complexity to the process of addiction recovery (Baingana et al., 2015). Personality disorders are particularly prevalent (e.g., Pennay et al., 2011) and are not only associated with global neurocognitive and specific EF deficits, (Fertuck et al., 2006; Ruocco and Carcone, 2016; Unoka and Richman, 2016), but also with dropout from SUD treatment (Brorson et al., 2013).

Given the high rates of head injury and psychiatric comorbidities in SUD populations, and the positive relationship of these variables with cognitive impairment, the application of evidence-based neuropsychological interventions designed for use in both brain injury (usually referred to as cognitive rehabilitation) and mental health (usually referred to as cognitive remediation) populations might be expected to result in reductions of cognitive impairment, and potentially lead to better SUD treatment outcomes. It has been recommended that these interventions be adapted for use in SUD treatment populations (Bates et al., 2013a) and there have been a number of attempts at this to date (e.g., Alfonso et al., 2011; Bickel et al., 2011; Houben et al., 2011; Valls-Serrano et al., 2016a).

Neuropsychological interventions for SUD populations have tended to adopt either a drill and practice (e.g., Houben et al., 2011) or strategy-based (e.g., Valls-Serrano et al., 2016a) approach. To our knowledge, there are no published studies incorporating a combined approach that utilises both domains. The cognitive remediation literature within psychiatry has suggested that whilst drill and practice approaches (e.g., computerized cognitive training) may lead to greater gains on cognitive test scores, strategy-based training (e.g., instruction in specific strategy use) leads to greater functional outcomes for individuals with schizophrenia (Paquin et al., 2014; Wykes et al., 2011). Combining approaches in an SUD population may result in greater gains across a range of measures. This study aimed to determine the effectiveness of a cognitive remediation intervention that incorporated both drill and practice and strategy-based training for a treatment seeking SUD population, inclusive of those with psychiatric and head injury comorbidities.

Assessment of EFs may be performance- (i.e., assessing performance on working memory, inhibition, and shifting tasks) or inventory-based (i.e., based on self-reports of executive functioning). Whilst performance-based measures of EFs are sensitive to brain impairment that implicates the frontal lobes (Jurado and Rosselli, 2007), some may demonstrate limited ecological validity and may not capture problems with everyday functioning as well as inventory-based measures (Isquith et al., 2013). Inventory- and performance-based measures of EFs are minimally correlated and may assess distinct components of EFs that contribute independently to clinical problems (Toplak et al., 2013). For example, to determine the relative sensitivities of performance- and inventory-based EFs measures in an SUD treatment population, Hagen et al. (2016) showed that inventory-based assessment using the Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A; Roth et al., 2005) better distinguished polysubstance users from controls and was more strongly associated with real-world social adjustment outcomes compared to performance-based measures, which included the Iowa Gambling Task (Bechara et al., 1994), the Trail-Making Test (Strauss et al., 2006), and the Stroop test (Golden, 1978). In light of these findings and to provide a more comprehensive assessment of EFs, the current study included both performance- and inventory-based measures.

The current study aimed to examine the effectiveness of cognitive remediation vs. treatment-as-usual (TAU) in: (1) improving performance- and inventory-based measures of EFs and (2) improving self-report measures of self-regulation. Quality of life was included as a secondary clinical outcome measure, as it plays an important role in sustained remission from SUDs (Laudet et al., 2009). We hypothesized that cognitive remediation would be effective in improving EFs, self-regulation, and quality of life.

2. Methods

2.1. Participants

Fifty participants were recruited from a women's residential treatment facility in Sydney run by We Help Ourselves (WHOs) – a large provider of residential SUD rehabilitation in Australia, utilising the Therapeutic Community model of treatment. Inclusion criteria for the study were: (i) diagnosis of substance abuse/dependence, based on DSM-IV-TR criteria, assessed using the Mini-International Neuropsychiatric Interview (MINI-Plus; Sheehan et al., 1998), (ii) a minimum abstinence period of 7 days (with confirmation of detoxification a prerequisite of entry to treatment), (iii) absence of any neurological, infectious, or other disease affecting the central nervous system (e.g., epileptic seizures, stroke, brain tumour, meningitis, encephalitis, multiple sclerosis, HIV positive), and (iv) English as native language. A condition of staying at the residential facility is that participants remain abstinent from substances of abuse and this is monitored through routine urinalysis (random resident checks occurring several times per week) and 24-h observation from experienced staff and co-residents.

2.2. Diagnostic and clinical assessment

Diagnostic and clinical assessment at baseline included the following: Psychiatric comorbidities (DSM-IV-TR) were assessed using the MINI-Plus and Standardised Assessment of Personality – Abbreviated Scale (Moran et al., 2003), as shown to be appropriate for SUD populations (Gonzalez, 2014; Hesse and Moran, 2010; Hesse et al., 2008). Questions were adapted from the Addiction Severity Index – Fifth Edition (ASI; McLellan et al., 1992) to assess lifetime substance use history. Additionally, a brief semi-structured interview was used to assess history of head injury. The Test of Premorbid Functioning (TOPF; Pearson Assessment, 2009) was used to estimate overall level of intellect.

2.3. Outcome measures

2.3.1. Executive functions – performance-based

2.3.1.1. Working memory: Working Memory Index (WMI; Wechsler Adult Intelligence Scale, fourth edition: WAIS-IV; Wechsler, 2008). The WMI of the WAIS-IV assesses components of working memory and is comprised of 2 subtests, which were administered according to standard instructions. The digit span subtest requires participants to recall various sequences of numbers (forward, backward, and in sequence) and the arithmetic subtest involves participants solving numerical problems within 30 s, after they have been read aloud by the examiner. The subtest scores were summed to yield a total score, which was then scaled to provide an index score, as per standardized scoring instructions.

2.3.1.2. Inhibition: Color-Word Interference Test (Delis-Kaplan Executive Function System: D-KEFS; Delis et al., 2001). This subtest of the D-KEFS assesses response inhibition and provides an auxiliary measure of shifting. Participants are instructed to read the items presented in each of four conditions as quickly and accurately as possible. Performance is measured in time (seconds). The first condition presents patches of colours and requires participants to name the colours. The second condition presents the words "red", "blue", and "green" and requires participants to read the words. The third condition