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Review

The trauma film paradigm as an experimental psychopathology model of psychological trauma: intrusive memories and beyond

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HIGHLIGHTS

- After trauma symptoms of post-traumatic stress such as intrusive memories may develop
- The trauma film paradigm offers an experimental psychopathology model to study trauma
- We reviewed 74 articles that used the paradigm since the earliest review in 2008
- The paradigm can guide clinical innovation, such as targeting intrusive memories
- DSM-5'sPTSD Criteria A allows for trauma exposure through work related movie viewing

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ABSTRACT

A better understanding of psychological trauma is fundamental to clinical psychology. Following traumatic event(s), a clinically significant number of people develop symptoms, including those of Acute Stress Disorder and/or Post Traumatic Stress Disorder. The trauma film paradigm offers an experimental psychopathology model to study both exposure and reactions to psychological trauma, including the hallmark symptom of intrusive memories. We reviewed 74 articles that have used this paradigm since the earliest review (Holmes & Bourne, 2008) until July 2014. Highlighting the different stages of trauma processing, i.e. *pre*-, *peri*- and *post*-trauma, the studies are divided according to manipulations *before*, *during* and *after* film viewing, for experimental as well as correlational designs. While the majority of studies focussed on the frequency of intrusive memories, other reactions to trauma were also modelled. We discuss the strengths and weaknesses of the trauma film paradigm as an experimental psychopathology model of trauma, consider ethical issues, and suggest future directions. By understanding the basic mechanisms underlying trauma symptom development, we can begin to translate findings from the laboratory to the clinic, test innovative science-driven interventions, and in the future reduce the debilitating effects of psychopathology following stressful and/or traumatic events.

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1. Introduction

1.1. Acute Stress Disorder (ASD) and Post Traumatic Stress Disorder (PTSD)

Over the course of their lifetime, most people will experience or witness a traumatic event. A traumatic event is defined in the Diagnostic and Statistical Manual of Mental Disorders as "*exposure to actual or threatened death, serious injury, or sexual violence*" (DSM-5; American Psychiatric Association, 2013, p.271) and may include, for example, interpersonal violence, road traffic accidents or rape. An addition to the recent DSM-5 also includes exposure to aversive details of trauma through electronic media, television and film when viewed in the line of work. A clinically significant number of people who experience such an event may go on to develop Acute Stress Disorder (ASD: in which symptomatology occurs in the first month following a trauma) and/or Post Traumatic Stress Disorder (PTSD: in which symptoms occur for at least one month following trauma; American Psychiatric Association, 2013). Reviews approximate lifetime prevalence rates of PTSD in the population as being between 5 and 12% (Breslau et al., 1998; Kessler, Sonnega, Bromet, Hughes & Nelson, 1995; World Health Organisation, 2003), with similar rates for ASD (e.g. Bryant, Creamer, O'Donnell, Silove & McFarlane, 2012). Individuals who are diagnosed with ASD have an increased likelihood (up to 36%) of going on to develop PTSD (Bryant et al., 2012).

1.2. Experimental psychopathology/experimental medicine models of ASD and PTSD

An experimental medicine model uses experimental approaches to model abnormal processes in nonclinical participants in order to identify mechanisms of the disorder and to demonstrate proof of concept evidence for clinical developments (Bailey, Dawson, Dourish & Nutt, 2011; Guttmacher, Murphy & Insel, 1983; Medical Research Council, 2015). This term ('experimental medicine model') is typically used in medical research context. In psychological treatment contexts, the term 'experimental psychopathology model' is used (Vervliet & Raes, 2013; Zvolensky, Lejuez, Stuart & Curtin, 2001), hitherto we use the latter term. However, we note the broad interest in an experimental psychopathology model, the trauma film paradigm, not only for psychological treatments but also for experimental medicine and pharmacological treatment (Kamboj & Curran, 2006). For a clinical understanding of the impact of psychological trauma (e.g. ASD and PTSD), an ideal experimental psychopathology model would simulate two distinct aspects of the disorder: exposure to trauma and subsequent symptoms of trauma.

Currently, Pavlovian threat conditioning is the dominant paradigm for research on mechanisms involved in stress and anxiety disorders (Beckers, Krypotos, Boddez, Effing & Kindt, 2013; LeDoux, 2014). In this paradigm a neutral stimulus (e.g. geometric shape) is paired with an aversive outcome (e.g. electric shock), via which this neutral stimulus acquires an aversive association and comes to elicit a defensive response by itself (LeDoux, 2014; Pavlov, 1927). Although this paradigm is excellent for studying simple cue outcome associations, it fails to mimic the complexity of a real traumatic experience (Foa, Steketee & Rothbaum, 1989; Kunze, Arntz & Kindt, 2015; Wegerer, Blechert, Kerschbaum & Wilhelm, 2013). The stimuli involved in a traumatic experience are numerous and multifaceted; standard fear conditioning is unlikely to produce the type of memory that later generates the wide array of stress symptoms that are observed after trauma, including the hallmark symptom of PTSD - intrusive memories of the traumatic event(s).

The trauma film paradigm on the other hand provides a platform for studying psychological trauma in the laboratory and has several advantages as an experimental psychopathology model. First, as a model of exposure to trauma, the paradigm uses film content showing those types of events listed as traumatic events in the DSM-5 (American

Psychiatric Association, 2013), i.e. events involving actual or perceived threat and serious injury (compared to fear conditioning models in which the stimulus is typically a single neutral image, such as a geometric shape, paired with a shock). We note that the DSM-5 revision now allows for exposure to trauma through "electronic media, television, movies or pictures" when occurring in the line of work, e.g. a police officer who has to repeatedly review murder footage via CCTV images. This addition to DSM-5 suggests that we need to better understand the impact of film material itself as a form of trauma exposure (e.g. Holman, Garfin & Silver, 2014; Silver et al., 2013). Second, exposure to the analogue trauma (film) elicits measurable responses analogous to symptoms experienced after actual trauma, including the hallmark symptom of intrusive memories of the traumatic event(s), physiological arousal, negative cognitions and mood (versus conditioned defensive responses, typically physiological such as fear-potentiated startle, within fear conditioning models). Importantly, from an experimental psychopathology perspective, experimentally-induced symptoms should typically be short lived, occurring only in the lab or for a limited number of days afterwards (Bailey et al., 2011). Accordingly, intrusive memories to trauma films in this paradigm tend to subside within a week (e.g. Butler, Wells & Dewick, 1995; Holmes, Brewin & Hennessy, 2004).

