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Imagery in the aftermath of viewing a traumatic film: Using cognitive tasks to modulate the development of involuntary memory

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ABSTRACT

Background and objectives: Involuntary autobiographical memories that spring unbidden into conscious awareness form part of everyday experience. In psychopathology, involuntary memories can be associated with significant distress. However, the cognitive mechanisms associated with the development of involuntary memories require further investigation and understanding. Since involuntary autobiographical memories are image-based, we tested predictions that visuospatial (but not other) established cognitive tasks could disrupt their consolidation when completed post-encoding.
Methods: In Experiment 1, participants watched a stressful film then immediately completed a visuospatial task (complex pattern tapping), a control-task (verbal task) or no-task. Involuntary memories of the film were recorded for 1-week. In Experiment 2, the cognitive tasks were administered 30-min post-film.
Results: Compared to both control and no-task conditions, completing a visuospatial task post-film reduced the frequency of later involuntary memories (Expts 1 and 2) but did not affect voluntary memory performance on a recognition task (Expt 2).
Limitations: Voluntary memory was assessed using a verbal recognition task and a broader range of memory tasks could be used. The relative difficulty of the cognitive tasks used was not directly established.
Conclusions: An established visuospatial task after encoding of a stressful experience selectively interferes with sensory-perceptual information processing and may therefore prevent the development of involuntary autobiographical memories.

1. Introduction

Cognitive models of autobiographical memory (e.g. Conway & Pleydell-Pearce, 2000) make an important distinction between voluntary and involuntary memory. A voluntary memory, for example, could include deliberately recalling a previous event. An involuntary memory would be a seemingly spontaneous recollection without deliberate intention to bring that event to mind (Anderson & Levy, 2009; Berntsen & Jacobsen, 2008; Johannessen & Berntsen, 2010; Mace, 2007; Mandler, 1994; Richardson-Klavehn, Gardner, & Java, 1994; Schacter, 1987). Involuntary memories are a common phenomenon in healthy adults (Bernsten, 1996; Kvavilashvili & Mandler, 2004). Indeed, Rubin and Berntsen (2009) report that frequencies of voluntary and involuntary recollections of significant events are comparable, making the relative lack of research in the area even more remarkable. Involuntary memories have broad relevance to experimental psychopathology and are highlighted as a critical transdiagnostic treatment target across a range of disorders (Brewin, Gregory, Lipton, & Burgess, 2010; Holmes & Hackmann, 2004; Holmes & Mathews, 2010).

Involuntary memories are typically sensory-perceptual rather than verbal (Arntz, de Groot, & Kindt, 2005; Brewer, 1996; Conway, 1990, 2005; Conway, Meares, & Standart, 2004; Conway & Pleydell-Pearce, 2000), relate to specific events rather than summaries across several events (Schlagman & Kvavilashvili, 2008) and are more frequently negative than positive (Bywaters, Andrade, & Turpin, 2004; Walker, Skowronski, Gibbons, Vogl, & Ritchie, 2009). However, laboratory research in experimental psychology has predominately focussed on memories associated with deliberate, intentional recollection. The basic cognitive processes underlying the development of involuntary memories are relatively

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under-explored. Improving our understanding of these processes would advance theoretical frameworks of involuntary memory development and inform evidence-based treatment innovation.

The stressful film paradigm is used to induce involuntary memories in healthy volunteers as an analogue of real-life experience and subsequent memory formation (Horowitz, 1969). Participants are shown a short aversive film in controlled laboratory conditions, allowing testing of specific hypotheses relating to subsequent involuntary memories (see Holmes & Bourne, 2008 for a review).

Experiments using the stressful film paradigm show that involuntary memories may be vulnerable to interference at encoding using specific cognitive tasks. Completing visuospatial working memory tasks *during* film viewing reduces subsequent involuntary memories (Holmes, Brewin, & Hennessy, 2004; Stuart, Holmes, & Brewin, 2006). Conversely, performing other tasks during the film, such as counting backwards, has been shown to increase involuntary memories relative to no-task controls in some studies (Bourne, Frasquilho, Roth, & Holmes, 2010; Holmes et al., 2004) but not others (e.g., Krans, Naring, Holmes, & Becker, 2009). Broadly, these findings support working memory models predicting that modality-specific, limited capacity resources are required for the encoding of involuntary memories (Andrade, Kemps, Werniers, May, & Szmalec, 2002; Baddeley & Andrade, 2000; Kavanagh, Freese, Andrade, & May, 2001; Kemps & Tiggemann, 2007; Krans, Naring, Holmes, & Becker, 2010; May, Andrade, Pannaboke, & Kavanagh, 2010). Here, we examine for the first time to our knowledge, whether established working memory tasks from the cognitive science literature can interfere with the development of involuntary memories when performed post-encoding of a stressful event. The current studies expand on previous work investigating the role of concurrent experimental task manipulations during the encoding stage on the development of involuntary memories (Bourne et al., 2010; Holmes et al., 2004; Stuart et al., 2006) by exploring the impact of completing task manipulations in the memory consolidation phase (following film viewing).

