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Recollecting positive and negative autobiographical memories disrupts working memory

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ABSTRACT

The present article reports two experiments examining the impact of recollecting emotionally valenced autobiographical memories on subsequent working memory (WM) task performance. Experiment 1 found that negatively valenced recollection significantly disrupted performance on a supra-span spatial WM task. Experiment 2 replicated and extended these findings to a verbal WM task (digit recall), and found that both negative and positive autobiographical recollections had a detrimental effect on verbal WM. In addition, we observed that these disruptive effects were more apparent on early trials, immediately following autobiographical recollection. Overall, these findings show that both positive and negative affect can disrupt WM when the mood-eliciting context is based on autobiographical memories. Furthermore, these results indicate that the emotional disruption of WM can take place across different modalities of WM (verbal and visuo-spatial).

It is well-known that emotions can influence cognitive function across a diverse range of tasks and settings. This interplay between emotions and cognitive function can have potentially serious consequences, for example, Young (2008) has identified negative effects of stress on cognitive performance as a major risk factor in airplane pilots. One key area of cognition that might be particularly susceptible to the effects of emotion is working memory (WM), that is, the ability to temporarily retain, manipulate, and respond to information drawn from the environment and long-term memory. For example, Baddeley (2007, 2013) and Baddeley, Banse, and Huang (2012) have argued that WM may be the cognitive control center in which emotional processing and evaluation take place. In line with this idea, a substantial body of evidence indicates that WM performance is impaired in individuals experiencing greater life event stress (e.g. Klein & Boals, 2001) and those with mood disorders such as depression (e.g. Christopher & MacDonald, 2005; Hartlage, Alloy, Vazquez, & Dykman, 1993). Likewise, studies testing healthy participants have also shown that experimentally-induced emotional states can affect WM performance (for a review, see Mitchell & Phillips, 2007). In particular, several studies have found that negative affect impairs WM performance (Kensinger & Corkin, 2003; Koch et al., 2007; Osaka, Yaoi, Minamoto, & Osaka; 2013; Shackman et al., 2006).

Classical models based on differences of allocation of cognitive resources between emotional and neutral contents are often invoked to explain these effects (e.g. Ellis & Ashbrook, 1988; Seibert & Ellis, 1998). According to these models, both negative and positive emotional states cause the occurrence of mood-related contents in WM. The maintenance and processing of these mood-related contents in WM would then mobilize attentional resources that would no longer be available for other tasks. This account leads to a prediction of emotional effects on WM that are nonspecific, that is, they are independent of whether affect is positive or negative. This account has received some support from data showing that both negative and positive affect can impair performance in tasks recruiting WM and executive control (e.g. Oaksford et al., 1996). In contrast, a different stream of evidence shows that negative and positive affect can have a differential effect on WM tasks. For instance, Gray (2001) found that spatial 2-back performance was enhanced by prior viewing of threat-related films and impaired following positive films, while verbal n-back revealed the reverse pattern of effects. In addition, many studies have also shown that positive affect can have a facilitating effect on WM and executive control tasks, which further challenges resource allocation models (Dreisbach & Goschke, 2004; Gray, 2001; Kuhl & Kazen, 1999). Many models have been invoked to account for these results. For instance, it has been argued that the effects of the neurotransmitter dopamine would mediate the effects of positive affect on cognitive tasks (Dreisbach et al., 2005; Ashby et al., 1999; Roesch-Ely et al., 2005). Other potential mediating factors have also been suggested, such as cognitive set, approach and withdrawal states, executive ability, and individual differences (e.g. Derakshan, Smyth, & Eysenck, 2009; Gray, Braver, & Raichle, 2002; Mitchell & Phillips, 2007; Schaefer et al., 2006).

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The picture emerging from these apparently divergent results is that the nature of the effects of emotion on WM and cognitive control depends on many factors, including the type of task used to induce affect (Banich et al., 2009; Gray, 2004). It is therefore important to map how different methods of emotion elicitation can lead to specific patterns of modulation of WM. A method of mood induction that has not previously been investigated in this context involves asking participants to retrieve emotional autobiographical memories (ABMs). Emotional ABMs are not only powerful methods to induce emotional states (Schaefer & Philippot, 2005), they also provide a particularly ecologically valid method of emotion elicitation, as retrieval of past memories is a frequent cause of emotional states in everyday life (e.g. Goodwin & Williams, 1982; Rimé, Noël, & Philippot, 1991).

Crucially, emotional induction through ABMs is very likely to involve WM processes, as the generation of ABMs is thought to involve the maintenance and manipulation of autobiographical contents in WM (Conway & Pleydell-Pearce, 2000; see also Dalgleish et al., 2007; Piolino, Desgranges, & Eustache, 2009). Importantly, if the ABM contents held in WM vary according to their emotional intensity, then specific consequences for WM function can be predicted. Compared to neutral contents, emotional contents are known to strongly mobilize attentional and WM resources for a variety of reasons: emotional contents can automatically attract attentional resources (Mermillod, Droit-Volet, Devaux, Schaefer, & Vermeulen, 2010; Öhman & Mineka, 2001); emotional contents lead to more rehearsal than neutral contents (Talarico, LaBar, & Rubin, 2004); emotional contents can also trigger attempts at cognitive regulation strategies that recruit WM resources (Ochsner, Bunge, Gross, & Gabrieli, 2002; Schaefer et al., 2003). For all these reasons, there is a well-known asymmetry in the allocation of attentional and WM resources between emotional and neutral contents (Watts, Buratto, Brotherhood, Barnacle, & Schaefer, 2014). Therefore, it could be hypothesized that the generation of emotional ABMs will recruit more WM resources than neutral ABMs, which could then impair performance on a WM task immediately following the generation of emotional ABMs.