For trauma research, a good experimental psychopathology model is important for future psychological treatment development, especially given that evidence based psychological interventions for the early stages following a traumatic event are lacking (National Institute for Health and Clinical Excellence, 2005; Roberts, Kitchiner, Kenardy & Bisson, 2010; Rose, Bisson, Churchill & Wessely, 2002). We also lack models of combination treatments, e.g. between psychological and pharmacological agents, which is important clinically.

1.3. Hallmark symptom of ASD and PTSD

A hallmark symptom of ASD and PTSD is the presence of recurrent, involuntary and distressing memories of the traumatic event(s) (American Psychiatric Association, 2013). In the DSM-IV-TR (American Psychiatric Association, 2000), intrusive *thoughts* were also included as re-experiencing symptoms, but the DSM-5 (American Psychiatric Association, 2013) specifically refers to intrusive *memories*. These intrusive memories often take the form of sensory-perceptual impressions, typically visual images (e.g. pictures in the mind's eye) that intrude involuntarily into consciousness. Cognitive models of PTSD (Brewin, 2001; Ehlers & Clark, 2000) place intrusive memories at the core of symptomatology – potentially driving the other three symptom clusters (avoidance, negative alterations in cognitions and mood, and arousal). Furthermore, there is some evidence that early re-experiencing symptoms, including intrusive memories, may contribute to the development of PTSD. A prospective study of 307 traumatic injury survivors showed that individuals who met a diagnosis of PTSD at 12 months had reported significantly higher re-experiencing symptoms 8-days post-trauma compared to those who did not go on to develop PTSD (Creamer, O'Donnell & Pattison, 2004; O'Donnell, Elliott, Lau & Creamer, 2007). This suggests that re-experiencing symptoms such as intrusions may play a role in subsequent PTSD development and represent a potential target for prevention.

Given their prominence in ASD and PTSD, delineating cognitive processes that might contribute to intrusive memory development and persistence would be advantageous. Research following real life traumatic events has highlighted, in particular, the importance of *peritraumatic* processing (processing occurring at or near the time of the traumatic event) for later PTSD symptom development (Ozer, Best, Lipsey & Weiss, 2003). However, one challenge of studies on real life trauma is their reliance upon retrospective self reports, which can be taken months or even years after the traumatic event. Retrospective reports can be prone to bias such as memory errors, social desirability concerns, and confounds such as an individual's current goals and attitudes (see Bovin & Marx, 2011), making it difficult to differentiate those processes which were initially involved, or which were the result of symptom development, as well as those that are involved in PTSD maintenance.

1.4. The trauma film paradigm

Using a prospective design with an experimental analogue of a traumatic event, such as the trauma film paradigm, may mitigate some challenges posed by studies on real life trauma. The paradigm, first developed in the 1960's to study psychological reactions to stress (Horowitz, 1969; Lazarus, 1964), provides a useful experimental psychopathology model for studying both exposure and reactions to traumatic events (see Fig. 1). Trauma films often consist of several film clips edited together, for example footage of car crashes and interpersonal violence. Viewing such films with a variety of scenes has been shown to reliably induce analogue symptoms such as intrusive memories of the film footage (cf. Weidmann, Conradi, Groger, Fehm & Fydrich, 2009). Indeed individuals may have intrusions related to several difference scenes (Clark, Niehaus, et al., 2014) allowing for the investigation of peritraumatic processes associated with later intrusions (e.g. by using techniques such as fMRI; Bourne, Mackay & Holmes, 2013).

The use of a controlled, standardised experimental trauma opens up a number of opportunities to investigate intrusive memory and also other outcomes. For example, it enables researchers to manipulate cognitive processes (before, during, or after the experimental trauma) that are hypothesised to impact intrusive memory development. The paradigm can be useful for the identification of peritraumatic and pre-existing trait variables that may serve as vulnerability factors to the occurrence of intrusive memories. It also allows researchers to test intervention techniques and procedures by modelling them in the laboratory or to assess proof of concept for new approaches to prevent the build up of intrusions (e.g. the use of imagery rescripting, Hagenaars & Arntz, 2012; or competing cognitive tasks, Holmes, James, Kilford & Deeprose, 2010).

1.5. Previous reviews of the trauma film paradigm

The earliest review by Holmes and Bourne (2008) examined the use of the trauma film paradigm to study peri-traumatic processing and intrusion development. A review of just 10 studies at the time concluded that there may be differential effects of visuospatial and verbal processing on intrusions, in line with a heuristic model of PTSD proposed in the same 2008 paper. A later theoretical review by Krans, Näring, Becker and Holmes (2009b) explored possible functions of intrusions after trauma, and included six papers to highlight the paradigm's use to study intrusions in the laboratory. An important review by Brewin (2014) reported studies with the paradigm to support two hypotheses: first, involuntary intrusions are selectively disrupted by visuospatial tasks versus no task controls (numerical group differences in 12 studies using films in a systematic review; Brewin, 2014, Table 2); and second, involuntary intrusions dissociate from voluntary memory of the same film (a meta-analysis based on 9 correlational studies; Brewin, 2014, Table 3). Subsequently, a meta-analysis of data from 16 studies using a similar protocol of the trauma film paradigm (Clark, Mackay & Holmes, 2015) investigated pre and peritraumatic factors in intrusion development. Lower emotional response to traumatic footage predicted an absence of later intrusions. However, additional aspects of the paradigm were not reviewed. Finally, a position piece by Clark and Mackay (2015) put forward a clinical neuroscience framework of intrusion development, illustrated by two studies combining the paradigm with neuroimaging. A broader review of the paradigm was not included.

