



Worry in imagery and verbal form: Effect on residual working memory capacity

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ABSTRACT

Worry-prone individuals have less residual working memory capacity during worry compared to low-worriers (Hayes, Hirsch, & Mathews, 2008). People typically worry in verbal form, and the present study investigated whether *verbal* worry depletes working memory capacity more than worry in imagery-based form. High and low-worriers performed a working memory task, random interval generation, whilst thinking about a worry in verbal or imagery form. High (but not low) worriers had less available working memory capacity when worrying in verbal compared to imagery-based form. The findings could not be accounted for by general attentional control, amount of negatively-valenced thought, or appraisals participants made about worry topics. The findings indicate that the *verbal* nature of worry is implicated in the depletion of working memory resources during worry among high-worriers, and point to the potential value of imagery-based techniques in cognitive-behavioural treatments for problematic worry.

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Worry is characterized by repetitive intrusive negative thoughts about future events. Excessive and uncontrollable worry is a hallmark feature of generalised anxiety disorder (GAD), a disorder associated with chronic cognitive, social and occupational impairment (Kessler et al., 1994). High-worriers can be distinguished from low-worriers by perceived, and actual, uncontrollability of worrisome intrusions (Borkovec, Robinson, Pruzinsky, & DePree, 1983). We have previously suggested that basic cognitive processes may be implicated in this uncontrollability of problematic worry (Hirsch, Hayes, & Mathews, 2009).

Research has shown that anxiety is associated with reduced attentional control and working memory capacity (Derryberry & Reed, 2002; Eysenck, 1979; Eysenck & Calvo, 1992). According to the model proposed by Baddeley and Hitch (1974), working memory is a limited-capacity resource comprised of an attentional control system (Engle & Kane, 2004), referred to as the central executive; and two subsidiary systems (for verbal and visual information). Eysenck and Calvo (1992) suggest that worry is responsible for the detrimental effect of anxiety on working memory, and executive functioning in particular. These proposals have been supported in a number of experimental (Crowe, Matthews, & Walkenhorst, 2007; Derakshan & Eysenck, 1998; MacLeod & Donnellan, 1993; Rapee, 1993; Richards, French,

Keogh, & Carter, 2000) and neuroimaging studies (Collette & Van der Linden, 2002; Santos, Wall, & Eysenck, submitted for publication). Rapee (1993) asked undergraduates to perform one of four tasks whilst simultaneously engaging in worry. The frequency of worry-related thoughts experienced during these phases was compared to the frequency reported when participants were engaging in worry without a second task. Two of the tasks assessed the central executive and either verbal (random generation of letters) or visuo-spatial processing (pressing buttons in a random pattern). The other two tasks tapped visuo-spatial (repeatedly pressing buttons in a particular pattern) or verbal (repeating the same letter) processing, but did not utilise the central executive. Only random generation of letters interfered with ability to worry, providing support for the proposal that worry is a verbal process that interferes with executive functioning. Hayes et al. (2008) directly assessed residual working memory capacity *during* worry. High (but not low) worriers showed more evidence of restricted working memory capacity during worry than when thinking about a positive topic. The authors concluded that depleted working memory resources during worry may be relevant to the persistence and perceived uncontrollability of worry. It may be that worry, once initiated, consumes working memory capacity. Inhibition of automatic responses and task switching (or 'mental set shifting') are both understood to be executive functions of working memory (Baddeley, 1966; Miyake et al., 2000). If worry depletes working memory, there may be less available working memory capacity to *inhibit* worrisome thoughts and *shift* to a more benign topic, maintaining the worry process (Hayes & Hirsch, 2007).

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Worry is dominated by verbal thought with few images (Bergman & Craske, 2000; Freeston, Dugas, & Ladouceur, 1996) and people with clinical levels of worry tend to worry in verbal form more than non-clinical volunteers (Borkovec & Inz, 1990; Hirsch, Hayes, Mathews, Perman, & Borkovec, submitted for publication). Borkovec and colleagues (Borkovec, Alcaine & Behar, 2004; Sibrava & Borkovec, 2006) proposed that verbal worry serves a cognitive avoidance function in response to threatening and distressing information (such as images). In keeping with this are cognitive-behavioural approaches that encourage individuals to engage in coping imagery rather than verbal worry (Borkovec, Newman, Pincus, & Lytle, 2002). In line with the proposal that verbal worry functions to avoid distressing information such as images, Butler, Wells and Dewick (1992) found that participants asked to worry about a distressing film clip they had watched (of an accident at work) reported less anxiety immediately after the worry period compared to those who had been asked to think about it images. Importantly however, the individuals who had engaged in worry actually experienced more intrusive images about the film over the next few days than those who had engaged in imagery. This finding was replicated by Wells and Papageorgiou (1995). In a recent study by Stokes and Hirsch (2010) high-worriers were trained to engage in either verbal or imagery-based mentation about a personally relevant worry topic. Verbal worry was found to result in an increase in negative thought intrusions after the worry period. In contrast, imagery led to a decrease in negative intrusions. The authors conclude that the predominantly verbal nature of worry is implicated in the maintenance of worry.

