



## Research paper

# Interference control training for PTSD: A randomized controlled trial of a novel computer-based intervention



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## ABSTRACT

Post-traumatic stress disorder (PTSD) is a chronic and debilitating condition characterized by persistent intrusive memories. Although effective treatments exist for PTSD, there is a need for development of alternative treatments. Diminished ability to control proactive interference may contribute to re-experiencing symptoms and may be a novel intervention target. The present study tested an intervention designed to modify proactive interference control clinicaltrials.gov identifier: (NCT02139137). Forty-two women with PTSD were randomly assigned to a computerized cognitive training or a control condition. The impact of these programs on cognitive performance and symptoms was assessed. PTSD re-experiencing symptoms and interference control performance improved significantly more for individuals in the training group relative to those in the control group. Other PTSD and general distress symptoms improved equally over time in both groups. Cognitive training of this type may hold promise as a novel intervention for reducing PTSD symptoms, although the mechanism of action and implications for models of PTSD requires future study.

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## 1. Introduction

Epidemiological estimates of exposure to trauma (defined by the *APA DSM-IV, 2000* “Criterion A”) range from 55 to 89% (Breslau et al., 1998a,b; Kessler, Sonnega, Bromet, & Hughes, 1995; Stein, Walker, Hazen, & Forde, 1997). Though many individuals experience PTSD-like symptoms in the immediate aftermath of a traumatic stressor (e.g., distressing memories), only a minority goes on to develop the chronic, debilitating symptoms that constitute PTSD (Kessler et al., 1995; McNally, Bryant, & Ehlers, 2003). Individual differences in characteristics present before, during, or after a traumatic event may be important in understanding why some individuals go on to develop PTSD while others recover naturally.

The ability to regulate thought content, including the emergence and dismissal of memories, is one such factor that may account for variability in PTSD development. Persistence of distressing intrusive thoughts may stem from ineffective utilization of cognitive systems – specifically aspects of executive functioning – to inhibit or down-regulate information (e.g., Anderson & Levy, 2008;

Joormann, Yoon, & Siemer, 2010; Verwoerd, de Jong, & Wessel, 2008). Recurrently accessing traumatic memories, potentially due to diminished executive functioning control, may conversely contribute to PTSD etiology or maintenance (e.g., McFarlane, Yehuda, & Clark, 2002). Executive functioning refers to domain-general control faculties that govern cognitive sub-processes used in higher order cognition (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). For the present purposes, the term *interference control* refers to the specific inhibitory sub-function of executive functioning designed to prevent irrelevant, incorrect, or otherwise unwanted but competing information from intruding into or persisting in working memory (e.g., Friedman & Miyake, 2004<sup>1</sup>). Interference control is a critical aspect of executive functioning that enables individuals to regulate unwanted thoughts by preventing

<sup>1</sup> Components of executive functioning utilized to regulate cognition have taken a variety of names based on different theoretical models (e.g., attention control, central executive, cognitive control; see Wessel, Overwijk, Verwoerd, & de Vrieze, 2008). The construct of interference control can be considered a type of inhibition; however, inhibition is multifaceted and may refer to inhibition of pre-potent responses, inhibition of interference from other cognitions or memories, or inhibition of interference from distractors. A thorough review of models (and controversies) related to executive functioning, inhibition and interference control is beyond the scope of this paper (see for example Friedman & Miyake, 2004).

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these thoughts from entering consciousness and removing these thoughts once they come to mind (Unsworth, 2010).

In the case of PTSD, converging evidence implicates interference control as a key regulatory process involved in modulating intrusive cognitions (i.e., re-experiencing symptoms). First, compared to healthy controls, individuals with PTSD demonstrate deficits in interference control (e.g., Aupperle, Melrose, Stein, & Paulus, 2012), and exhibit differences in recruitment of brain regions thought to form the neural substrates of executive functioning (Etkin & Wager, 2007). Individuals with PTSD show difficulty controlling *proactive interference*, or difficulty regulating interference from previously learned stimuli when attempting to remember more recently learned stimuli (e.g., Bunting, 2006), and difficulty controlling proactive interference is associated with the re-experiencing PTSD symptom cluster (Bomyea, Lang, & Amir, 2012; Vasterling, Brailey, Constans, & Sutker, 1998). However, existing studies do not specify if interference control difficulty is a pre-existing risk factor for PTSD development, a maintenance factor, or a consequence of the disorder.

Second, interference control ability is inversely associated with intrusive thoughts about stressful experiences. Studies find that greater ability to control proactive interference is associated with fewer intrusive memories after an analogue traumatic stressor (e.g., Verwoerd, Wessel, & de Jong, 2009; Verwoerd, Wessel, de Jong, Nieuwenhuis, & Huntjens, 2011; Wessel et al., 2008). Performance during working memory capacity (WMC) tasks is similarly associated with intrusive thoughts during deliberate thought suppression attempts. WMC tasks assess the amount of information that can be kept in working memory, and are highly dependent on one's ability to utilize interference control (Bunting, 2006; Conway et al., 2005; Friedman & Miyake, 2004; Lustig, May, & Hasher, 2001; May, Hasher, & Kane, 1999). Results from two studies by Brewin and colleagues indicated that better WMC performance was associated with fewer intrusive thoughts while participants attempted to suppress neutral and negative, personally-relevant thoughts (Brewin & Beaton, 2002; Brewin & Smart, 2005). The association between proactive interference control and intrusive thoughts is consistent with the hypothesis that re-experiencing symptoms are manifestations of a breakdown or deficiency in this cognitive process.