To our knowledge the current paper is the first to provide a systematic review and capture the burgeoning number of studies since 2008. Critically, unlike the previous reviews, our review provides a broad perspective of the trauma film paradigm, by conducting a review to

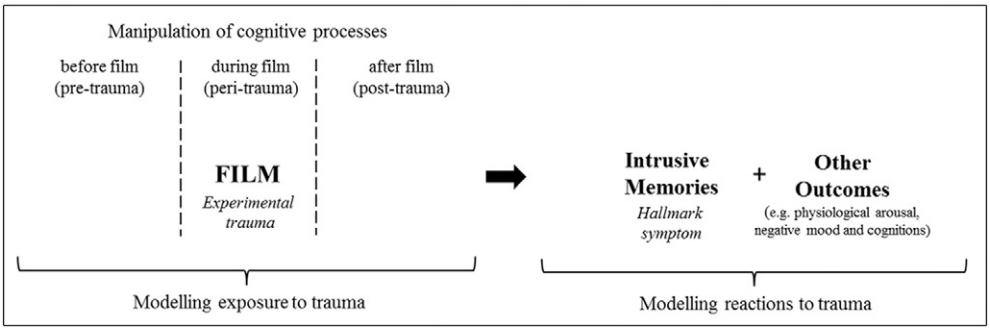

Fig. 1. The trauma film paradigm as an experimental psychopathology model for both exposure and reactions to trauma, modelling pre-, peri and post-traumatic stages.

showcase the numerous ways in which the paradigm has been used within an experimental psychopathology model to inform us about processes related to both exposure and reactions to trauma.

1.6. Aims and scope

The aims and scope of the current paper are as follows: to systematically review studies using the trauma film paradigm since 2008 – a paradigm which can aid researchers to address clinical questions regarding psychological trauma. This is placed within the context of an experimental psychopathology model of psychological trauma. The time period has seen a vast expansion of studies. The literature that emerged from the review is organised according to pre-, peri- and post- traumatic stages. These map onto procedural variations within the trauma film paradigm (see Fig. 1), i.e. manipulations before, during and after trauma film viewing, and their impact on subsequent intrusive memories of the film. Furthermore, we review studies investigating individual differences in intrusive memory development. In addition to intrusive memories, the hallmark symptom of ASD and PTSD, we review other outcomes that model different reactions to trauma (see Fig. 1), such as negative mood and cognitions, and physiological arousal. Finally, we evaluate the strengths and weaknesses of the trauma film paradigm as an experimental psychopathology model of trauma, and consider ethical issues. Future directions are suggested. It is beyond the scope of the current review to provide a meta-analysis and/or to test specific hypotheses.

2. Systematic review methodology

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Welch et al., 2012) were used as a basis for our Review to find and select relevant papers.

2.1. Search strategy

Scopus and Web of Knowledge databases were searched on the date 29/07/2014. Search terms were "trauma* film" OR "stress* film" "trauma* video" OR "stress* video" OR "trauma* movie OR stress* movie" (using 'abstracts, keywords, and article titles' in Scopus and 'Topic' in Web of Science). The dates considered in the search were limited to the years 2007 to 2014. Results were further refined by excluding the following subject areas (physics and astronomy; biochemistry; genetics and molecular biological sciences; pharmacology, toxicology and pharmaceutics; material science; chemistry; chemical engineering; and engineering). Results were augmented by records identified through other sources (the Journal of Experimental Psychopathology not listed on Scopus or Web of Knowledge; and the addition of 'Citation Alerts' received from Scopus and Web of Knowledge in relation to the earlier review by Holmes and Bourne (2008)). Titles and Abstracts were used to screen suitable articles for inclusion (see inclusion and exclusion criteria below). Due to the global nature of our review (i.e., to provide a descriptive overview of the trauma film paradigm as model of trauma) and the heterogeneity of the studies, a formal synthesis (i.e. meta-analysis) was not conducted. Rather, a review was conducted using the details above.

2.2. Inclusion and exclusion criteria

Studies were included if 1) they used traumatic or negative film stimuli within an experimental or prospective study design framework; 2) the paper was published in a peer-reviewed journal. *Exclusion criteria*: Studies were excluded if 1) the studies were present in the earlier literature review by Holmes and Bourne (2008); 2) the article was a selective or systematic review or published conference proceeding/abstract.

One hundred and forty-one papers were identified; 78 were discarded based on exclusion criteria detailed above. 11 articles were identified through other sources yielding a total of 74 articles in the current review.

3. Results

Seventy-four journal articles were found that met the review criteria, yielding a total of 87 separate trauma film studies. These studies are presented in the current review in four sections; 1) manipulations of cognitive processes before and during film viewing to influence intrusive memory frequency; 2) manipulations of cognitive processes after film viewing to influence intrusive memory frequency; 3) correlational designs investigating trait and peritraumatic factors and intrusive memories; and 4) trauma film studies investigating trauma-related responses other than intrusive memories. Tables 1 to 3 provide an 'at a glance' overview of the studies and their measures included in Sections 1–3 (the use of the paradigm to investigate intrusive memories). Tables A.1 to A.4 (see Appendix A) provide full details and main results for each of the studies that used the paradigm to study both intrusive memories – Sections 1 to 3, and other outcome variables – Section 4.

Intrusive memory frequency was measured using a variety of approaches. The majority of studies ($n = 66$) used a pen and paper diary methodology in which participants noted down each time they experienced an intrusive memory of the experimental trauma. Typically, intrusive memories in such studies are defined as involuntary visual mental images (or other senses such as sounds or bodily sensations) from the film, as opposed to involuntary verbal thoughts, described as words and phrases. Four studies introduced a technological element to the daily diary, and used either the Internet (Ball & Brewin, 2012; Bisby, Brewin, Leitz & Curran, 2009; Bisby, King, Brewin, Burgess & Curran, 2010; Kamboj et al., 2014) or mobile phone SMS (short messaging service) technology as a method of both sending reminders about completing the diary, as well as providing a platform to report the occurrence of intrusions (Malik, Goodwin & Holmes, 2012; Malik, Goodwin, Hoppitt & Holmes, 2014).

Table 1
Summary of experimental methods used to study intrusive memories in experimental designs using manipulations before/during trauma film viewing.

