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Visuospatial context learning and configuration learning is associated with analogue traumatic intrusions

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ABSTRACT

Background and objectives: Cognitive and information processing theories of Post-Traumatic Stress Disorder (PTSD) assert that trauma intrusions are characterized by poor contextual embedding of visuospatial memories. Therefore, efficient encoding of visuospatial contextual information might protect against intrusions. We tested this idea using indices of visuospatial memory embedding along with the trauma film paradigm.
Methods: Individual differences in spatial configuration learning, as well as the degree to which visual recognition memory depends on its visual encoding context (i.e., memory contextualization), were assessed in 81 healthy participants. Next, participants viewed a distressing film. Intrusions and other PTSD analogue symptoms were assessed subsequently.
Results: Participants displaying stronger memory contextualization developed fewer intrusions and PTSD analogue symptoms. Spatial configuration learning was unrelated to memory contextualization and, contrary to prior findings, predicted higher levels of intrusions.
Limitations: Due to the analogue design, our findings may not translate directly to clinical populations. Furthermore, due to the correlational design of the study, causal relations remain to be tested.
Conclusions: Our results suggest a protective role for the ability to integrate memories in their original visual learning context against the development of PTSD symptoms.
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Many people experience potentially traumatic situations at some point in their life, such as natural disasters, severe accidents, or violent crimes (Darves-Bornoz et al., 2008). Although most trauma victims adjust well (Bonanno & Mancini, 2008), a considerable proportion develops trauma-related psychopathology, such as Post-Traumatic Stress Disorder (PTSD; American Psychiatric Association, 2013). Characteristically, many victims suffer from recurrent involuntary memories in the form of vivid images that are highly distressing and rich in sensory detail (e.g., intrusions, flashbacks). To explain the hyper-accessibility of traumatic memories, various theoretical models of PTSD attribute a critical role to mechanisms of memory encoding, consolidation, or retrieval (Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000; Rubin, Berntsen, & Bohni, 2008).

Cognitive and information processing theories assert that intrusions in PTSD lack contextual integration within the autobiographical memory structure. For example, according to the revised dual-representation model (Brewin, Gregory, Lipton, & Burgess, 2010), if representations of a traumatic experience have been stored in isolation from the original encoding context, matching perceptual cues can involuntarily trigger sensation-near representations, resulting in subjective re-experiencing of the trauma. Similarly, Ehlers and Clark (2000) posit that due to strong perceptual priming in PTSD, cues with even vague sensory similarity to the traumatic event can trigger intrusions, which often appear to be disjointed from relevant contextual information. Taken together, it follows that individuals who are better able to store and discriminate environmental cues from the original traumatic scenes might be less vulnerable to develop intrusive trauma memories.

In line with this assertion, Meyer, Smeets, Giesbrecht, Quaedflieg, Girardelli, et al. (2013a) found that individuals who displayed superior implicit learning of spatial configurations

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reported fewer intrusive memories after viewing a trauma film. Arguably, individuals who excel in configuration learning are better able to distinguish trauma cues from perceptually similar stimuli in the environment, resulting in a lower likelihood of trauma memories being activated. Moreover, implicit spatial configuration learning depends crucially on medial temporal lobe structures (Goldfarb, Chun, & Phelps, 2016; Preston & Gabrieli, 2008) that have been theorized to be involved in the construction of abstract representations from visuospatial input (e.g., allocentric, or context-based representations; Brewin et al., 2010). Therefore, better spatial configuration learning might also be linked to efficient encoding and binding (also see Farrell, 2012) of the visuospatial context in which a traumatic event took place.

However, the ability to merely discriminate cues is necessary but perhaps not sufficient to protect against intrusions: central perceptual elements of a traumatic experience should also be integrated within the visual representation of their original encoding context (i.e., *memory contextualization*). Thereby, perceptual trauma memories would become more context-dependent and less likely to be triggered out of context. By including an additional novel task to assess memory contextualization, the current study investigated whether the association between spatial configuration learning and intrusions is mediated by memory contextualization.

We expected to replicate the finding that participants with superior spatial configuration learning report fewer intrusive memories after viewing a trauma film. Moreover, we predicted memory contextualization to be associated with fewer intrusive trauma film intrusions, because it may prevent emotional memories from being activated in isolation (Brewin et al., 2010; Ehlers & Clark, 2000) and limit generalization of potential memory triggers. Finally, assuming that spatial configuration learning facilitates visuospatial scene discrimination, we expected this memory function to be associated with memory contextualization.

