



# Perceptual processing during trauma, priming and the development of intrusive memories

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## ARTICLE INFO

### Article history:

Received 10 October 2011  
Received in revised form  
2 July 2012  
Accepted 10 October 2012

### Keywords:

Trauma memories  
Enhanced perceptual priming  
Posttraumatic stress disorder  
Data-driven processing  
Dissociation

## ABSTRACT

**Background:** Intrusive reexperiencing in posttraumatic stress disorder (PTSD) is commonly triggered by stimuli with perceptual similarity to those present during the trauma. Information processing theories suggest that perceptual processing during the trauma and enhanced perceptual priming contribute to the easy triggering of intrusive memories by these cues.

**Methods:** Healthy volunteers ( $N = 51$ ) watched neutral and trauma picture stories on a computer screen. Neutral objects that were unrelated to the content of the stories briefly appeared in the interval between the pictures. Dissociation and data-driven processing (as indicators of perceptual processing) and state anxiety during the stories were assessed with self-report questionnaires. After filler tasks, participants completed a blurred object identification task to assess priming and a recognition memory task. Intrusive memories were assessed with telephone interviews 2 weeks and 3 months later.

**Results:** Neutral objects were more strongly primed if they occurred in the context of trauma stories than if they occurred during neutral stories, although the effect size was only moderate ( $\eta_p^2 = .08$ ) and only significant when trauma stories were presented first. Regardless of story order, enhanced perceptual priming predicted intrusive memories at 2-week follow-up ( $N = 51$ ), but not at 3 months ( $n = 40$ ). Data-driven processing, dissociation and anxiety increases during the trauma stories also predicted intrusive memories. Enhanced perceptual priming and data-driven processing were associated with lower verbal intelligence.

**Limitations:** It is unclear to what extent these findings generalize to real-life traumatic events and whether they are specific to negative emotional events.

**Conclusions:** The results provide some support for the role of perceptual processing and perceptual priming in reexperiencing symptoms.

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## 1. Introduction

Intrusive memories are considered the hallmark symptom of posttraumatic stress disorder (PTSD). They commonly consist of relatively brief sensory impressions from the trauma (Hackmann, Ehlers, Speckens, & Clark, 2004; Reynolds & Brewin, 1999; Van der Kolk & Fisler, 1995), that are experienced as happening in the “here and now” rather than being a memory from the past (Hackmann et al., 2004; Michael, Ehlers, Halligan, & Clark, 2005), and are easily triggered by a wide range of internal and external cues (Southwick et al., 1993; Van der Kolk & Fisler, 1995). Intrusive

memories and their triggers can include those that bear no meaningful relationship with the traumatic event but are only temporally associated (Ehlers & Clark, 2000; Ehlers et al., 2002; Speckens, Ehlers, Hackmann, Ruths, & Clark, 2007). The present experiment investigated two related processes that may be involved in the easy triggering of intrusive memories, perceptual processing during the trauma and perceptual priming.

### 1.1. Perceptual priming

Priming is a type of implicit memory that is characterized by enhanced identification of previously seen stimuli (Schacter, 1992). Ehlers and Clark (2000) proposed that the easy triggering of intrusive memories by perceptually similar stimuli is, in part, a function of *strong perceptual priming*. They suggested that trauma survivors who acquire strong priming for stimuli that they

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encountered during the traumatic event have a reduced perceptual threshold for these stimuli. This makes it more likely that they detect potential triggers of intrusive memories in their environment.

There is preliminary evidence for a role of perceptual priming in PTSD. Several studies found that after encoding trauma-related and neutral material, people with PTSD show greater perceptual priming for trauma-related material compared to controls in word-stem completion or perceptual identification tasks (e.g., Amir, Leiner, & Bomyea, 2010; Ehring & Ehlers, 2011; Michael, Ehlers, & Halligan, 2005). Priming predicted PTSD severity 6 months later (Ehring & Ehlers, 2011; Michael, Ehlers, & Halligan, 2005). Kleim, Ehring, and Ehlers (2012) further found that trauma survivors with PTSD show perceptual processing advantages in identifying blurred trauma-related pictures compared to those without PTSD.

Experimental analogue studies provided initial support for the role of perceptual priming in the development of intrusive trauma memories (Arntz, de Groot, & Kindt, 2005; Ehlers, Mauchnik, & Handley, *in press*; Ehlers, Michael, Chen, Payne, & Shan, 2006; Michael & Ehlers, 2007). For example, a paradigm developed by Ehlers et al. (2006) investigates priming for neutral objects that are perceived just before something “traumatic” happens. Participants watch a series of “traumatic” and neutral picture stories, each comprising three pictures. The content of the first picture is neutral, introduces the main character of the story, and contains neutral objects for which priming was later measured. The plot then unfolds in the second picture either in a traumatic or in a neutral way. The last picture depicts the outcome of the story. With this paradigm, neutral stimuli that preceded a “traumatic” event showed enhanced perceptual priming and predicted intrusive memories (Ehlers et al., 2006; Michael & Ehlers, 2007).