			Method of intrusion measurement				
Reference [reverse chronological order]	Intrusions	Frequency	Diary	IES (R)	Lab monitoring	Other methods	Other measure(s)
1. Hawkins and Cougle (2013)	✓	✓	✓		✓		–
2. Woud, Postma, Holmes, and Mackintosh (2013)	✓	✓					–
3. Schaich, Watkins, and Ehring (2013)	✓	✓	✓		✓	✓	IQ
4. Pearson (2012)	✓	✓	✓				–
5. Brown, Joscelyne, Dorfman, Marmar, and Bryant (2012)	✓	✓			✓	✓	R-SR
6. Marks, Steel, and Peters (2012)	✓	✓	✓		✓	✓	TMQ
7. Logan and O'Kearney (2012)	✓	✓	✓	✓			–
8. Bourne, Frasquilho, Roth, and Holmes (2010); Expt 1	✓	✓	✓				–
9. Bourne et al. (2010); Expt 2	✓	✓	✓				–
10. Krans, Näring, Holmes, and Becker (2010)	✓	✓	✓				–
11. Hagenaars, Brewin, van Minnen, Holmes, and Hoogduin (2010); Expt 1	✓	✓	✓				–
12. Hagenaars et al. (2010); Expt 2	✓	✓	✓				–
13. Bisby et al. (2010)	✓	✓	✓			✓	VAS
14. Krans, Näring and Becker (2009a)	✓	✓	✓				–
15. Ferree and Cahill (2009)	✓	✓				✓	R-SR
16. Bisby, Brewin, Leitz, and Curran (2009)	✓	✓	✓				–
17. Nixon, Nehmy, and Seymour (2007)	✓	✓		✓	✓		–
Total	17/17	17/17	13/17	2/17	5/17	5/17	5/17

Note. IES(R) = Impact of Event Scale - Revised; IQ = Intrusion Questionnaire (Hackmann et al., 2004; Michael et al., 2005); R-SR = Retrospective Self-Report; TMQ = Trauma Memory Questionnaire (Halligan et al., 2003); VAS = Visual Analogue Scale.

Another method used to measure intrusion frequency involved laboratory-based intrusion monitoring ($n = 18$). Laboratory-based methods typically require participants to report intrusive memories over short periods of time (lasting between 2 and 5 min) either shortly after trauma film viewing, or following brief reminders of the trauma film at a follow-up session up to a week after film viewing. Some studies used self-report questionnaires ($n = 45$) to index intrusive memories, including the Impact of Event Scale (IES; Horowitz, Wilner & Alvarez, 1979), the Intrusion Questionnaire (Michael, Ehlers, Halligan & Clark, 2005), and the Trauma Memory Questionnaire (Halligan, Michael, Clark & Ehlers, 2003).

3.1. Manipulations of cognitive processes before and during film viewing to influence intrusive memory frequency (Table 1 and Appendix Table A1)

Seventeen studies were identified that manipulated cognitive processes before ($n = 6$) or during film viewing ($n = 11$). Six of these studies attempted to modulate the development of subsequent intrusive memories by asking participants to take part in visuospatial or verbal based tasks at the same time as viewing the film. Information processing theories of PTSD predict that intrusive memories following trauma may arise due to enhanced sensory-perceptual processing (sometimes referred to as data-driven processing) and reduced higher-order cognitive

Table 2
Summary of experimental methods used to study intrusive memories in experimental designs using manipulations after trauma film viewing.

			Method of intrusion measurement				
Reference [reverse chronological order]	Intrusions	Frequency	Diary	IES (R)	Lab monitoring	Other methods	Other measure(s)
1. Jobson and Dalgleish (2014); Expt. 2	✓	✓	✓				–
2. Takarangi, Strange, and Lindsay (2014); Expt. 1	✓	✓			✓		–
3. Takarangi, Strange and Lindsay 2014; Expt. 2	✓	✓			✓		–
4. Wegerer, Bleschert, Kerschbaum and Wilhelm (2013)				✓		✓	IMQ
5. Krans, Janecko, and Bos (2013)	✓	✓		✓	✓	✓	IQ
6. Luo et al., 2013; Expt. 1	✓	✓	✓				–
7. Luo, Jiang, Dang, Huang, Chen & Zheng, 2013; Expt. 2	✓	✓	✓				–
8. Luo, Jiang, Dang, Huang, Chen & Zheng, 2013; Expt. 3	✓	✓	✓				–
9. Woud, Holmes, Postma, Dalgleish, & Mackintosh 2012	✓	✓	✓	✓			–
10. Hagenaars & Arntz 2012	✓	✓	✓				–
11. Hagenaars 2012	✓	✓	✓				–
12. Verwoerd, Wessel, & de Jong 2012	✓	✓	✓	✓		✓	IMS
13. Deeprose, Zhang, Dejong, Dalgleish, & Holmes 2012; Expt. 1	✓	✓	✓				–
14. Deeprose, Zhang, Dejong, Dalgleish & Holmes, 2012; Expt. 2	✓	✓	✓				–
15. Ball & Brewin 2012	✓	✓	✓			✓	IMQ
16. Krans & Bos 2012	✓	✓			✓	✓	IES
17. Holmes, James, Kilford & Deeprose 2010; Expt. 1	✓	✓	✓				–
18. Holmes, James, Kilford & Deeprose 2010; Expt. 2	✓	✓	✓				–
19. Pruitt & Hazlett-Stevens 2010	✓	✓	✓			✓	–
20. Zetsche, Ehring, & Ehlers 2009	✓	✓			✓	✓	IMQ
21. Ehring, Szeimies, and Schaffrick 2009	✓	✓				✓	IQ
22. Holmes, James, Coode-Bate, and Deeprose 2009	✓	✓	✓	✓			–
23. Krans, Näring, and Becker 2009c	✓	✓	✓				–
24. Nixon, Cain, Nehmy, & Seymour, 2009a	✓	✓	✓		✓		–
25. Nixon, Cain, Nehmy, & Seymour 2009b	✓	✓	✓		✓		–
26. Buck, Kindt, and van den Hout 2009	✓	✓				✓	VAS
Total	25/26	25/26	18/26	5/26	7/26	3/26	8/26

Note. IES(R) = Impact of Event Scale (Revised); IMQ = Intrusive Memory Questionnaire (Michael & Ehlers, 2007); IQ = Intrusion Questionnaire (Hackmann et al., 2004; Michael et al., 2005); IMS = Impact of Movie Scale (an adapted version of the Impact of Event Scale); VAS = Visual Analogue Scale.

Table 3
Summary of experimental methods used to study intrusive memories in correlational designs.

