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Assessment of Executive Function in Patients With Substance Use Disorder: A Comparison of Inventory- and Performance-Based Assessment

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ABSTRACT

Introduction: Chronic polysubstance abuse (SUD) is associated with neurophysiological and neuroanatomical changes. Neurocognitive impairment tends to affect quality of life, occupational functioning, and the ability to benefit from therapy. Neurocognitive assessment is thus of importance, but costly and not widely available. Therefore, in a busy clinical setting, procedures that include readily available measures targeting core cognitive deficits would be beneficial. This paper investigates the utility of psychometric tests and a questionnaire-based inventory to assess "hot" and "cold" neurocognitive measures of executive functions (EF) in adults with a substance use disorder. Hot decision-making processes are associated with emotional, affective, and visceral responses, while cold executive functions are associated with rational decision-making.
Material and Methods: Subjects with polysubstance abuse (n = 126) and healthy controls (n = 32) were compared on hot (Iowa Gambling Task) and cold (Stroop and the Trail Making Test) measures of EF, in addition to a questionnaire assessing everyday EF related problems (BRIEF-A; Behavior Rating Inventory of Executive Function – Adult, self-report version). Information about the substance abuse and social adjustment were assessed by self-report. Logistic regression analyses were applied to assess independent correlates of SUD status and social adjustment. A multiple linear regression was performed to predict the number of previous treatment attempts.
Results: The psychometric test of hot EF (the Iowa Gambling Task) did not differentiate the patients with polysubstance abuse from controls, and was not associated with social adjustment. The psychometric tests of cold EF distinguished somewhat between the groups and were associated with one indicator of social adjustment. The BRIEF-A differentiated between groups on all the clinical scales and was associated with three out of five social adjustment indicators ("criminal lifestyle," "conflict with caregiver," and "stable housing.").
Conclusions: The BRIEF-A inventory was the most sensitive measure of executive function in patients with substance use disorder, followed by measures of cold executive function. BRIEF-A should therefore be considered as an integral part of the clinical routine when assessing patients with SUD.
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1. Introduction

Chronic substance use disorder (SUD) is associated with cognitive impairment (Rogers & Robbins, 2001; Vik, Cellucci, Jarchow, & Hedt, 2004; Yucel, Lubman, Solowij, & Brewer, 2007), with prevalence estimates varying between 20% and 80% among treatment-seeking abusers of alcohol and drugs (Bates, Bowden, & Barry, 2002; Copersino et al., 2009).

Although the majority of studies have focused on disorders related to alcohol use, there is growing evidence indicating similar cognitive

Abbreviations: SUD, Substance Use Disorder; EF, executive function; IGT, Iowa Gambling Task; BRIEF-A, Behavior Rating Inventory of Executive Function – Adult version; TMT A+B, Trail Making Test parts A and B; Stroop CW, The computerized Stroop Color Word test; AUDIT, The Alcohol Use Disorders Identification Test; DUDIT, The Drug Use Disorders Identification Test; WASI, Wechsler Abbreviated Scale of Intelligence; MI, Metacognition Index; BRI, Behavioral Regulation Index; GEC, Global Executive Composite.

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deficits associated with polysubstance use (Fernandez-Serrano, Perez-Garcia, & Verdejo-Garcia, 2011; Grant & Judd, 1976; Vik et al., 2004). More specifically, abusers of alcohol, opiates, and stimulants show impairment on tasks assessing different aspects of executive function (EF), including decision-making and emotional control (Barry & Petry, 2008; Bechara, 2005; Dolan, Bechara, & Nathan, 2008; Verdejo-Garcia & Bechara, 2010; Verdejo-Garcia, Bechara, Recknor, & Perez-Garcia, 2006). Central symptoms of EF deficits include reduced sensitivity to future consequences and impaired decision-making in real-life situations (Bechara et al., 2001; Grant, Contoreggi, & London, 2000; Schoenbaum & Shaham, 2008), reduced ability to suppress responses and evaluate consequences, as well as a preference for smaller, instantaneous rewards over larger, delayed rewards (Cardinal, Winstanley, Robbins, & Everitt, 2004). These deficits commonly present even after 6 months of abstinence among polysubstance abusers (Fernandez-Serrano et al., 2011).

EF dysfunction has an impact on quality of life and occupational functioning, which subsequently affects the course of rehabilitation therapy and level of community integration among patients with SUD (Fernandez-Serrano et al., 2011). In a clinical context, patients with polysubstance abuse may demonstrate intelligence, learning and memory, language, and attention within the normal range, but may still show considerable impairment in emotional function, decision-making, and social behavior (Bechara, 2005). More specifically, an association has been reported between cognitive deficits and low treatment adherence (Bates, Pawlak, Tonigan, & Buckman, 2006), poor attendance at outpatient therapy sessions (Guthrie & Elliott, 1980), low willingness to change (Blume & Marlatt, 2009), reduced self-insight (Horner, Harvey, & Denier, 1999), denial of substance abuse (Rinn, Desai, Rosenblatt, & Gastfriend, 2002), increased impulsivity, and less abstinence from the substance of abuse following treatment termination (Aharonovich et al., 2006). Impaired EF has also been linked to medical and legal problems among this patient group (Bechara et al., 2001; Paulus, Tapert, & Schuckit, 2005).