1. Method

1.1. Participants

Eighty-one undergraduates (63 women) with a mean age of 21.5 years ($SD = 2.7$) were recruited via advertisements at Maastricht University campus and completed the study. Prior to the study, candidate participants received information about the study and a screening form via email. Candidates were instructed to reply only if they were still interested and eligible for participation, using the following exclusion criteria: (1) recent psychological or psychiatric problems, (2) drug or alcohol abuse, (3) blood phobia or a history of a severe accident, assault, or injury, and (4) prior participation in similar trauma film studies. Furthermore, participants were required to be fluent in Dutch and have normal or corrected-to-normal vision. They received partial course credit or financial compensation (€25) in return for their participation. The study was approved by the standing ethical committee of the Faculty of Psychology and Neuroscience, Maastricht University.

1.2. Spatial configuration learning

We employed the abbreviated Spatial Contextual Cueing Task (SCCT; Bennett, Barnes, Howard, & Howard, 2009; Meyer et al., 2013a,b). Participants are required to find a single target with the shape of a rotated 'T' pointing left or right among 11 'L'-shaped distractors and indicate in which direction the target points as fast and accurately as possible by pressing a button. Across 30 blocks with 12 trials each, half of the target and distractor configurations were repeated, whereas novel configurations were presented on the other half of the trials. Target direction (left or right) varied randomly across all trials. Since repeated configurations predict the target location, they facilitate the search and reduce reaction times (RT) in repeated compared to novel configurations. This learning effect quantifies spatial configuration learning. For further details about the programming of this task, see Meyer et al. (2013a; supplementary material).

1.2.1. Scoring

The median RT of trials with accurate responses was extracted for each block, separately for novel and repeated trials. In line with Meyer et al. (2013a,b), these scores were averaged across three consecutive epochs of 9, 10, and 10 blocks (omitting the very first block, because no repetition had occurred yet). To quantify spatial configuration learning, we subtracted average median RT scores on repeated trials from novel trials. A more positive difference score indicates stronger spatial configuration learning. In line with prior studies using the SCCT in healthy young adults (Bennett et al., 2009; Meyer et al. 2013a,b), accuracy scores were close to ceiling (M >95%) and therefore not considered in the analyses.

1.3. Visual memory contextualization

On the basis of a contextual memory task with word stimuli used previously by Van Ast, Cornelisse, Meeter, Joëls, and Kindt (2013), this task measures the speed and accuracy with which participants recognize neutral and emotional pictures of objects that were presented in an earlier encoding phase.

1.3.1. Stimuli

One-hundred and twenty pictures of different objects served as stimuli. The pictures were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005) and their visual backgrounds were deleted using Photoshop (Adobe, San Jose, CA, USA). Objects were either neutral or negative. Within each valence category, there were equal numbers of objects most likely encountered indoors (e.g., chair, burglar), in nature (e.g., mushroom, snake), or in an urban context (e.g., umbrella, handgun). In addition, 60 creative-commons licensed pictures taken from the Internet were used, displaying emotionally neutral background scenes indoor (e.g., living room, $n = 20$), nature (e.g., forest, $n = 20$), or urban (e.g., city street, $n = 20$).

1.3.2. Encoding phase

Each trial began with a 1 s fixation cross on a black background, followed by a 700 × 933 pixels background scene picture that was shown for 2.5 s. One second after background picture onset, an object picture appeared in the foreground within a grey 300 × 400 pixels frame. The object was displayed for 2 s, outlasting background picture offset for 500 ms. After that, participants were asked to provide valence and arousal ratings of the object within its background using two respective Self-Assessment Manikin (SAM; Bradley & Lang, 1999) ratings in randomized order, in order to stimulate deep encoding (Craik & Lockhart, 1972).

The encoding phase consisted of 60 trials, where each background picture was paired with one out of 60 object pictures (30 neutral/30 negative). Trial sequence and stimulus composition was randomized for each participant, with the restriction that background-object combinations matched in terms of scene (i.e., indoor, nature, urban) and that the same valence (neutral, negative) did not occur more than 3 times consecutively. To reduce possible primacy effects, the task began with three additional, fixed practice trials with neutral objects. Participants were instructed to vividly imagine each foreground item and its meaning within the shown background scene, stimulating active *binding* of the object and background, rather than encoding of the object-background

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