



## Full Length Article

# The relationship between executive functions and emotion regulation in females attending therapeutic community treatment for substance use disorder



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## ABSTRACT

**Background:** Difficulties in emotion regulation influence the development of substance use disorder (SUD), its severity, course, treatment outcomes, and relapse. Impaired executive functions (EFs) are common in SUD populations and may relate to emotion dysregulation. The current study tested whether performance on three basic EF tasks ('working memory', 'inhibition', and 'task-switching') and/or inventory-based assessment of EF were related to difficulties in emotion regulation in females attending residential SUD therapeutic community treatment.

**Methods:** Cross-sectional design in which participants ( $N = 50$ , all female) completed a questionnaire battery including the Difficulties in Emotion Regulation Scale (DERS) and Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A) was used. Participants also completed neuropsychological assessment of EF including the Working Memory Index (WMI; Wechsler Adult Intelligence Scale), and measures of inhibition and task-switching (Color-Word Interference Test; Delis-Kaplan Executive Function System).

**Results:** Executive dysfunction, as assessed by the Global Executive Composite (GEC; BRIEF-A), and personality disorder indicators (Standardised Assessment of Personality – Abbreviated Scale; SAPAS) were positively correlated with DERS scores. Sequential hierarchical regression indicated that task-switching, GEC, and SAPAS scores statistically predicted DERS scores, while working memory and inhibition did not. Mediation analysis indicated that there was a significant indirect effect of GEC scores and task-switching performance on DERS scores, through SAPAS scores.

**Conclusions:** Impairment of EF, particularly task-switching, is related to difficulties in emotion regulation in a female sample attending residential SUD treatment. Cognitive training interventions that improve task-switching performance may be beneficial in promoting effective emotion regulation and improved SUD treatment outcomes.

## 1. Introduction

When an emotion arises, a complex interplay between subjective experience, cognition, physiological changes, and behavioral components takes place, with neural bases such as the lateral prefrontal and parietal cortices, the ventral anterior cingulate, and ventromedial prefrontal cortices implicated (Etkin et al., 2015). The pursuit of desired emotional states in everyday life is ubiquitous, and “emotion regulation” denotes this process of modifying the intensity or duration of existing emotions in order to maintain goal-directed behavior (Tamir, 2016).

Emotion dysregulation is implicated in various forms of psychopathology (Aldao et al., 2010), including substance use disorder (SUD;

Cheetham et al., 2010), in which it has a significant effect on the initiation, severity, and prognosis of the disorder (Wilcox et al., 2016). For example, the capacity for effective emotion regulation is under development during adolescence and may, in combination with other risk factors, increase the likelihood of early initiation of substance use, disruption of neuromaturation processes, and subsequent poor prognosis (Gladwin et al., 2011; Lubman et al., 2007; Smith and Cyders, 2016; Wills et al., 2016). Individuals with affective disorders (e.g., anxiety and mood disorders) commonly experience comorbid SUD and, conversely, SUDs also contribute to the development of affective disorders (Cheetham et al., 2010). Additionally, SUD populations experience greater difficulties with emotion regulation relative to controls (Wilcox and Adinoff, 2015), and substance use may develop as a

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mechanism to relieve negative affect (Blevins et al., 2016). Emotion dysregulation increases the severity of SUD (Tull et al., 2015) and predicts relapse to substance use (Witkiewitz and Wu, 2010), while reductions in negative affect predict reduced SUD severity following treatment completion (Mo and Deane, 2016).

Akin to the role of emotion dysregulation in SUD, cognitive deficits are commonly observed and also impede the treatment process. Cognitive impairment is one of the four most common risk factors for dropout from SUD treatment (Brorson et al., 2013), and the specific impairment of executive function (EF) is well documented in SUD populations (Fernández-Serrano et al., 2010; Hester et al., 2010).

Along with the challenges to effective SUD treatment associated with emotion dysregulation and cognitive deficits, comorbid personality disorder is a significant risk factor for early dropout (Brorson et al., 2013) and is highly prevalent in SUD populations (Grant et al., 2015, 2016). Furthermore, personality disorder is independently associated with cognitive deficits; the most commonly observed deficits occur in memory, decision-making, and EFs (Unoka and Richman, 2016).

While several conceptualizations of EF exist, Miyake et al. (2000) proposed the *unity/diversity framework* of EF, which posits three separable, basic EFs: ‘working memory’, ‘inhibition’, and ‘task-switching’ (Friedman and Miyake, 2017; Miyake and Friedman, 2012). Working memory refers to the capacity to monitor and alter the contents of working memory, inhibition is the ability to override an unwanted distraction to maintain task-focus, and task-switching involves flexibly switching attention between tasks or mental sets (Hofmann et al., 2012).

