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Cognition and impulsivity in adults with attention deficit hyperactivity disorder with and without cocaine and/or crack dependence

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ABSTRACT

Background: Substance use disorder (SUD) is a common comorbidity in adults with attention deficit-hyperactivity disorder (ADHD). However,there have been few studies on cognitive profiles of these patients. Impulsivity is also commonly increased in both disorders. The central aim of this study was to compare cognition and impulsivity in subjects who had ADHD and cocaine dependence (ADHD + COC group) to those with ADHD only (ADHD-noSUD group). We hypothesized that the ADHD + COC group would show more marked cognitive dysfunction and greater impulsivity than their counterparts with ADHD only.

Methods: A total of 70 adult patients diagnosed with ADHD according to (DSM-IV-TR) criteria were enrolled; 36 with ADHD + COC and 34 with ADHD-noSUD. All study participants were evaluated with a sociodemographic questionnaire; the Mini International Neuropsychiatric Interview; the Adult ADHD Self-Report Scale; the Addiction Severity Index; the Alcohol, Smoking and Substance Involvement Screening Test; the Barratt Impulsiveness Scale; and a comprehensive neurocognitive battery.

Results: Compared to individuals with ADHD-noSUD, ADHD + COC individuals had significantly lower mean IQ and higher motor impulsivity. On average, the ADHD + COC group also performed more poorly on tasks assessing verbal skills, vigilance, implicit learning during decision making, and ADHD-noSUD performed more poorly on selective attention, information processing, and visual search.

Conclusions: Our results support the integrative theory of ADHD based on the cognitive and affective neuroscience model, and suggests that ADHD-noSUD patients have impairments in cognitive regulation, while ADHD + COC patients have impairments in both cognitive and affective regulation.

1. Introduction

Attention deficit-hyperactivity disorder (ADHD) and substance use disorder (SUD) are common and often coexist in adults. The risk of developing cocaine (COC) abuse is two times higher in individuals with (vs. without) ADHD (Lee et al., 2011). The prevalence of ADHD is high among patients with COC dependence, reaching 23.1% (Van-Emmerick-Van Oortmerssen, 2012). Two recent studies of adults with COC dependence demonstrated considerable frequencies of comorbid ADHD: 20.5% (Pérez de los Cobos et al., 2011) and 25.0% (Daigre et al., 2013). Compared to their counterparts without ADHD, COC-dependent adults with ADHD are more severe in different aspects of the disorder: they initiated drug use at a younger age, were younger at first hospitalization, used COC more frequently or

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intensely, and were more likely to abandon treatments (Carroll and Rounsaville, 1993; Levin et al., 2007; Arias et al., 2008; Pérez de los Cobos et al., 2011).

Both patients with ADHD or SUD show deficits in executive function and high impulsivity and preference for immediate (versus delayed) rewards can promote drug addiction among individuals with ADHD (de Wit, 2009).

Studies of patients with both ADHD and SUD demonstrated cognitive impairments compared to those with ADHD alone or healthy controls. These include lower intelligence-quotient (IQ) scores, fewer years of education, as well as more marked deficits in working memory, verbal comprehension, perceptual organization, processing speed, and attention (Ginsberg et al., 2010; Bihlar Muld et al., 2013). On the other hand, COC-dependent patients with ADHD did not show differences in interference control (Stroop Test), time reproduction (visual time reproduction paradigm), attentional set-shifting (Trail Making Tasks A and B) and working memory (n-back Task) compared to their counterparts with ADHD only or healthy controls. Nevertheless, they had higher motor impulsivity with lower response inhibition (Stop Signal Task) and cognitive impulsivity (Delayed Discounting Test; Crunelle et al., 2013). Using the Barratt Impulsiveness Scale (BIS-11) Crunelle et al. (2013) also demonstrated higher attention impulsivity in the COC-dependent patients with ADHD compared to ADHD-only and healthy-control groups. Pérez de los Cobos et al. (2011), who compared patients with probable adult ADHD and concomitant COC dependence with COC dependence patients, reported that the former group had higher scores in the BIS-11 than the latter.

Two other studies investigated the impact of ADHD in COC use or dependence. Vonmoos et al. (2013), using a neuropsychological battery, observed that the presence of ADHD as a comorbidity either to recreational cocaine users or to dependent cocaine users worsened the scores of a global cognitive index in comparison to their counterparts without ADHD. Vergara-Moragues et al. (2011) used Barkley's Current Behavior Scale Self-Report to measure executive function in patients with COC dependence and ADHD, compared to COC dependence without ADHD.