Although existing literature posits that an association exists between proactive interference control and intrusive thoughts, it does not speak to the potential causal role of interference control in recurrent intrusive cognitions. Studies examining cognitive mechanisms of anxiety have addressed the question of causality through randomization of participants to experimental cognitive retraining programs, wherein participants repeatedly practice engaging in specific tasks to manipulate the target cognitive process (e.g., attentional bias, interpretation bias; Beard, 2011; Macleod, 2012; Macleod & Mathews, 2012). Data from other psychiatric and healthy samples suggests that aspects of executive functioning performance are malleable with practice (e.g., Keshayan, Vinogradov, Rumsey, Sherrill, & Wagner, 2014). Moreover, one study found that executive functioning training impacted regulation of intrusive thoughts in non-clinical samples (Bomyea & Amir, 2011). Reductions in intrusive thoughts as a result of interference control training in a clinical sample would substantiate theoretical accounts of interference control as a potential mechanism for dysregulation of intrusive thoughts in psychopathology (e.g., Verwoerd et al., 2008). However, the clinical applications of executive functioning training programs for PTSD symptoms have yet to be explored.

Examining proactive interference control as an intervention target in PTSD has the potential to contribute to our understanding and treatment of the disorder in a number of ways. Existing psychosocial treatments focus on the content of trauma-related cognitions—that is, the types of negative beliefs and expectations

an individual has about trauma-related stimuli and cues. While these cognitive behavioral treatments (e.g., prolonged exposure, cognitive processing therapy) are effective and empirically supported (Ponniah & Hollon, 2009), they require considerable time and effort from patients and may not be universally feasible, well received, or effective (Bradley, Greene, Russ, Dutra, & Westen, 2005; Schottenbauer, Glass, Arnkoff, Tendick, & Gray, 2008). In contrast, interference control training would aim to alter the functioning of basic cognitive systems hypothesized to regulate re-experiencing symptoms. If effective, this type of training would inform models of interference control in PTSD, and potentially provide a novel approach to treatment that complements existing intervention techniques.

The current study reports the results of a pilot randomized controlled trial of a computer-based proactive control training program in women with PTSD secondary to sexual trauma (clinicaltrials.gov Identifier: NCT02139137). The sample was limited to a specific trauma type for a number of reasons. Given that sexual assault confers a higher risk for PTSD than many other trauma types, it is critical to conduct clinical research in this population (e.g., Breslau et al., 1998a,b; National Center for Posttraumatic Stress Disorder, 2005). Results from the current trial can also be compared to a substantial body of literature of randomized controlled trials in this population. Participants were assigned to an eight-session cognitive training (high interference control; HIC) or control program (low interference control; LIC). The primary goal was to assess preliminary efficacy of the training on cognitions and symptoms from baseline to post-training. We hypothesized that individuals in the training condition would demonstrate improved cognitive performance (indexed by a WMC task) and decreased PTSD re-experiencing symptoms (indexed by the Clinician Administered PTSD Scale-Re-experiencing subscale), relative to the control condition. Secondary goals were to assess the clinical significance of PTSD symptom change, examine generalizability of symptom change to other PTSD symptom clusters, general distress and functional impairment, and understand the feasibility and tolerability of the training program.

## 2. Materials and methods

### 2.1. Participants

Participants included 47 women between the ages of 18 and 65 diagnosed with PTSD secondary to sexual trauma. The study was approved by the institutional review boards (IRB) at the University of California, San Diego and San Diego State University (SDSU). Individuals were recruited to participate through several sources, including the university subject pool at SDSU and referrals through affiliated mental health providers. IRB-approved recruitment materials were also posted on multiple college campuses in San Diego County, CA, in community posting areas, and through online websites (e.g., [www.craigslist.org](http://www.craigslist.org)). All recruitment materials and the informed consent documents indicated that participants would be participating in an experimental study testing the effects of a computer-based program on anxiety and traumatic stress symptoms.

At the initial intake assessment, diagnostic status was determined by a doctoral-level trainee under the supervision of a licensed clinical psychologist (A.J.L.). The Structured Clinical Interview for DSM-IV (SCID-IV; First, Spitzer, Gibbon, & Williams, 1994), a semi-structured interview that assesses past and present diagnostic criteria, was used to collect information about Axis-I disorders and treatment history. PTSD diagnosis was determined using the Clinician-Administered PTSD Scale for DSM-IV (CAPS; Blake, Weathers, & Nagy, 1995). Interviews were videotaped, and a

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