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Contextualisation in the revised dual representation theory of PTSD: A response to Pearson and colleagues☆

Chris R. Brewin*, Neil Burgess [1]

University College London, UK

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ABSTRACT

Three recent studies (Pearson, 2012; Pearson, Ross, & Webster, 2012) purported to test the revised dual representation theory of posttraumatic stress disorder (Brewin, Gregory, Lipton, & Burgess, 2010) by manipulating the amount of additional information accompanying traumatic stimulus materials and assessing the effect on subsequent intrusive memories. Here we point out that these studies involve a misunderstanding of the meaning of "contextual" within the theory, such that the manipulation would be unlikely to have had the intended effect and the results are ambiguous with respect to the theory. Past and future experimental tests of the theory are discussed.

The dual representation theory of posttraumatic stress disorder (PTSD) (Brewin, Dalgleish, & Joseph, 1996) was recently updated to be consistent with developments in cognitive neuroscience (Brewin, Gregory, Lipton, & Burgess, 2010; Byrne, Becker, & Burgess, 2007). In this revision the involuntary flashbacks characteristic of the disorder were proposed to arise from an imbalance or dissociation between sensory-bound and contextual representations encoded at the time of the trauma. In three studies with healthy volunteers Pearson and colleagues (Pearson, 2012; Pearson, Ross, & Webster, 2012) attempted to test the theory by manipulating the amount of additional information made available to participants exposed to traumatic materials. These authors obtained results that they concluded were inconsistent with the revised dual representation theory (DRT). However, Pearson's experimental interpretation appears to contain a fundamental misunderstanding of the meaning of "context" in the DRT, which is unfortunately compounded by the way they employ an experimental analogue of traumatic experience. We conclude that, insofar as their results are interpretable with respect to the DRT, the studies of Pearson and colleagues offer mild support to the theory.

The DRT assumes that two different types of memory representation are encoded at the time of the traumatic event. One type of representation includes sensory details and affective/emotional state experienced during the traumatic event (sensory-bound representation or S-rep for short). The other includes a subset of the sensory input, recoded into an abstract structural description, along with the spatial and personal context of the person experiencing the event (contextual representation or C-rep for short). Thus, S-reps and C-reps are not primarily distinguished by the type of input (e.g. sensory versus verbal) but represent different aspects of the input that are derived from it by different types of processing. In healthy memory the S-rep and C-rep are tightly associated, such that an S-rep is generally retrieved via the associated C-rep. Access to C-reps is under voluntary control but may also occur involuntarily. According to the DRT, direct involuntary activation and re-experiencing of S-reps occurs when the S-rep is very strongly encoded, due to the extreme affective salience of the traumatic event, and the C-rep is either encoded weakly or without the usual tight association to the S-rep. This might be due to stress-induced down-regulation of the hippocampal memory system (Jacobs & Nadel, 1985), and/or due to a dissociative response to the traumatic event.

Within the DRT, one aspect of therapy or normal recovery can be considered to be (re)association of the S-rep with its corresponding C-rep, so that the sensory and affective/emotional representation of the traumatic event can be seen in its appropriate context. This has

* Corresponding author. Clinical, Educational & Health Psychology, University College London, Gower Street, London WC1E 6BT, UK.
E-mail address: c.brewin@ucl.ac.uk (C.R. Brewin).

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beneficial consequences, such as allowing the difference between that context (the associated C-rep) and current personal context to be appreciated and used to control the retrieval of the S-rep, allowing integration with other autobiographical knowledge, and facilitating deliberate recall and communication of the details of the traumatic event. The proposed imbalance between S-reps and C-reps in PTSD is also consistent with the observation that, while intrusive sensory and affective representations of a traumatic event are frequent in PTSD, consciously controlled "context-dependent" or "episodic" memories for the traumatic events are often impaired (Brewin, 2013). The DRT also corresponds to animal studies of fear conditioning, in which acquisition of the association between a sensory stimulus and an aversive event leads to subsequent involuntary fearful responses to the stimulus, such as fear-potentiated startle. These changes depend on associative links between sensory representations and internal representations of emotional states in the S-rep, and likely mediated by the amygdala. However, the expression of these fearful responses is controlled by the C-rep (likely mediated by the hippocampus) so that, for example, they only occur within the same physical context in which the aversive event was experienced.

A number of studies have sought to test the theory using the trauma film paradigm adopted by Pearson and colleagues (Holmes & Bourne, 2008). In these studies participants are exposed to segments of film lasting several minutes that include traumatic or disturbing elements, and the occurrence of involuntary images from the film is measured over the succeeding week using a daily diary. The trauma film paradigm is designed to attract and hold participants' attention, provoke arousal and feelings of personal involvement and empathy, mimicking a real-life event. To this end an auditory commentary is typically included that provides a context for the scenes being shown (e.g., it describes who the victims of a car crash were and where they were going at the time of the accident). An extensive body of research shows that empathy (Levine & Edelstein, 2009), as well as arousal and personal involvement (Holland & Kensinger, 2010), increase the probability of recall. In fact, auditory commentaries have been shown to produce intrusive visual images even when unaccompanied by any visual materials (Krans, Näring, Holmes, & Becker, 2010).