Reference [reverse chronological order]	Intrusion	Frequency	Method of intrusion measurement: Diary	IES (R)	Lab monitoring	Other methods	Other measures
1. Malik, Goodwin, Hoppitt, and Holmes (2014)	✓	✓	✓	✓	✓		–
2. Chou, La Marca, Steptoe, and Brewin (2014a)	✓	✓	✓			✓	PDS
3. Chou, La Marca, Steptoe, and Brewin (2014b)	✓	✓	✓				–
4. Belcher and Kangas (2014)	✓	✓	✓	✓			–
5. Kamboj et al. (2014)	✓	✓	✓				–
6. Clark, Mackay and Holmes (2015)	✓	✓	✓				–
7. Jobson and Dalgleish (2014); Expt. 1	✓	✓	✓				–
8. Monds, Paterson, Kemp, and Bryant (2013)	✓	✓		✓			–
9. Wegerer et al. (2013)	✓	✓		✓	✓	✓	IMQ
10. Morina, Leibold, and Ehring (2013)	✓	✓	✓		✓	✓	IQ
11. Bourne et al. (2013)	✓		✓				–
12. Meyer et al. (2013)	✓	✓	✓	✓		✓	PSS-SR
13. Laposa and Rector (2012)	✓	✓	✓	✓			–
14. Bomyea and Amir (2012)	✓	✓			✓		–
15. Hagenaars and Putman (2011)	✓	✓	✓				–
16. Hagenaars and Krans (2011)	✓	✓	✓	✓			–
17. Krans, Näring, Speckens, and Becker (2011)	✓	✓	✓				–
18. Verwoerd, Wessel, de Jong, Nieuwenhuis, and Huntjens (2011)	✓	✓	✓			✓	IMS
19. Bisby, King, Brewin, Burgess, and Curran (2010)	✓	✓	✓			✓	VAS
20. Wilksch and Nixon (2010)	✓	✓	✓		✓		–
21. Wessel, Huntjens, and Verwoerd (2010)	✓	✓			✓		–
22. Verwoerd, Wessel, de Jong, and Nieuwenhuis (2009)	✓	✓	✓			✓	IMS
23. Laposa and Alden (2008)	✓	✓	✓	✓			–
24. Wessel, Overwijk, Verwoerd, and de Vrieze (2008); Expt. 1	✓	✓	✓				–
25. Wessel et al. (2008); Expt. 2	✓	✓					–
Total	25/25	24/25	20/25	8/25	6/25	7/25	7/25

Note. IES (R) = Impact of Event Scale (Revised); IMQ = Intrusive Memory Questionnaire (Michael & Ehlers, 2007); IMS = Impact of Movie Scale (an adapted version of the Impact of Event Scale); IQ = Intrusions Questionnaire; PDS = Post Traumatic Stress Diagnostic Scale; PSS-SR = PTSD Symptom Scale-Self Report; VAS = Visual Analogue Scale.

processing (e.g. reduced conceptual or contextual processing) at the time of trauma (e.g. Brewin, 2001; Brewin, Gregory, Lipton & Burgess, 2010; Ehlers & Clark, 2000). Presenting, for example, a competing visuospatial task is hypothesised to limit the resources available for sensory-perceptual processing and hence reduce subsequent image-based intrusive memories of the film compared to presenting a non-visuospatial concurrent task or no concurrent task. In contrast, concurrent verbal tasks might be predicted to increase intrusive memories (due to competition for verbal resources required for contextual integration of the trauma memory; for a diagramatic summary of models see, Holmes & Bourne, 2008). Note that the term "verbal" in PTSD theories refers to conceptual or contextual processing.

3.1.1. Manipulations of cognitive processes before and during film viewing: visuospatial tasks

Visuospatial tasks have been used concurrent to trauma film viewing to modulate subsequent intrusive memory frequency. Relative to non-visuospatial (e.g. counting backwards in 3s) and no-task control conditions, competing visuospatial tasks, including modelling clay into predetermined geometric shapes (Logan & O'Kearney, 2012) and tapping predetermined complex pattern sequences on a concealed keypad (Expt. 1; Bourne, Frasquilho, Roth & Holmes, 2010; Krans, Näring & Becker, 2009a), have showed to reduce later intrusive memories. However, Marks, Steel, and Peters (2012) found that both tapping a complex pattern and no-task controls led to equivalent intrusion frequency. Two methodological differences between Marks et al. (2012) and previous studies may account for the lack of significant visuospatial task effect on intrusions. The first difference concerns the nature of the tapping task. Marks et al. (2012) argued that they used a prohibitively difficult visuospatial tapping task relative to previous studies such as Bourne et al. (2010) and Krans, Näring, Holmes and Becker (2009c). A second difference concerns the population recruited. Whereas most studies recruit non-clinical samples, Marks et al. (2012) recruited individuals who were on the higher and lower ends of a continuum of schizotypy experiences: participants with high schizotypy reported having anomalous experiences akin to those in psychosis (but with no clinical diagnosis), whereas participants with low schizotypy scored low on a schizotypy measure Oxford Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason & Claridge, 1995). The beneficial effects of visuospatial task on reducing intrusive memories as found in several studies (e.g., Bourne et al., 2010; Holmes, James, Coode-Bate & Deeprose, 2009; Holmes, James, et al., 2010; Krans, Näring & Becker, 2009a; Logan & O'Kearney, 2012; plus earlier studies e.g. Holmes et al., 2004) may not apply to individuals on either extremes of the schizotypy continuum.

Most visuospatial tasks performed concurrently with trauma film viewing involve physical movements (for example, clay modelling involves spatial hand movements, as does tapping sequences) representing a possible explanation for task effectiveness. However, Krans, Näring, Holmes, et al. (2010) found that a concurrent configural movement task (chewing gum in a specific way, thought to employ propriospatial resources but not visuospatial) was similar to the no-task control, in that it did not lead to a subsequent reduction in intrusive memories compared to the visuospatial tapping group. It was suggested that visuospatial movement, rather than general movement per se, may be involved in the reduction of later intrusive memory frequency of a trauma film. The role of different types of concurrent physical movement on intrusive memory development is still to be clarified. No studies investigated the use of visuospatial cognitive tasks before film viewing to reduce subsequent intrusive memory development.

3.1.2. Manipulations of cognitive processes before and during film viewing: verbal tasks

There are mixed findings regarding the impact of a concurrent verbal task on intrusion frequency. For example, concurrent verbal tasks in which participants are asked to count backwards in 3's (Expt. 1; Bourne et al., 2010; Logan & O'Kearney, 2012) resulted in a comparable number of intrusions relative to a no-task control condition, whereas counting backwards in 7's *increased* intrusive memories across the subsequent week (Expt. 2; Bourne et al., 2010) as did holding a

predetermined 9 digit number in mind (Nixon, Nehmy & Seymour, 2007). Further, one study found that a verbal based task (counting backwards in 3's) undertaken concurrently with film viewing resulted in fewer intrusive memories relative to a verbal enhancement task (verbalising emotions and thoughts) but not a no-task group, when controlling for demand characteristics (Krans, Näring & Becker, 2009a). Again, no studies investigated the use of verbal cognitive tasks before film viewing to reduce subsequent intrusive memory development.

