



Self-regulation and treatment retention in cocaine dependent individuals: A longitudinal study

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ABSTRACT

Background: We aimed to explore the association between baseline executive functioning and treatment outcome in Therapeutic Communities (TCs).

Methods: We used a longitudinal descriptive design: a baseline neuropsychological assessment was performed within the first 30 days of treatment in TCs. Once participants finished or abandoned treatment, the information about time of stay in treatment was computed for each individual. The study was conducted across six TCs located in the region of Andalusia (Spain): Cartaya, Almonte, Mijas, Los Palacios, La Línea, and Tarifa. Participants were 131 patients with cocaine dependence who initiated and finished treatment in TCs between January 2009 and December 2010 (2 years). Cognitive assessment was composed of general measures of executive functioning: Letter Number Sequencing (working memory) and Similarities (reasoning), and executive tasks sensitive to ventromedial prefrontal cortex dysfunction, including the Delis–Kaplan Stroop test (inhibition/cognitive switching), the Revised-Strategy Application Test (strategy application/multitasking), and the Iowa Gambling Task (decision-making). The outcome measure was retention, defined as time in TC treatment (number of days).

Results: Poor executive functioning significantly predicted shorter treatment retention in cocaine dependent individuals on TC residential treatment (14% of explained variance). Reduced performance on the R-SAT, a multitasking test taxing the ability to develop and apply the best strategy to organize multiple sub-routine tasks in order to achieve a long-term goal, was the most powerful predictor of treatment retention.

Conclusions: Self-regulation deficits predict the capacity to remain in residential treatment among cocaine dependents.

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1. Introduction

Addiction is currently conceptualized as a chronic, often relapsing brain disorder that causes compulsive drug use despite harmful consequences to the addicted individual (National Institute of Drug Abuse, 2011). Cocaine and heroin dependence are considered brain disorders in light of evidence of drug-related neuroadaptations in brain systems that are critical for executive control of behavior, with particular relevance of the ventromedial prefrontal cortex, including the medial orbitofrontal cortex, frontal pole, and adjacent anterior cingulate regions (Alia-Klein et al., 2011; Franklin

et al., 2002; Langleben et al., 2008; Tanabe et al., 2009). The orbitofrontal cortex is primarily involved in reward-based updating of representations of the affective value of reinforcers (Buckley et al., 2009; Kringelbach, 2005), and therefore it plays a key role in driving behavior according to long-term goals or delayed reinforcers (Bechara, 2005; Sellitto et al., 2010). Adjacent anterior frontal regions, such as the anterior cingulate cortex and medial aspects of the frontopolar cortex (Bechara, 2004), are also relevant to set and follow plans and rules (and inhibiting competitive responses) in order to achieve long-term goals and intentions (Burgess, 2010; Dreher et al., 2008). Although often elusive, the cognitive deficits associated with ventromedial prefrontal cortex dysfunction include strategy application, cognitive switching, and decision-making (Levine et al., 1998; Tranel et al., 2007; Zald and Andreotti, 2010), which are thought to hinder substance use behavior change (Blume and Marlatt, 2009). The persistence of these

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deficits may contribute to explain that efforts to develop effective treatment interventions for cocaine and heroin dependence have been frequently unfulfilling (Faggiano et al., 2003; Knapp et al., 2007). Therapeutic communities are one of the most popular treatments for the rehabilitation of drug users in Europe and the United States. Although there is little evidence that TCs offer significant benefits with respect to other psychosocial interventions, there is substantial support to the notion that residential treatment (versus day treatment), and longer retention in treatment are robustly associated with reduced attrition and higher abstinence rates (Simpson et al., 1999; Smith et al., 2006). Therefore, one of the key questions to address in order to improve addiction treatment outcomes is that of which individual differences among addicted individuals are able to predict longer retention in TC treatment.

There is a vast literature about predictors of treatment outcome in cocaine and heroin dependence; relevant predictors can be grouped into socio-demographic factors (such as gender, age, employment or marital status), clinical factors (such as polydrug use, severity of addiction, or comorbid psychopathology), and psychological factors (such as impulsive personality, motivation for treatment, or craving) (Reske and Paulus, 2008). However, none of these factors are by themselves or in combination compelling enough to predict addiction treatment outcomes, so that in the last years there has been a burgeoning interest in using cognitive performance indices to improve prediction of outcomes. As compared to other sources of prediction, cognition offers several advantages, including the assumption that it is more closely associated with the brain neuroadaptations that define the chronic relapsing nature of addiction (Paulus et al., 2005; Sinha et al., 2006), and the evidence that it is able to predict several other factors that impact on treatment outcomes, such as severity of drug use, employment problems or psychiatric comorbidities (Verdejo-García et al., 2006). Accordingly, available studies have shown that cognitive measures, specifically, executive function tests, can significantly predict clinical outcome in cocaine and heroin dependent patients. A range of studies have shown that general measures of cognitive functioning, and specific probes of response inhibition (the Stroop test) and switching (the Wisconsin Card Sorting Test) significantly predict treatment completion in cocaine outpatients (Aharonovich et al., 2003, 2006; Streeter et al., 2008; Turner et al., 2009). Similarly, Passeti et al. (2008) showed that decision-making performance (measured by two different probes using the Iowa Gambling Task and the Cambridge Gamble Task) predicted 3-month relapse in opiate users on community treatment and substitution pharmacotherapy.