With neurocognitive deficits recognized as an adverse variable affecting recovery and treatment adherence in SUD patients, a thorough examination of cognitive functioning, including assessment of EF, is of paramount importance with regard to formulation of an effective and clear individual treatment plan, and by this to facilitate improved everyday coping and functioning in this patient population.

However, neurocognitive assessment services are both expensive and time consuming. Furthermore, specialized neuropsychological expertise is usually rare in outpatient settings of SUD treatment. The infrequent inclusion of cognitive assessment in clinical practice was illustrated in a recent study from Norway (Vaskinn & Egeland, 2012), in spite of being recognized as important in the Norwegian national guidelines for diagnosing and treating patients with SUD.

To sum up, it is important to develop and apply assessment protocols that both are brief and simple enough to be included in a busy clinical setting, and of importance to real-life situations and treatment.

The need for clinic-friendly neurocognitive measures motivated the present study to investigate two theoretical EF components, referred to as "cold" and "hot" EF, in a group of patients with SUD. Both hot and cold neurocognitive processes are involved in decision-making (Seguin & Zelazo, 2005). Hot and cold decision-making processes are rarely investigated simultaneously. Often studies tend to emphasize the cold pathway at the expense of the hot pathway (Séguin, Arseneault, & Tremblay, 2007). Previous studies have found, that when compared with controls, SUD patients exhibit lower scores on performance based measures on EF and emotion processing measures, and PET studies have established an association between specific neural correlates related to cold and hot executive functions, respectively (Moreno-López et al., 2012).

Related to decision-making, cold EF refers to abilities of importance when contrasting various alternatives and comparing risk/benefit ratios (Séguin et al., 2007). Cold cognitive processes are thus involved in a wide range of abilities, including the ability to keep attention sustained and focused, to be cognitively flexible, and be able to plan and organize goal-directed behavior (Burgess, 2000; Stuss, Shallice, Alexander, & Picton, 1995). These abilities are commonly measured by psychometric tests such as the Stroop test (MacLeod, 1991) and the Trail Making Test (Kortte, Horner, & Windham, 2002; Strauss, Allen, Jorgensen, & Cramer, 2005). Neurobiologically, these cognitive processes are shown to be particularly associated with activation in dorsolateral prefrontal cortex (Castellanos, Sonuga-Barke, Milham, & Tannock, 2006).

Hot EF involves processes with a more distinct emotional or motivational salience (Kerr & Zelazo, 2004; Zelazo & Müller, 2002), and have increasingly been linked to the orbitofrontal cortex (Anderson, Barrash, Bechara, & Tranel, 2006; Kerr & Zelazo, 2004). Impaired hot EF have a strong impact on behavioral choices in everyday situations, especially when stimuli with distinct emotional salience interact with logical or cold EF (Sonuga-Barke, 2003). The conventional method for assessing hot EF has been performance-based decision-making tasks with emotional-laden contingencies (Chan, Shum, Toulopoulou, & Chen, 2008). A key challenge for participants in these tasks is to make long-term advantageous decisions in uncertain and ambiguous test settings. The Iowa Gambling Task (IGT) is one such test (Bechara & Damasio, 2002), where impairments has been shown in individuals with alcohol, cocaine, and opioid use disorders (Bartzokis et al., 2000; Bechara & Damasio, 2002; Bechara et al., 2001). It has even been argued that the high proportion of relapse after treatment discharge may be attributed to impaired hot EF, particularly when exposed to emotional-laden situations previously associated with substance abuse (Hunt, Barnett, & Branch, 1971; McKay et al., 1997, 2004).

In addition to performance-based tests, EF can also be investigated using self-report scales or questionnaires in which participants are asked about their function in real-life situations. These scales, for example the 75-item Behavior Rating Inventory of Executive Functions – Adult Version (BRIEF-A) (Roth, Isquith, & Gioia, 2005; Roth, Lance, Isquith, Fischer, & Giancola, 2013), have been shown to have a higher ecological validity than results obtained in a structured test environment (Isquith, Roth, & Gioia, 2013; Roth et al., 2005). Furthermore, they clearly have time and cost advantages over laboratory-based performance measures.

With an aim to document EF impairment in patients with SUD of importance to real-life social adjustment and treatment, the present study included a set of tests of the theoretical cold and hot components of EF, including both psychometric tests and a questionnaire-based inventory (BRIEF-A). We investigated their efficiency in characterizing the SUD patients when compared to a control group.

2. Material and methods

2.1. Design

The study was part of a prospective, longitudinal cohort study of an SUD patient sample who started a new treatment sequence in the Stavanger University Hospital catchment area. This paper presents data collected from SUD patients admitted to both outpatient and residential treatment facilities. To minimize contamination from drug withdrawal and acute neurotoxic effects from psychoactive substance, participants were tested after 2 weeks of abstinence (Miller, 1985). The project was approved by the Regional Ethical Committee (REK 2011/1877).

2.2. Participants and procedures

One hundred and fifty participants were recruited from outpatient and residential treatment facilities within the region, across 10 enrollment sites. Patients were recruited between March 2012 and May 2013. Consecutive enrollment was continued until the required number of participants was recruited. The SUD group included patients reporting use of more than one drug at a single occasion or a history of having injected or abused multiple drugs, based on responses to the Alcohol Use Disorders Identification Test (AUDIT) (Bohn, Babor, &

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