3.1.3. Manipulations of cognitive processes before and during film viewing: other methods

Of the 10 studies have used methods other than competing tasks, 6 manipulated cognitive processing *before* film viewing. For example, a computerised Cognitive Bias Modification (CBM) task was employed to train participants' appraisals of their responses to a traumatic event. Participants were presented with a series of ambiguous vignettes (based on items of the Post Traumatic Cognition Inventory (PTCI) Self subscale; Foa, Ehlers, Clark, Tolin & Orsillo, 1999) in which the final word was incomplete. They were asked to complete this word fragment by filling in the first missing letter. This final word disambiguated the vignette in a functional direction (the positive training group) or in a non-functional direction (the negative training group), e.g. *in a crisis, I predict my responses will be h-lpf-l/u-el-ss*. Participants who were trained, pre-film, to appraise potential symptoms following exposure to a negative event in a more functional way reported less distress arising from their intrusive memories over the following week (Woud, Postma, Holmes & Mackintosh, 2013). Similarly, providing positive verbal feedback (ostensibly derived from a personality questionnaire) that a participant would be able to cope well during a traumatic experience, pre-film, resulted in those participants reporting subsequently fewer intrusive memories compared to those who received feedback that they would not cope well (Brown, Joscelyne, Dorfman, Marmar & Bryant, 2012). Training participants to use a concrete processing style – thinking about the events and imaging them as vividly as possibly – relative to an abstract processing style – thinking about the causes, meanings and implications of the event – was shown to eliminate the association between high trait rumination and higher subsequent intrusive memory frequency (Schaich, Watkins & Ehring, 2013).

Studies have also looked at the impact of prior alcohol and nicotine consumption on intrusive memory development following analogue trauma. Two studies found that a low dose of alcohol before film viewing led to more intrusive memories of the film than a high dose or placebo control, whereas a high dose of alcohol led to fewer intrusions than placebo control (Bisby, Brewin et al., 2009; Bisby King et al., 2010). Other research investigating associations between cigarette smoking and PTSD found that participants who ingested a nicotine lozenge as compared to a placebo lozenge prior to viewing a traumatic film reported experiencing more intrusive memories immediately after film viewing, but not over 1 week (Hawkins & Cougle, 2013).

Comparing the impact of movement and dissociation has also been investigated using the trauma film paradigm. For example, a comparison of full-body deliberate non-movement (where participants are told that they must not move while watching the film) and dissociative non-movement (experimenter-induced dissociation resulting in a perceived inability to move while watching the film) resulted in an increase in image based intrusive memories but not verbal thoughts, compared to watching the film normally (Expt. 1; Hagenaars, Brewin, van Minnen, Holmes & Hoogduin, 2010). This was interpreted as akin to a freezing response common following trauma.

Other research has shown that auditory contextual information provided with scenes from a traumatic film led to a subsequent increase in intrusive memory frequency compared to if the film scenes were viewed without audio commentary provided (Pearson, 2012). This finding may be explained in relation to emotional processing (a greater emotional response to the film was elicited due to the addition of context provided by the audio commentary) at the time of the event (see also Clark et al., 2015), as well as in terms of relevance and involvement (context may enhance involvement and the perception of relevance and thereby increase its impact; Conway & Pleydell-Pearce, 2000). Findings may also be explained in terms of the method by which context was introduced to participants – i.e. via audio commentary. For example, research has also shown that intrusive images of trauma can be generated merely from listening to verbal reports of the trauma (Krans, Näring, Holmes, et al., 2009c).

Finally, two studies compared trauma films with neutral films. One study investigated both intrusions (spontaneous intrusive recollections) and memory for the film to investigate memory for neutral and emotional experiences (Ferree & Cahill, 2009). Findings showed that participants retrospectively reported greater levels of intrusions following an emotional event (trauma film) relative to neutral event (neutral film). Further, there was some evidence that participants' phase in their menstrual cycle may influence intrusive memories (Ferree & Cahill, 2009). Another study found that watching trauma film material resulted in more intrusive images than intrusive thoughts, whereas a neutral film material led to equivalent number of images and thoughts experienced over the subsequent week (Expt. 2; Hagenaars et al., 2010).

3.2. Manipulations of cognitive processing after film viewing to influence intrusive memory frequency (see Table 2 and appendix Table A2)

Twenty-six studies were identified that explored the effect of experimentally manipulating cognitive processes *after*, rather than before or during, trauma film viewing; thereby extending the time-frame and potential clinical applicability of such methods to influence intrusive memory frequency.

3.2.1. Manipulations of cognitive processing after film viewing to influence intrusive memory: visuospatial and verbal tasks

Several studies used visuospatial and/or verbal based tasks undertaken at various time points post-film viewing to investigate their impact on intrusive memory frequency. Performing a visuospatial pattern tapping task immediately after film viewing was found to reduce intrusive memory frequency in one experiment (Expt. 1; Deeprose, Zhang, Dejong, Dalgleish & Holmes, 2012), relative to a verbal interference task (counting backwards in 3's) or no task. In a second experiment within the same study, the time frame between film viewing and task administration was extended to 30 min. Again, results showed that a visuospatial pattern tapping task, relative to a verbal interference task (counting backwards in 7's) or no task, reduced intrusions over the subsequent week (Expt. 2; Deeprose et al., 2012). Continuing with a time frame of 30 min between trauma film and task, other studies tested the potential for less laboratory centric, and more ecologically valid visuospatial tasks which might reduce intrusion frequency, such as the visuospatial computer game 'Tetris' (Green & Bavelier, 2003). Results showed that, relative to no task, playing the computer game Tetris reduced subsequent intrusions over the week, and led to a lower score on the IES Intrusion subscale (Holmes et al., 2009). In a related study, Tetris game play was compared to a verbal based computer game, Pub Quiz, and no task. In the week following the trauma film, those in the Tetris group had fewer intrusions compared to both Pub Quiz and no task; further, those allocated to the Pub Quiz group actually experienced *more* intrusions than a no-task group (Expt. 1; Holmes, James, et al., 2010). Notably, the effect of playing the computer tame Tetris, relative to the computer game Pub Quiz or no task, on reducing intrusive memories was also demonstrated when tasks were performed 4 h after film viewing (Expt. 2; Holmes, James, et al., 2010).