It has been proposed that these basic EFs (i.e., working memory, inhibition, and task-switching) may subserve effective emotion regulation (Hofmann et al., 2012; Schmeichel and Tang, 2015). The contributions of working memory, inhibition, and task-switching to emotion regulation have been explored in a number of studies, predominantly drawing from nonclinical populations. For example, a series of studies explored the role of working memory (assessed using the operation span task) in emotion regulation within a university student sample (Schmeichel and Demaree, 2010; Schmeichel et al., 2008). Participants with a higher working memory capacity were better able to appraise emotional stimuli and, consequently, more effectively experience and express emotion (Schmeichel et al., 2008). These abilities were not confounded with higher working memory capacity leading to participants being better able to follow instructions (Schmeichel and Demaree, 2010). Another study in a community sample found that effective reappraisal of emotions was predicted by higher working memory capacity in a modified operation span task (McRae et al., 2012). The specific role of updating the contents of working memory in emotion regulation was explored in university students using the emotional 2-back task (Pe et al., 2015). Participants with better updating abilities displayed higher levels of emotional reactivity but were more quickly and effectively able to regulate their emotions and return to a baseline level of arousal.

Several studies have demonstrated links between inhibition and emotion regulation. Inhibition performance, as measured by the Stroop task, was found to predict effective restraint of socially inappropriate behaviors in university students (von Hippel and Gonsalkorale, 2005). Similarly, university students who demonstrated poorer inhibition performance in the stop-signal task experienced larger increases in negative emotions following an emotion induction paradigm than to those with better inhibition performance (Tang and Schmeichel, 2014). In a sample of 5- to 7-year-old children, inhibition performance assessed by a go/no-go task predicted effort exerted in regulating emotions (Hudson and Jacques, 2014), with similar findings demonstrated in preschool-aged children (Carlson and Wang, 2007). In a clinical sample of patients with frontal lobe damage, inhibition performance via a go/no-go task mediated the relationship between prefrontal lobe damage and maladaptive emotion regulation strategies (Falquez et al., 2015).

There is a paucity of studies investigating the role of task-switching in emotion regulation (Schmeichel and Tang, 2015). The previously mentioned study of working memory by McRae et al. (2012) also included a measure of task-switching (i.e., set-shifting costs based on a standardized global/local task) and found that task-switching predicted both effective reappraisal of emotions and working memory capacity.

While a range of studies have investigated the role of working memory, inhibition, and (to a lesser extent) task-switching, these studies have primarily involved nonclinical populations. To the best of our knowledge the role of these basic EFs in emotion regulation have not been explored in an SUD population. There is also a paucity of studies directly examining a relationship between EFs and emotion regulation in other psychiatric populations despite clear deficits in each of these domains being widely reported (e.g., EF deficits in depression (Snyder, 2013); anxiety (de Lima Muller et al., 2015); bipolar disorder (Cullen et al., 2016); schizophrenia (Kluwe-Schiavon et al., 2013); post-traumatic stress disorder (Polak et al., 2012); borderline personality disorder (McClure et al., 2016); and with emotion regulation deficits in these same populations (e.g., Gratz et al., 2016; Green et al., 2007; Joormann and Stanton, 2016; Seligowski et al., 2015; van Zutphen et al., 2015; Zilverstand et al., 2016).

While these basic performance-based EF tasks are sensitive to impairment of the frontal lobes (Jurado and Rosselli, 2007), some tasks may arguably have limited ecological validity and may not capture impaired functioning as effectively as inventory-based (i.e., self-report) assessment of EFs (Isquith et al., 2013). Furthermore, performance- and inventory-based measures of EFs are minimally correlated and may assess distinct components of EFs (Toplak et al., 2013). For example, inventory-based assessment of EFs, using the Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A; Roth et al., 2005) more effectively distinguished polysubstance users from controls and was more strongly associated with social adjustment outcomes compared to performance-based measures (Hagen et al., 2016). In light of these considerations, the current study included both performance- and inventory-based assessment of EFs.

Given the importance of emotion regulation in SUD treatment and the potential connection between EFs and effective emotion regulation, the current study sought to ascertain whether inventory-based assessment of EFs and/or performance-based assessment of working memory, inhibition, and task-switching performance were related to difficulties in emotion regulation in an all-female residential SUD population. A further aim of the current study was to explore the role of personality disorder in the relationship between EFs and emotion dysregulation, given its high prevalence in SUD populations, deleterious effect on SUD treatment, and independent association with cognitive deficits.

## 2. Materials and methods

### 2.1. Participants

Participants ( $N = 50$ ) were recruited from We Help Ourselves (WHOs), a large provider of residential SUD treatment in Australia which utilises the Therapeutic Community model of treatment (De Leon, 1989). Inclusion criteria for the study were (i) diagnosis of substance abuse/dependence, based on DSM-IV-TR criteria<sup>1</sup> 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 as a prerequisite of entry to treatment), (iii) absence of any neurological, infectious, or other disease affecting the

<sup>1</sup> DSM-5 criteria for substance use disorder do not separate abuse and dependence but provide criteria for these specifiers. Despite this, DSM-5 criteria are almost identical to those used in DSM-IV-TR (with the exception of removal of recurrent legal problems associated with substance use criterion and the addition of craving or strong desire to use a substance criterion, as well as slight changes in number of criteria required to meet diagnostic thresholds).

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