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Shorter communication

Fractionating the role of executive control in control over worry: A preliminary investigation

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ABSTRACT

Uncontrollable anxious thought characterizes a number of emotional disorders. Little is known, however, about the cognitive mechanisms that underlie the ability to control these thoughts. The present study investigated the extent to which two well-characterized executive control processes—working memory and inhibition—are engaged when an individual attempts to control worry. Participants completed a concurrent assessment of these processes while attempting to control personally-relevant worried and neutral thoughts. To examine the specificity of these effects to attempts to control worry, versus a residual "depletion" effect of having previously engaged in worry, a subset of participants completed the assessment without instructions to control their worried or neutral thoughts. Attempts to control worry engaged working memory and inhibition to a greater extent than did attempts to control neutral thought. This increased engagement was not explained solely by anxious affect, nor was it significantly associated with trait worry. Engagement did not differ by group, suggesting that executive control depletion by worry cannot be dismissed as an alternative explanation of these findings. These results highlight working memory and inhibition as potentially valuable constructs for deepening our understanding of the nature and treatment of worry and its control.

Uncontrollable worry is the core feature of generalized anxiety disorder (GAD), a disorder associated with diminished quality of life, decreased productivity, and substantial economic burden (Hoffman, Dukes, & Wittchen, 2008). Among individuals with GAD, higher perceived uncontrollability (i.e., difficulty of sustained dismissal) of worry is associated with greater clinical severity, even after other features of GAD are controlled (Hallion & Ruscio, 2013). Uncontrollable worry also affects many adults who do not qualify for a diagnosis of GAD (Ruscio et al., 2005) yet still suffer negative physical and emotional consequences (Watkins, 2008). Although treatments for worry have improved over time, many individuals continue to experience uncontrollable worry after treatment (Mitte, 2005).

One reason for the limited success of current treatments may be our limited understanding of the "cold" cognitive mechanisms that underlie the experience and control of worry and other unwanted thoughts. Intentionally attending to certain stimuli while ignoring others engages a number of executive control processes, the limited cognitive resources responsible for controlled cognition (Cowan, 2005). Two of the most widely recognized executive control processes are working memory (WM), the mental workspace responsible for storing and manipulating information over short periods of time, and inhibition, the ability to override a prepotent response in order to make a task-appropriate but less dominant response (Miyake et al., 2000).

A small but growing literature suggests a link between executive control and the experience of worry and other unwanted thoughts (Hirsch & Mathews, 2012). For example, higher trait worry and GAD are associated with poorer performance on some WM tasks (Christopher & MacDonald, 2005). In experimental research, depressed individuals demonstrated more impaired WM and inhibition after rumination (a repetitive thought process similar to worry) compared to neutral thought ($d = 0.77$, Philippot & Brutoux, 2008; $d = 0.85$, Watkins & Brown, 2002). Similarly, high worriers demonstrated more impaired WM during worry compared to positive thought ($d = 1.00$; Hayes, Hirsch, & Mathews, 2008). Consistent with theoretical accounts of worry as a verbal-linguistic process (Borkovec, Robinson, Pruzinsky, & DePree, 1983), WM is particularly impaired when participants worry in verbal, rather than imagery, form (Leigh & Hirsch, 2011), and ability to worry is impaired during verbal, but not visuospatial, WM tasks (Rapee, 1993).

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A recent theoretical account suggests that the impairments in executive control that are evoked by worry may contribute to the maintenance of uncontrollable worry (Hirsch & Mathews, 2012). Broadly, this model proposes that redirecting one's thoughts away from worry relies on the very executive control processes that worry impairs. That is, worry impairs executive control, which prevents the worrier from terminating his or her worry. The findings reviewed above support the first stage of this model (i.e., worry impairs executive control). However, the proposal that controlling worry relies on the same resources that are impaired by worry remains untested.

Indirect support for this possibility comes from the thought suppression and emotion regulation literatures. Greater WM has been linked to better ability to suppress anxiety-provoking thoughts (Brewin & Smart, 2005; although see Wessel, Overwijk, Verwoerd, & de Vrieze, 2008). The addition of a WM load impaired participants' abilities to suppress thoughts about an upsetting film (Nixon, Cain, Nehmy, & Seymour, 2009), while WM training improved thought suppression ability (Bomyea & Amir, 2011). Finally, exaggerating one's emotional response was found to have a lasting "depleting" effect on WM (Schmeichel, 2007). Although these findings are suggestive, no studies have tested directly whether, and to what extent, attempts to control worry rely on executive control.

