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Written cues provoke involuntary cognitions about a trauma analogue

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After trauma people commonly experience intrusive memories and involuntary elaborative cognitions, such as imagined future events. Involuntary elaborative cognitions differ from intrusive memories because they involve the construction of a *novel* scenario, rather than the retrieval of a specific past event. Presenting multiple, unrelated cues together—compared to isolated cues—might elicit more elaborative cognitions by encouraging the extraction of distinct memory traces to construct a novel event. Conversely, isolated cues might elicit more intrusive memories by encouraging retrieval of a specific memory. We investigated these ideas using a vigilance task consisting of written cues. Participants viewed negative photos and then viewed either no cues, single cues (e.g., *knife*), or cues presented together as randomly selected triplets (e.g., *skull sick hunger*). Cues encouraged involuntary cognitions. However, frequency of intrusive memories and involuntary elaborative cognitions did not depend on whether cues were presented singularly or as triplets.

General Audience Summary

Following traumatic experiences people often experience intrusive memories, such as a car crash victim remembering the moment of impact. In addition to intrusive memories, however, people can also experience thoughts or images about the trauma that include imagined details: *involuntary elaborative cognitions*. For example, a victim might involuntarily imagine their injuries from a car crash as more severe than they actually are. According to some theorists, imagining an event is different from remembering the past because it requires a person to bring to mind elements of several different memories—as opposed to a single memory—and combine these memories to construct a novel (i.e., non-experienced) event. One possibility, therefore, is that involuntary elaborative cognitions will occur more often when a person is presented with multiple cues that are related to different memories *together*, compared to when they are presented with an *isolated* cue related to one specific memory. We investigated this possibility by exposing participants ($N = 162$) to negative photos depicting graphic scenes, including death. After viewing the photos, participants saw line patterns and pressed a key whenever the lines were presented vertically. During this task, some participants saw words (cues) related to the photos (e.g., *knife*). Some participants saw single words; other participants saw randomly generated triplet words (e.g., *skull sick hunger*). Participants exposed to cues experienced more involuntary cognitions than participants who were not exposed to cues. However, it did not make a difference if cues were presented singularly or as a group of three.

Keywords: Intrusions, Trauma, Involuntary cognitions

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People diagnosed with post-traumatic stress disorder (PTSD) can experience spontaneous intrusive memories of their trauma that are repetitive, often disruptive, and distressing (Kvavilashvili, 2014). These people can also experience involuntary elaborative cognitions: images or thoughts about the trauma that include imagined (non-experienced) details (Reynolds & Brewin, 1998). We know little about whether the mechanisms underlying intrusive memories and involuntary elaborative cognitions differ. However, because involuntary elaborative cognitions involve the construction of a *novel* scenario using disparate details in memory, the presentation of multiple, unrelated cues *together* may elicit these cognitions more than an isolated cue, by encouraging people to extract and recombine different memory traces. Conversely, for intrusive memories, isolated cues may be superior to multiple cues because they activate a specific trace in the memory network. Our goal was to test this proposal.

Most involuntary-cognition research has focused on involuntary autobiographical memories (IAMs): memories of personal experiences that arise spontaneously (Berntsen, 1996). We know that IAMs typically occur in response to cues that resemble some central feature of the remembered event, such as a certain object or person (e.g., Berntsen, 1996; Berntsen & Hall, 2004; Mace, 2004, 2006). These cognitions often occur with little disruption to everyday activities; IAMs are therefore distinct from *intrusive memories*, which are usually negative, repetitive, unwanted, and sometimes disruptive (Kvavilashvili, 2014).