Memory consolidation refers to the process of stabilization following initial acquisition of information, during which memories are subject to interference for a period of 6-h (Nader, 2003; Walker, Brakefield, Hobson, & Stickgold, 2003). Thus, we previously predicted that completing a visuospatial task after viewing a stressful film would interrupt the consolidation of the sensory-perceptual information required for the development of involuntary memories via competition for the same limited cognitive resources (Holmes, James, Coode-Bate, & Deeprose, 2009; Holmes, James, Kilford, & Deeprose, 2010). In accordance with this, we found that playing the visuospatial computer game "Tetris" (Green & Bavelier, 2003; Sims & Mayer, 2002; Stickgold, Malia, Maguire, Roddenbury, & O'Connor, 2000) after a stressful film reduced involuntary memories relative to a no-task control condition (Holmes et al., 2009) and relative to a both a no-task control condition and a comparable verbal computer game "Pub Quiz" (Holmes et al., 2010).

The "visuospatial hypothesis" predicts that "Tetris" competes for the same sensory-perceptual resources as involuntary memories. We argue that the beneficial effects of "Tetris" in reducing involuntary memory development are attributable to the visuospatial nature of the game rather than providing distraction or enjoyment (Holmes et al., 2010). However, according to a general attention and working memory approach, it is possible that any task could interfere with the development of negative involuntary memories due to loading on the central executive (Engelhard, van den Hout, Janssen, & van der Beek, 2010; Engelhard, van den Hout, & Smeets, 2011; Gunter & Bodner, 2008; van den Hout et al., 2011; van den Hout et al., 2010; van den Hout, Muris, Salemink, & Kindt, 2001; Krans, Naring, & Becker, 2009). Our "visuospatial hypothesis" needs to be tested by examining whether an established visuospatial working memory task (e.g. complex pattern tapping; Baddeley & Andrade, 2000) also serves to reduce the development of involuntary memories in comparison to an established control task (e.g. counting backwords; Vallar & Baddeley, 1982).

We report two studies designed to extend our initial findings (Holmes et al., 2009; Holmes et al., 2010) utilizing working memory tasks previously used in the cognitive psychology literature rather than computer games. In Experiment 1, participants watched the stressful film then immediately completed a visuospatial task (complex pattern tapping), a control-task (backwards counting) or no-task. In Experiment 2, we extended the time-frame from immediately post-film to 30-min post-film.

2. Experiment 1

The visuospatial task involved tapping a five-key pattern on a keyboard concealed from view (Moar, 1978) as reported in Holmes et al. (2004) and Morris (1987). The control-task involved counting backwards aloud from specified three-digit numbers (Holmes et al., 2004, Expt. 3; Tree, Longmore, Majerus, & Evans, 2011; Vallar & Baddeley, 1982). The main outcome was the number of involuntary memories of the film over 1-week. We predicted participants in the visuospatial condition would have fewer involuntary memories relative to both the control-task and no-task task conditions.

2.1. Method

2.1.1. Overview and procedure

All participants completed baseline assessments, pre-film mood ratings and received standardized training on both the visuospatial task and control-task before watching a stressful film. During the film, participants were asked to sit still and pay close attention, imagining that they were "a bystander" present and involved at the scenes of the events being shown. They were asked not to look away or shut their eyes as they would be asked questions about the contents of the film later. Immediately after the film, participants completed ratings for post-film mood, attention paid to film and personal relevance of the film and then completed the assigned experimental task for 10-min. They were then shown how to complete the involuntary memory diary and after 7 days, returned for a follow-up session.

2.1.2. Participants

Sixty volunteers (39 females), with an age range from 18 to 58 (mean = 27.4) were paid a small fee for participation. Participants were recruited locally via online advertisements. For ethical considerations, recruitment materials mentioned that the film would contain graphic and potentially disturbing images. As part of informed consent, all participants confirmed that they had not received any treatment for a mental health problem, nor were planning to undertake a university examination in the following week. A minimization scheme (Scott, McPherson, Ramsay, & Campbell, 2002; Treasure & MacRae, 1998) was used to allocate participants to experimental groups and to ensure equivalence in age, BDI, and STAI-T.

2.1.3. Stressful film

A 9-min stressful film (based on Holmes et al., 2009) comprised 13 extracts of film footage already in the public domain such as Public Information Films. Five scenes depicted motor vehicle