The aim of this study was to further explore the association between baseline cognitive functioning and treatment outcome by introducing a number of relevant novelties related to the cognitive testing, and to the population and treatment settings examined. With respect to the cognitive battery, we introduced a number of neuropsychological measures thought to be: (i) more sensitive to probe ventromedial prefrontal cortex related dysfunction (Cato et al., 2004; Li et al., 2010; Levine et al., 1998, 2000), and (ii) more ecologically valid in terms of prediction of adverse life events in addicted individuals (Verdejo-García et al., 2006, 2007). With respect to the treatment setting, we chose to examine outcomes in TCs, which offered a number of methodological advantages above other settings, including the rigorous systematic control of illicit drug-taking and the guaranteed follow-up of all participants. Our targeted sample was formed by patients diagnosed with cocaine dependence, many of which also had regular use of heroin. This substance use pattern was representative of the majority of individuals requesting treatment for drug-related disorders in Europe and the US (EMCDDA Statistical Bulletin, 2010; SAMHSA Treatment Episode Data Set, 2007), a makeup that increased the clinical significance of potential findings. Our main hypothesis was that poor

executive control functioning, especially on tests sensitive to ventromedial prefrontal cortex dysfunction, will be associated with shorter treatment retention in TC.

2. Methods

2.1. Design

Longitudinal descriptive. A baseline neuropsychological assessment was performed within the first 30 days of treatment in Therapeutic Communities (TCs). Once participants finished or abandoned treatment, the information about time of stay in treatment was computed for each individual.

2.2. Participants

The targeted population consisted of individuals with a diagnosis of cocaine dependence that initiated and finished treatment in TCs between January 2009 and December 2010 (2 years). To obtain the sample, we defined the sampling context of those patients with cocaine use related disorders who entered treatment on six different TCs located in the region of Andalusia (Spain): Cartaya, Almonte, Mijas, Los Palacios, La Línea, and Tarifa. The six TCs belong to the regional public health care system dedicated to addiction problems, and they all have a common treatment program, based on multidisciplinary interventions including CBT, psychoeducation and occupational therapy, which was originally developed and periodically updated by a clinical committee—formed by clinicians from the different centers (Arenas et al., 2003). Cocaine dependent patients are referred to these TCs from outpatient clinics coordinated by the same public health care network; the main reasons for referral are (i) inability to maintain abstinence during outpatient treatment, and/or (ii) clinicians' or patients' perception of the need of more continuous and intensive treatment. Admissions to TCs are always voluntary, and the allocation of the patients to the different centers is managed by a central computerized information system (<https://www.sipasda.info/>), which allocates the applicants mainly as a function of space availability.

During the sampling period, between January 2009 and December 2010, a total number of 322 individuals with cocaine use related disorders initiated treatment in these TCs; 286 of these individuals stayed in the TCs for more than 15 days—this was the minimum time of controlled abstinence required to enter the study. The main inclusion criteria to enter the study were: (1) meeting DSM-IV-TR criteria for cocaine dependence, and (2) being able to understand tests instructions and perform the neuropsychological assessment. DSM-IV-TR criteria were determined by the Spanish version of the Psychiatric Research Interview for Substance and Mental Disorders (Torrens et al., 2004). Participants meeting criteria for nicotine dependence or alcohol abuse (but not dependence) were also included. In addition, participants had to meet a minimum abstinence of 15 days; this interval was chosen to avoid potential effects of acute intoxication or withdrawal symptoms on cognitive performance. The mean duration of abstinence at the time of testing was 33.9 days (SD = 21.6). Sixty percent of the patients initiating treatment met these inclusion criteria ($n = 172$). All these patients were invited to participate in the study, but seven of them refused after reading the explanatory statement. The final sample was formed by 165 patients, of which 131 had finished treatment before December 2010. The remaining 34 patients were still following treatment by December 2010, and therefore they were not included in this study. The distribution of participants by treatment site was: 24.4% from TC Los Palacios, 20.6% from TC Tarifa, 20.6% from TC La Línea, 16.8% from TC Almonte, 13.7% from TC Cartaya, and 3.8% from TC Mijas.

2.3. Instruments

2.3.1. General indices of executive functioning. Working memory: Letter Number Sequencing (LNS) (Wechsler, 1997): Participants were read a sequence in which letters and numbers are combined, and were asked to reproduce the sequence heard, first placing the numbers in ascending order and then the letters in alphabetical order. The dependent variable from this test was the total number of correct items.

Analogical reasoning: Similarities (Wechsler, 1997): Pairs of words describing common objects or concepts were read, and participants had to indicate how these objects/concepts are similar or what they have in common. The dependent variable from this test was the number of correct items.

2.3.2. Tests sensitive to ventromedial prefrontal cortex functioning. Response inhibition and switching: Stroop Color-Word Interference Test (CWIT, Delis et al., 2001): We used this paper and pencil version of the Stroop test based on lesion evidence showing its discriminative validity to detect performance deficits associated with ventromedial prefrontal damage (Cato et al., 2004). This test has also shown adequate reliability, and construct validity for the assessment of inhibition and switching skills (Delis et al., 2001). The test consists of four different parts, each containing 50 items. Part 1 (Color Naming) presents patches of colors, and participants had to name them as quickly and accurately as possible. Part 2 (Reading) presents the words "red," "blue" and "green" printed in black ink, and participants had to read aloud these words. Part 3 (Inhibition) introduces the interference effect: the words "red," "blue" and "green" are printed in incongruent colors ink, and participants had to name the color and ignore the word. Part 4 (Switching) has similar items to Part 3,

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