Although intrusive memories feature in PTSD, not all cognitions in PTSD are memories. People with PTSD also experience involuntary elaborative cognitions: thoughts or images that contain imagined details (Reynolds & Brewin, 1998). For example, in one study, 22% of trauma victims reported that their intrusions were typically *exaggerated* versions of the trauma (Merckelbach, Muris, Horselenberg, & Rassin, 1998). Similarly, another study found that patients with traumatic hand injuries frequently experienced involuntary images in which their injury appeared more severe than it was in reality (Grunert, Devine, Matloub, Sanger, & Yousif, 1988). More recently, Reynolds and Brewin found that participants with PTSD sometimes experienced involuntary cognitions about potential future events or imagined outcomes. For example, one participant experienced intrusive images of a funeral after learning a relative had cancer. Although the cognitions reported across these studies likely contain details from memory, they also include imagined details.

Determining what mechanisms underlie intrusive memories and elaborative cognitions after trauma could potentially be used to devise therapeutic methods to reduce their occurrence. Within the cognitive literature a prevailing theory is that cues resembling features of previous events encourage a spreading of activation within the memory network, leading to IAMs (e.g., Berntsen, 2009; Mace, 2007). As the potential for overlap between a cue and a memory increases, IAM frequency should also increase (e.g., Berntsen, 2009; Conway, 2005). Given that IAMs and intrusive memories share features, perhaps this same mechanism explains intrusive memories in PTSD. Indeed, trauma-related cues provoke intrusive memories (e.g., Brewin, Huntley, &

Whalley, 2012). For example, Michael, Ehlers, Halligan, and Clark (2005) found that displaying pictures of different assaults to assault victims provoked intrusive memories of participants' own assault. Trauma analogue studies (e.g., Krans, Näring, Holmes, & Becker, 2010) reveal similar findings; for example, after viewing negative photos, participants who later viewed blurred versions of those photos experienced intrusive memories (Krans, Pearson, Maier, & Moulds, 2016).

But does this cue-overlap principle apply to involuntary elaborative cognitions? Although related theory is sparse, Berntsen and Jacobsen (2008) propose that involuntary future events—a type of elaborative cognition—reflect the automatic construction of a “false memory” through activation of the same associative network supporting IAMs. The person knows the cognition is not a memory, based on semantic knowledge, yet relives the cognition as if it truly happened. Like IAMs, the cognition is constructed almost entirely from elements of memory. However, unlike IAMs, people construct the imagined event using elements from different memories. This idea aligns with theories of episodic future thinking (e.g., Schacter & Addis, 2007; Tulving, 1983). For example, according to Addis, Wong, and Schacter (2007), unlike remembering, imagining an event requires people to extract and flexibly recombine distinct memories to construct a novel and coherent image or event.

If this theory explains elaborative cognitions, then the more access one has to elements of distinct memories at a given time, the more frequently they should experience elaborative cognitions. Thus, multiple and unrelated cues presented together—that activate elements of distinct memories simultaneously—may be better than isolated cues at eliciting involuntary elaborative cognitions, by assisting people to extract disparate details to construct a novel event. Conversely, for intrusive memories, multiple cues presented together may be *less* effective than singular cues. Indeed, researchers propose that a distinct cue related exclusively to one memory will elicit IAMs more than a cue related to many memories, because distinct cues isolate relevant nodes in the associative network but not irrelevant nodes that disrupt retrieval (e.g., Berntsen, Staugaard, & Sørensen, 2013). Thus, when a person is presented with multiple, unrelated cues together, network activation might be too imprecise and therefore intrusive memories might be unlikely. We investigated these ideas by manipulating the number of cues presented together after exposing participants to a series of negative International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) photos.

We had two aims: to determine whether written cues provoke intrusive memories and elaborative cognitions about negative photos, and whether multiple cues presented together elicit more elaborative cognitions than singular cues, consistent with proposed underlying mechanisms. To address these aims, we followed previous studies that have monitored and/or provoked involuntary cognitions with cues immediately after a trauma analogue for a short period (e.g., Nixon, Cain, Nehmy, & Seymour, 2009). Regarding the cuing procedure, we adapted a laboratory-based paradigm developed by Schlagman and Kvavilashvili (2008) in which participants completed a monotonous vigilance task while viewing task-irrelevant cue phrases (e.g., *going on a*

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