The present study examined the extent to which controlling worry draws on WM and inhibition, two executive control processes linked to worry and rumination. Participants engaged in experimentally induced worry and neutral thought. After each thought induction, a subset of participants ("Control Thoughts" group) attempted to control those worried and neutral thoughts while completing a computerized measure of WM and inhibition. This dual task approach capitalizes on the limited nature of executive control: To the extent that controlling worry relies on a specific executive control process (e.g., WM), performance on a concurrently performed task that relies on the same process should suffer (Engle, Conway, Tuholski, & Shisler, 1995). As little is known about the extent to which thought control strategies differentially rely on executive control, participants in the Control Thoughts group were randomly assigned to use one of three common thought control strategies to control both their worry and neutral thoughts.

As the present study assessed WM and inhibition after participants engaged in worry, it was possible that executive control impairments observed during attempts to control worry could be a consequence of having engaged in worry, rather than of attempting to control worry. To our knowledge, no studies have shown a lasting "depleting" effect of worry on executive control, although such an effect would be consistent with recent theoretical accounts (Hirsch & Mathews, 2012). To test the specificity of the effects, a second subset of participants ("No Instruction" group) completed the executive control task without instructions to control their thoughts.

We hypothesized that attempts to control worry would result in poorer WM and inhibition performance compared to attempts to control neutral thought. We further hypothesized that participants who attempted to control worry would experience greater executive control impairment than participants who worried but did *not* attempt to control their thoughts.

Method

Participants

Participants were 100 undergraduate students (56% female). All were age 18 or older, with no history of traumatic brain injury, no current stimulant medication, and no current or past antipsychotic medication. As undergraduate samples include the full range of trait worry scores (Ruscio, Borkovec, & Ruscio, 2001), no requirements based on trait worry or GAD status were imposed.

Materials

Experimental apparatus

The experiment was administered on Dell Pentium IV desktop computers using E-Prime Professional. Stimuli were presented in black ink on a light gray background and were centered on the screen.

Executive control

Participants completed the WM and Inhibition Task (WMIT; Hallion, Coutanche, & Jha, under review; manuscript available upon request), a novel computerized task that provides a simultaneous assessment of WM—particularly the maintenance component of WM—and inhibition. Assessing WM and inhibition simultaneously, rather than sequentially, facilitates within-subjects comparisons and reduces the likelihood that fatigue or mind wandering could confound the results.

The stimuli and general instructions were adapted from the AX-Continuous Performance Task (Barch et al., 1997). In the WMIT, participants view a series of letter stimuli (see Fig. 1). Each stimulus is presented individually for 150 ms, followed by a 300 ms fixation cross. After every third stimulus, the fixation cross is presented for 1300 ms and participants respond as follows: Press "k" if the last letter was X, but only if it was preceded by A. Press "f" in all other cases (i.e., when the last letter is not X, or when the last letter is X preceded by a letter other than A).

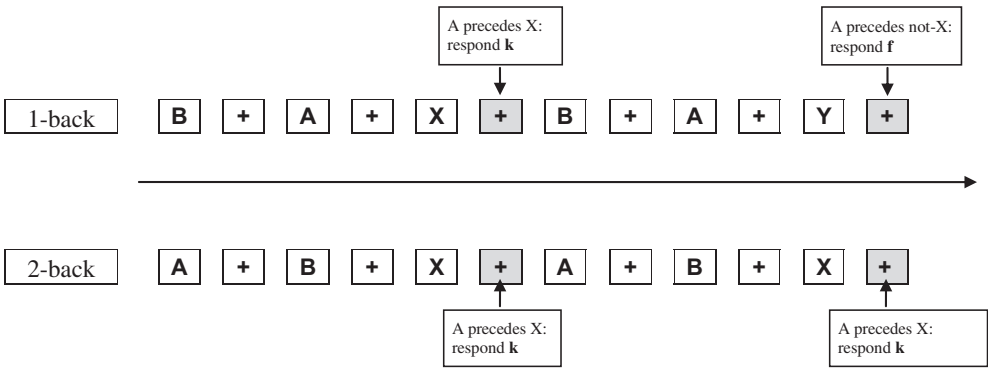

Fig. 1. A schematic of the working memory and inhibition task. Working memory is assessed by comparing performance in the 2-back (high demand) vs. 1-back (low demand) conditions. Inhibition is assessed by comparing performance when the correct response is "f" (high demand) vs. "k" (low demand).