3.2.2. Manipulations of cognitive processing after film viewing to influence intrusive memory frequency: other methods

Several studies have explored the impact of post film thought suppression, and the potential moderating role of cognitive load, on

subsequent intrusion development. In such studies, thought suppression required deliberate attempts to push unwanted thoughts out of mind, whereas increasing cognitive load was achieved by adding demands to one's limited cognitive capacity, e.g., using competing tasks (visuospatial or verbal tasks). Paradoxically, suppressing memories for an event has been shown to increase the accessibility of that event (Wenzlaff & Wegner, 2000), while cognitive demand placed upon an individual may hinder suppression ability. Therefore, Nixon, Cain, Nehmy, and Seymour (2009a) investigated whether cognitive load, of the kind already shown to have an impact on intrusions (visuospatial and verbal based tasks), would impact on suppression and thus intrusion frequency over 1 week (in a diary), as well as immediately and 7 days post film viewing (using a 5 min intrusion monitoring task). Conditions comprised holding a 9 digit list in mind (verbal task) versus visuospatial sequence tapping, both with instructions to suppress memory of the trauma film, in addition to a hyperventilation task with suppression, suppression only, and no suppression control conditions. No group differences were found on intrusion frequency for either of the intrusion monitoring tasks or the intrusion diary. In contrast, the duration of intrusions reported by participants was longer for those in the no suppression control group following the intrusion monitoring task administered 1 week post film (Nixon et al., 2009a). However, a second study found that holding a 9 digit list in mind (verbal task) and suppression (relative to suppression only, verbal cognitive load only and no task control) led to participants experiencing a greater number of intrusions in the diary compared to the other groups (Nixon, Cain, Nehmy & Seymour, 2009b). This finding was consistent with the notion that suppression may be a maladaptive coping strategy in the longer term, and is in line with previous studies that show that verbal based tasks following an analogue trauma may enhance subsequent intrusive memory frequency (Bourne et al., 2010; Holmes et al., 2004). In contrast, post-film suppression (participants discriminated between two tones every time an involuntary memory was experienced) versus conceptual processing (elaboration of the film context and meaning aided by written statements and follow up responses) was compared in a further study, with no difference found in subsequent intrusive memory frequency (Buck, Kindt & van den Hout, 2009). As the effects of thought suppression on subsequent intrusions across studies were mixed, it is possible that such effects are moderated by various factors, such as the specific suppression instruction of the study.

Studies have also manipulated thinking styles such as 'abstract' versus 'concrete', 'ruminative' versus 'integrative', and 'why' versus 'what' immediately after trauma film viewing. In one, participants who were encouraged to use a concrete thinking style, by reading road-traffic related concrete thoughts about the film, experienced fewer intrusions relative to those who read non related statements (Ehring, Szeimies & Schaffrick, 2009). In contrast, those who were encouraged to use abstract ruminative thinking, by dwelling on several ruminative sentences displayed on a computer screen, did not show such benefits relating to intrusion frequency. Another study used the trauma film paradigm to examine the effects of rumination on intrusive memories and mood (Zetsche, Ehring & Ehlers, 2009). After film viewing, participants were either encouraged to ruminate (dwelling on 'why' and 'what if' statements about the film such as '*how can I drive again with thinking what could happen*'), to integrate the memory (thinking about the film chronologically and thinking about the experience of watching the film in a self referential way, such as distinguishing film viewing from their own non-traumatic road traffic experiences), or they were distracted by means of a quiz involving mentally listing particular categories that were presented on a screen. Although rumination led to less recovery from sad mood following the film and higher scores on a self report measure of intrusions (an Intrusive Memory Questionnaire), there was no significant difference between these groups on intrusion frequency over the course of a week. Yet, despite the lack of a group difference, a subsequent exploratory analysis indicated that the degree of rumination indeed correlated positively with intrusion frequency across all conditions. In a similar study (Ball & Brewin, 2012), participants were asked to ruminate on 'why' and 'what if' type questions either about the film or other matters (the financial crisis) immediately after film viewing and over the course of the subsequent six days (for 5 min per day). A third group was included as a no rumination control. The two rumination groups combined reported more intrusive memories over the week compared to the no rumination control group; however, intrusion frequency did not differ in the two rumination groups. Furthermore, two forms of verbal processing undertaken post film were contrasted in a study by Luo et al. (2013) in which participants performed either a why focused (to think about the causes of the event), a what focused (to describe the events) or no narration task. They found that why focused processing led to increased intrusive memory frequency (Expt. 1; Luo et al., 2013) compared to what focused verbal processing and no narration. An additional experiment found that describing the events from a first person versus third person vantage point led to no significant differences in intrusive memory frequency (Expt. 2 and 3; Luo et al., 2013). Taken together, these studies suggest that ruminative thinking styles (focussing on verbal descriptions of causes and consequences of the event) play a role in exacerbating intrusion development.

Future oriented worry and its impact on maintaining anxiety and intrusion frequency following trauma film exposure was the focus of a study by Pruitt and Hazlett-Stevens (2010). In a group setting, participants were shown a trauma film before being allocated to one of five conditions. Three groups were required to worry about a personally relevant topic according to particular future oriented time frames, either within the next 15 min, one week, or one year. A fourth group was asked to worry with no constraint on time period. The fifth group was asked to engage in visual imagery (thinking about the film in the form of pictures). Self reported levels of anxiety (STAI; Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983) were taken at baseline, pre and post film, post manipulation, and at follow up. Intrusion frequency was recorded over the course of three days post film. Results showed an overall decrease in anxiety with no differences between the groups. Contrary to predictions, participants in the visual imagery group reported significantly more intrusions compared to the worry groups, suggesting future-oriented worrying about personally relevant topics under certain circumstances (i.e. after exposure to a traumatic film) may be beneficial by providing a distraction (Pruitt & Hazlett-Stevens, 2010).