Pearson (2012) sought to test DRT by either presenting or withholding the auditory commentary shown with the trauma film. Similarly, Pearson et al. (2012) presented or withheld similar explanatory material associated with traumatic pictures (giving them the label of either 'war' or 'crime'). In their three studies those images accompanied by explanatory material intruded more frequently over subsequent days.

By referring to the additional information as "contextual" Pearson et al. assumed that, according to the DRT, its presence should automatically strengthen C-reps relative to S-reps and thus reduce the number of intrusions. However, as explained above, the way a traumatic event is encoded into S-reps and C-reps within the DRT does not bear any straightforward relationship to the *amount of additional information* present in the input, or its modality of presentation. Rather, it results from an interaction between the information contained in the input and how the input is processed (as determined by factors such as hippocampal efficiency, concurrent distractor tasks, or dissociation). Thus, simply manipulating the presence of additional information does not test the theory in the way assumed by Pearson and colleagues.

Since S-reps encode the affective and emotional states experienced, providing additional information concerning the traumatic images that increases the participant's arousal, understanding of what is being shown, personal involvement, or empathy, may strengthen the S-rep corresponding to the traumatic event, contrary to Pearson et al.'s assumption. This additional involvement may also weaken the C-rep because participants are less aware of their own spatial and personal context. Conversely, any direct effect on the C-rep of additional information concerning the traumatic images would depend on the relationship of this information to the participant's own spatial and personal context, and would probably be negligible in the Pearson et al. studies. Thus, according to the DRT, the additional information presented by Pearson and colleagues could *increase* subsequent intrusive imagery, in line with their findings, and the findings of Krans et al. (2010).

The variable effects of supplying additional information could be tested by carrying out experiments similar to Pearson's that also include a control condition in which other kinds of material accompanied the scenes (for example, information that the scenes were from a training film or that the scenes depicted in images had been staged). A prediction that could validly have been derived from DRT is that additional emotionally valenced or empathetic information should lead to increased intrusive imagery relative to information that increases the participant's sense of distance from the traumatic event shown.

How else might the proposed relationship between S-reps, C-reps, and intrusive imagery be tested? Much previous work has focused on the prediction that concurrent visuospatial tasks that compete for resources with S-reps during encoding or consolidation will reduce the number of later intrusive images, whereas verbal tasks that compete for resources with C-reps will increase the number of intrusive images. Thus, manipulations have focused on changing the way the sensory input is processed at, or very soon after, encoding. A recent review (Brewin, 2013) found that visuospatial tasks, such as pattern tapping or playing the video game Tetris, during or shortly after watching the film did reduce subsequent intrusions, relative to a control condition, in 12 out of 13 studies. The effects of concurrent verbal tasks were more varied. Whereas counting backwards in 3s or 7s reliably increased intrusive images relative to baseline, other tasks such as remembering a 9-digit number had no effect on them. This suggests that only some verbal tasks compete successfully for resources with C-reps, consistent with the revised version of the theory, which stresses the nature of the representations involved rather than their modality *per se*.

Another approach has been to investigate the different characteristics of S-reps and C-reps laid down in remembering a visuospatial scene. S-reps, being sensory-bound should correspond to the egocentric image specific to the viewpoint from which the scene was perceived, whereas C-reps should correspond to a more abstract structural representation of the allocentric spatial context depicted in the scene. Processing by the hippocampus is specifically required for recognizing an object's location within a scene when tested from a shifted point of view as compared to recognizing it from the same point of view (King, Burgess, Hartley, Vargha-Khadem, & O'Keefe, 2002; King, Trinkler, Hartley, Vargha-Khadem, & Burgess, 2004), consistent with the proposed neural mediation of C-reps within DRT (in this case, spatial context).

Accordingly, Bisby and colleagues (Bisby, King, Brewin, Burgess, & Curran, 2010) measured individual differences in participants' ability to remember object locations from the same or from a shifted point of view prior to showing them a trauma film. Weak shifted-view memory relative to same-view memory predicted increased intrusive memories over the following week. Using similar methods Glazer and colleagues (Glazer, Mason, King, & Brewin, 2013) found that the naturally occurring intrusive memories of individuals with weaker shifted-view location memory were more strongly characterised by a lack of temporal context (increased "nowness").

These very recent experiments suggest a number of new opportunities to test DRT. The theory suggests that certain pre-

existing cognitive characteristics associated with enhanced hippocampal functioning such as above average allocentric spatial processing will confer protection against the development of PTSD. Neuroimaging investigations could compare the structural and functional neural correlates of flashbacks in PTSD patients to the brain structures proposed to support S-reps and C-reps (see, for example, Kroes, Whalley, Rugg, & Brewin, 2011; Whalley et al., 2013). On the treatment side, DRT suggests that PTSD will be helped by interventions that either enhance ventral stream processing of trauma memories, for example by encouraging the visualisation of trauma scenes from alternative perspectives, or interfere with dorsal stream processing, for example using transcranial direct-current stimulation.

In conclusion, we welcome the attempts of Pearson and colleagues to test the DRT in novel ways, but we hope that future experiments avoid further confusion associated with the multiple potential uses of the word "context". To facilitate this, we have outlined some of the ways in which the DRT has been tested, how it might be tested further in future, and how this knowledge might be exploited for the benefit of patients.

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