The neuropsychological model proposed by Nigg and Casey (2005), considers that children with the ADHD-combined subtype have deficits in cognitive and affective control. This model posited that they have impairments in cognition related to executive control, in tasks that require prolonged effort and concentration. Such disruptions could weaken self-control (i.e., impaired cognitive regulation). In fact, a study showed that patients with ADHD or with SUD had deficits in executive function (Martínez-Raga and Knecht, 2012).

Nigg and Casey (2005) also suggested, however, that impairments in affective regulation, reward expectation, and delay aversion are observed in children with ADHD. These disruptions could lead to enhanced impulsivity and more marked emotional dysregulation (i.e., impaired affective regulation) in ADHD (Martel et al., 2009).

Although Nigg and Casey (2005) proposed their model in the context of childhood development, it seems to accommodate observations on adults with ADHD as well as SUD. One study has evaluated deficits in cognition and impulsivity in patients with both ADHD and COC dependence; but the study involved relatively small patient sample of ADHD and COC dependence ($n = 11$; Crunelle et al., 2013).

In order to address this knowledge gap, we undertook the present study to evaluate potential differences in executive function, verbal memory, and impulsivity between adults with ADHD and COC dependence (i.e., ADHD + COC group) or ADHD without substance use disorder (i.e., ADHD-noSUD group). We hypothesized that cognitive and emotional profiles would differ between the two groups, with the ADHD-noSUD group showing marked impairments in cognitive control and the ADHD + COC group exhibiting greater deficits in cognitive as well as emotional and motivational control.

2. Materials and methods

2.1. Participants

From May, 2010 through October, 2012, we included 70 patients with ADHD according to criteria from the *Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (Text Revision;* DSM-IV-TR*;* American Psychiatric Association (APA), 2000). Cocaine-dependent patients with ADHD (designated the ADHD + COC group) were recruited from among those under treatment at a therapeutic community (Associação para Promoção da Oração e do Trabalho – APOT [Association for Promotion of Prayer and Work]) in the city of Campinas, Brazil, or from one of two inpatient units in the city of São Paulo, Brazil. These comprised the Detoxification Unit of Taipas General Hospital; and the Interdisciplinary Group for Alcohol and Drug Studies Clinic (GREA) at the Institute of Psychiatry of the Clinical Hospital of the Faculty of Medicine, University of São Paulo (Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo; IPQ–HCFMUSP). We recruited patients who had ADHD but not SUD (designated the ADHD-noSUD group) from among those seeking treatment at the outpatient clinic of the Research Program for Attention Deficit Hyperactivity Disorder in Adults at the IPQ–HCFMUSP.

Eligible patients were between 18 and 60 years of age; had completed at least the fourth grade of elementary school; had IQ $\geq$ 80; and had received a diagnosis of ADHD according to DSM-IV-TR criteria but had no history of using ADHD medications. Also excluded in both subgroups were patients who had a history of: 1) a neurological conditions leading to loss of consciousness for >10 min (e.g., stroke, epilepsy, head trauma, ecc) and other neurological conditions that could impair cognition or 2) any serious medical condition.

Additional criteria for inclusion in the ADHD + COC group were: 1) receiving a diagnosis of powder or crack cocaine dependence (based on DSM-IV-TR criteria) and 2) having been abstinent for $\geq$15 days (as verified by urine testing). To be included in the ADHD-noSUD group, patients could not have a history of drug abuse or dependence.

2.2. Sociodemographic and clinical assessments

Sociodemographic data, including, age, gender, race, marital status, years of education, number of school-grades repeated, and employment status were collected in all patients. In the ADHD + COC subgroup, we collected data related to the preference and frequency of using powder or crack cocaine.

The diagnostic interview was based on the Structured Clinical Interview for DSM-IV-TR (APA 2000) and the Schedule for Affective Disorders and Schizophrenia for School-Age Children Present and Lifetime Version (KSADS-PL; Kaufman et al., 1997). All patients completed the 18-item Adult ADHD Self-Report Scale (ASRS; Mattos et al., 2006). The Mini International Neuropsychiatric Interview (MINI), version 5.0.0. (Amorim, 2000) was administered to both groups to verify the presence of 21 other psychiatric diagnosis and SUD. The Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST), Henrique et al. (2004) was used to screen the level of risk of the involvement with different substances (Lower, Moderate, and High). Only the module Drugs and Alcohol Use from version 6 of the Addiction Severity Index (ASI; Kessler and Pechansky, 2006), was employed in both groups. The Barratt Impulsiveness Scale, version 11 (BIS-11; von Diemen et al., 2007),