These characteristics of emotional ABMs create a context in which WM could be modulated by ABM-induced emotion following the prediction of resource allocation models of emotion–cognition interactions. Specifically, emotional ABMs are very likely to activate mood-relevant contents in WM (Conway & Pleydell-Pearce, 2000; Ellis & Ashbrook, 1988) that will divert cognitive resources necessary to perform a WM task immediately following ABM retrieval. However, to date, emotional ABM retrieval has had only limited use in investigations of emotional effects on cognitive processes. For instance, Phillips, Bull, Adams, and Fraser (2002) observed that retrieval of positive ABMs impaired inhibition and switching performance in a subsequent Stroop task, thus revealing disruption of executive function. To our knowledge no previous studies have examined how retrieval of valenced ABMs impacts on a standard measure of WM incorporating temporary storage.

We aimed to address this gap in the existing literature using the ABM retrieval methodology developed by Schaefer and Philippot (2005), in which participants retrieve and describe emotionally valenced and neutral personal autobiographical memories. This method has been shown to produce reliable changes in self-reported emotional feelings and autonomic nervous system measures for valenced memories compared to neutral memories, with these effects being equivalent in magnitude for positive and negative memories (Fay & Finlayson, 2011; Schaefer & Philippot, 2005).

Under our approach, each participant performed a WM task immediately following each of the ABM retrieval phases. The measure we used to gauge the effects of ABM mood induction was immediate serial recall of supra-span sequences, either using a spatial Corsi task in Experiment 1 or an aurally presented digit recall task (Experiment 2). Both Corsi and digit recall are commonly used measures of WM (Baddeley, 2003), and are often assumed to tap separable visuospatial and phonological sub-components, as set out in the model of WM proposed by Baddeley and Hitch (1974). Therefore, significant effects of emotion on either or both types of WM task would indicate whether these effects are modality-specific (i.e. visuospatial or verbal), or if they rely on modality-general attentional control. Few studies have examined effects of emotion induction across different modalities, and these have typically used very different elicitation methods (e.g. Gray, 2001). In line with classical models of emotion–cognition interaction (Ellis & Ashbrook, 1988; Seibert & Ellis, 1991), and with the assumption that emotional ABMs will tap WM resources to a greater extent than neutral ABMs, we expected that recollecting emotional ABMs would have a detrimental effect on an immediately subsequent WM task.

The supra-span method allows the use of a single sequence length titrated to each participant's memory span. This approach provides a sensitive measure of WM that is constant in length, enabling us to track the impact of ABM-based emotion induction across trials. As measures of WM and executive function are typically obtained following induction, it is likely that any effect of these manipulations will be particularly powerful during early trials immediately following the induction procedure, before waning across the course of the trial block.

1. Experiment 1

This experiment examined performance on a Corsi spatial WM task, immediately after retrieval of a neutral or negatively valenced ABM. Physical and computerized variants of this task have been frequently used to assess spatial WM processing and capacity (e.g. Burke, Allen, & Gonzalez, 2012; De Renzi, 1982), with studies suggesting a dissociation from verbal (Vandierendonck, Kemps, Fastame, & Szmalec, 2004) and visual WM (Della Sala, Gray, Baddeley, Allamano, & Wilson, 1999) and a role for executive function, particularly for longer sequences (Vandierendonck et al., 2004). Due to recollection of a negatively valenced ABM possibly eliciting more vivid visual imagery, and/or leading to attentional capture and thus loading on executive resources, we predicted that this condition would reveal less accurate performance on the subsequent visuospatial WM task, relative to the neutral recollection condition.

1.1. Method

1.1.1. Participants

There were 24 English-speaking participants (8 male, 16 female) in this study, aged between 19 and 36 years (mean = 23.4). All participants were right-handed and had normal or corrected-to-normal vision.

1.1.2. Design and procedure

Emotional valence of ABM was manipulated using a repeated measures design, with valence having two levels (negative, neutral). The single testing session consisted of a Corsi span pre-test and the two experimental blocks (each featuring ABM recollection followed by a set of spatial recall trials). Order of conditions was fully counterbalanced across participants.

In line with the supra-span method, each experimental session started with a Corsi span pre-test to establish, for each participant, the sequence length to implement in the main phase of the study. Stimuli were displayed on an 18.4″ screen, using an adapted version of the Psychology Experiment Building Language (PEBL) computerized Corsi task (Mueller and Piper, 2014).

Each trial started with a screen displaying the text “Ready” for 1000 ms. Next, a screen presenting an array of 9 blue squares (each 3×3 cm in size) was presented during 1000 ms on a black background, in locations that were consistent across participants and trials (see Fig. 1). Next, one of the squares (the “target”) was highlighted by flashing in yellow for 1000 ms, before reverting back to blue. Just after this, another one of the locations would become a target, being highlighted in the same fashion. The number of targets that were sequentially highlighted