### 1.2. Perceptual processing during trauma

Information processing models of PTSD suggest that strong encoding of perceptual information and relatively weak encoding of contextual information during trauma predicts subsequent reexperiencing symptoms (Brewin, Dalgleish, & Joseph, 1996; Brewin, Gregory, Lipton, & Burgess, 2010; Ehlers & Clark, 2000). Two related ways of processing that may facilitate strong encoding of perceptual information have been investigated in PTSD; (i) data-driven processing (Roediger, 1990) refers to encoding that focuses on the surface level features of a situation (i.e., sensory details such as colours and shapes) rather than its meaning (Ehlers & Clark, 2000), and (ii) dissociation is a complex concept involving a lack of integration of subjective experiences including depersonalization, derealization, altered time perception and emotional numbing (e.g., Van der Kolk & Fisler, 1995). It has been suggested that dissociation during trauma may in part predict PTSD because, like data-driven processing, it leads to preferential encoding of perceptual information (Ehlers & Clark, 2000). It has further been suggested that dissociation during a traumatic event decreases focal attention, thereby interfering with meaningful processing of the traumatic event and promoting a nonverbal, perceptual processing style (Brewin et al., 1996; Siegel, 1995).

Clinical and analogue studies found that data-driven processing and dissociation predict later reexperiencing and PTSD (e.g., Ehring, Ehlers, & Glucksman, 2008; Halligan, Michael, Clark, & Ehlers, 2003; Holmes, Brewin, & Hennessy, 2004). It is not yet clear by which mechanisms these forms of processing during the trauma contribute to PTSD. One possible pathway is perceptual priming (Ehlers & Clark, 2000) which is thought to rely heavily on perceptual operations and unconscious processes and should therefore benefit from encoding styles that favour perceptual information (Roediger, 1990). In line with this hypothesis, data-driven

processing and dissociation correlated with priming in clinical and analogue studies (Ehlers et al., 2006; Lyttle, Dorahy, Hanna, & Huntjens, 2010; Michael & Ehlers, 2007).

### 1.3. Aims of the study

A new version of Ehlers et al.'s (2006) paradigm to investigate perceptual priming for objects from traumatic contexts and its relationship with processing styles and intrusions was developed to address some limitations of the earlier paradigm. First, the number of primed neutral objects was increased. Second, objects were no longer presented *within* the slides of the picture stories, but interspersed in the intervals between story pictures so that they could be counterbalanced across trauma and neutral stories.

The study investigated the following hypotheses:

**Hypothesis 1.** Neutral stimuli are more strongly primed if they occur in a traumatic context than if they occur in a neutral context.

**Hypothesis 2.** Enhanced perceptual priming for objects previously seen in a traumatic context predicts subsequent intrusive memories.

**Hypothesis 3.** Data-driven processing and state dissociation during traumatic stories predict subsequent intrusive memories.

**Hypothesis 4.** Data-driven processing and state dissociation predict enhanced perceptual priming for trauma-related stimuli.

In addition, we assessed recognition memory for objects previously seen in traumatic and neutral contexts to check the possible influence of explicit memory on priming effects. On the basis of previous results with a similar paradigm (Ehlers et al., 2006; Michael & Ehlers, 2007), we did not expect an influence of story context on recognition memory. We also assessed state anxiety and verbal intelligence to explore their relationship with priming and intrusive memories.

## 2. Material and methods

### 2.1. Participants

Fifty-six healthy volunteers were recruited from a database of people interested in participating in research. Potential participants were excluded if they had a history of past trauma ( $n = 0$ ), were currently suffering from depression or blood/injury phobia ( $n = 0$ ), had previous experience with related psychological experiments ( $n = 3$ ) and/or had frequent previous exposure to distressing visual stimuli (e.g., professional background involving exposure to dead bodies or photos of mutilated bodies,  $n = 2$ ). Thus, the final sample comprised 51 participants (27 male). Ages ranged from 18 to 68 years ( $M = 30.6$ ;  $SD = 11.4$ ). All participants completed the first follow-up interview at 2 weeks after the experiment (100%); and 41 (80%) participated in the second follow-up interview after 3 months. Participants received £15 as reimbursement for their time and travel expenses.

### 2.2. Experimental paradigms

The experiment was programmed with SuperLab 4.0 (Cedrus Corp, San Pedro, CA, USA). Picture stories and memory tests were presented on a 17" Dell monitor using a Dell Optiplex PC (GX 270).

#### 2.2.1. Picture stories

Participants watched two trauma and two neutral picture stories comprising eight pictures on a computer screen, and listened to a narrative of what was happening in the story. Presentation mode was adapted from Cahill, Prins, Weber, and McGaugh (1994) and

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