The verbal mentation that characterizes worry, and particularly the worry of those with GAD, appears to maintain distressing intrusive thoughts and images, and therefore the worry process. Imagery, in contrast, does not seem to have this effect. One hypothesis is that verbally-based worry depletes available working memory capacity to a greater extent than worry in imagery-based form, leaving less resources available to inhibit or switch away from worrisome thoughts. Alternatively, it could be argued that high-worriers are 'well-practised' in verbal worry, and so might consume less capacity, as with expert performance acquired through extended practice (Ericsson & Kintsch, 1995). In this way verbal worry would be expected to deplete working memory to a lesser extent than worry in imagery, with no such effect among low-worriers.

The current study aimed to explore the effect of verbal worry on residual working memory capacity compared to imagery-based worry among people with high and low levels of worry. Consistent with the study of Hayes et al. (2008), we employed Baddeley's (1966) dual-task method. Performance on a concurrent task (random generation) was used to measure residual working memory capacity whilst high and low-worriers engaged in verbal or imagery-based worry. Generating random sequences require high levels of attentional monitoring and control (Baddeley, 1986) to overcome the tendency to produce sequences that are well practiced (e.g. ascending or descending series). To the extent that limited working memory resources are consumed by other tasks (e.g. worry), the generated output is less random (Baddeley, Emslie, Kolodny, & Duncan, 1998).

Vandierendonck, De Vooght, and Van der Goten (1998) proposed a version of the random generation task in which participants tap a key at random intervals in time. Random interval generation (RIG) utilises central executive resources with minimal loading on verbal or visuo-spatial processes (Stuyven & Van der Goten, 1995; Vandierendonck, 2000; Vandierendonck, Kemps, Fastame, & Szmalec, 2004). Using the dual-task method, this RIG task allows evaluation of the comparable effect of verbal and imagery-based mentation on working memory. The current study

developed and validated a method of analysing the data from this RIG task to derive widely used outcome measures (Towse & Neil, 1998).

In order to explore whether there were differences in performance on the RIG task when participants were not engaged in worry, high and low-worriers also completed the RIG task without a concurrent task. High-worriers report more negatively-valenced thought in general during worry compared to low-worriers, who typically report more neutral thoughts (Mathews & Milroy, 1994). They have also been found to appraise their worries more negatively than low-worriers (Vasey & Borkovec, 1992), and to endorse poorer attentional control in general than low-worriers (Pruzinsky & Borkovec, 1990). Participants were asked to rate thought valence during the experimental period, appraisals of their worries, and to complete a questionnaire designed to assess self-reported general attentional control, in order to rule out the possibility that these factors underpinned the hypothesized differences in working memory.

The aim of the study was to directly compare the effect of worry in imagery and verbal-linguistic form on residual working memory capacity among high and low-worriers. It was hypothesized that high-worriers would have less residual working memory capacity when engaged in verbal compared to imagery-based worry, which would not be accounted for by appraisals of worries, amount of negative content, nor self-reported general attentional control.

Method

Design

High and low-worry groups underwent a baseline RIG phase which comprised the single RIG task. This was followed by Imagery or Verbal Conditions which participants underwent in counter-balanced order (within groups). These comprised: a mentation training phase when participants received training in verbal thought or imagery; a worry focus phase, when participants focused on a worry in verbal thought or imagery; and a worry test phase when participants completed the RIG task whilst continuing to focus on their worry in the designated mentation style.

Participants

Seventy-eight participants from King's College London were selected based on scores on the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990). Those scoring above 55 were included in the high-worry group (Molina & Borkovec, 1994) and below 43 in the low-worry group (Gillis, Haaga, & Ford, 1995).

Seven participants were excluded as they reported that their thoughts about the worry topic (in either condition) were more than 50% positive. Twenty-three participants were excluded as they were not successful in worrying in the designated mentation type (less than 50% images in the imagery condition or words in the verbal condition, with no significant differences in the number of those excluded from the imagery or verbal condition, or the high and low-worry groups¹). There were no significant differences between those included and excluded from the study in overall attentional control,

¹ Of those excluded from the High-Worry Group, nine were excluded on the basis of difficulty engaging in imagery-based mentation, and three on the basis of verbal mentation. Four low-worriers were excluded due to difficulties engaging in imagery, and seven on the basis of verbal mentation. Fisher's Exact Tests did not indicate significant differences in the number of those excluded from the imagery or verbal condition, or the high and low-worry groups.

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