Cognitive Bias Modification (CBM, the process of altering cognitive biases) procedures have also been employed post film. Woud, Holmes, Postma, Dalgleish, and Mackintosh (2012) found that training a positive re appraisal style (of self-efficacy beliefs and emotional reactions elicited by the film) led to fewer intrusive memories of the film reported in a diary over the subsequent week compared to participants trained with a negative appraisal style. Another study showed that training participants to avoid negative reminders of the trauma film resulted in fewer intrusive memories as compared to no training (Verwoerd, Wessel & de Jong, 2012). Training comprised an attentional bias modification task (a variant of the exogenic cueing task; ECT), in which reminder cues (stills from the film) were always presented in a different location than the probe (invalid trial), while neutral control stimuli were always presented in the same location as the probe (valid trial), to reinforce attention away from the film reminders.

Different types of imagery techniques (analogues of therapeutic interventions) have been used to modulate intrusive memory frequency (Hagenaars, 2012; Hagenaars & Arntz, 2012), with techniques being administered 30 min post trauma film viewing. Imagery 'rescripting' (retrieving the aversive memory and then altering the outcome) resulted in fewer intrusive memories (image based) over the following week compared to both imagery re-experiencing (repeated retrieval of the aversive memory promoting habituation or fear extinction), or positive imagery (vividly imagining an unrelated positive memory) (Hagenaars & Arntz, 2012). In a subsequent study comparing imagery rescripting

and re-experiencing in an anxious and non anxious sample there was a replication of the main result that imagery re-experiencing led to more intrusions (both images and thoughts were examined in this study) relative to imagery rescripting, but no differences were found in intrusion frequency between anxious and non anxious groups. However, analysis showed that imagery re-experiencing, relative to imagery rescripting, led to greater numbers of image-based intrusions (but not intrusions based on verbal thoughts), for those in the anxious group (Hagenaars, 2012).

Finally, the impact of post film memory tests for a trauma film on subsequent intrusive memory development was examined in two studies, both of which drew on cognitive models of PTSD (Ehlers & Clark, 2000) suggesting that intrusions occur when traumatic memories are not integrated properly into autobiographical memory. Administering a recognition memory test for particular sections of the trauma film immediately after film viewing led to fewer intrusive memories over 1 week for those sections for which the test was given (Krans, Näring, Holmes & Becker, 2009d), with the suggestion that the memory test had aided the integration of the film in autobiographical memory. Indeed, Jobson and Dalgleish (2014) demonstrated that removing a post film narrative task resulted in a significant increase in the number of intrusions compared to a prior experiment in which participants did perform a narrative task. This suggests that the act of providing a narrative enhanced (culturally appropriate) memory integration, thereby reducing involuntary memory recall (Expt. 2; Jobson & Dalgleish, 2014). Two additional studies used the prospect of a memory test for the trauma film to manipulate conscious versus unconscious thought related to the film, and assessed these thought processes in relation to their impact on involuntary intrusions (Krans & Bos, 2012; Krans, Janecko & Bos, 2013). Following film viewing, participants were randomly assigned to one of three conditions: a conscious thought group required participants to think about the film for 4 min knowing that there would then be a memory test afterwards (a structured, sequential recall test); the unconscious thought group performed a 2 back task (monitoring a sequence of numbers and indicating if there was a match between a current number and the number presented two instances back in the sequence) while knowing that they would be required to perform a memory test afterwards: and finally, a mere distraction group completed the 2 back task but was informed that they would not be questioned further. In the first study (Krans & Bos, 2012), intrusion frequency was measured using laboratory-based monitoring, i.e., the Intrusion Provocation Task (a sequence of still images of the film was shown one after the other, after which participants indicated how many intrusions they experienced for the 2-min duration). Participants in the unconscious thought condition had significantly fewer intrusive memories relative to the other conditions. In a follow up (Krans & Bos, 2012; Krans et al., 2013), the same pattern of results was found using the intrusion subscale of the IES administered after brief reminders of the film (still images). The authors suggested that unconscious thought helped organise the trauma related information in a conceptual way, allowing for better integration into autobiographical memory and resulting in a reduction in intrusion frequency.

3.3. Correlational designs investigating trait and peritraumatic associations and intrusive memories (see Table 3 and appendix Table A3)

A number of correlational studies have identified both peritraumatic and more stable factors that could potentially play a role in the development of intrusive memory ($n = 24$ studies). The majority of these studies have focussed on the frequency of intrusive memories in relation to personality characteristics, cognitive abilities, and peritraumatic psychological, physiological and endocrinological responses. Accordingly, the structure of this section highlights various individual differences factors: peritraumatic psychological states, peritraumatic physiological states, cognitive functions, and gender differences. In describing these studies, we focus on the results that were highlighted by the authors themselves, i.e., the testing of their a priori hypotheses, and on any exploratory results that they mention explicitly.

3.3.1. Individual differences in peritraumatic psychological states and intrusive memory development

First, higher intrusive memory frequency has been associated with a number of peritraumatic factors, such as higher state anxiety (Hagenaars et al., 2010; Laposa & Alden, 2008); horror, and sadness (Hagenaars et al., 2010); state dissociation, post trauma rumination, lack of self referent processing (Laposa & Rector, 2012) and, as shown in a meta analysis comprising 16 studies using the trauma film paradigm, higher negative emotional responses to the film (Clark et al., 2015). Higher intrusive memory frequency has further been related to more stable characteristics, such as trait anxiety and depressive symptoms (Clark et al., 2015; Laposa & Alden, 2008); higher trait thought suppression (Wilksch & Nixon, 2010); greater propensity to feel disgust (Bomyea & Amir, 2012); higher vividness of general mental imagery use (Morina, Leibold & Ehring, 2013); higher spontaneous use of imagery (Krans, Näring, Speckens & Becker, 2011); higher trait dissociation (Hagenaars & Krans, 2011; Laposa & Alden, 2008); and higher score on The Mood Disorder Questionnaire (MDQ; Meyer et al., 2011) used to screen for bipolar disorder (Malik et al., 2014). Interestingly, the effect of trait dissociation has been proposed to be mediated by peritraumatic horror (Hagenaars & Krans, 2011).

3.3.2. Individual differences in peritraumatic physiological states and intrusive memory development

Intrusive memory development has also been associated with various physiological responses. For example, greater heart rate decreases were observed for scenes from the trauma film that were subsequently intrusive compared to non intrusive (Chou, La Marca, Steptoe & Brewin, 2014b). Another study revealed that an increase in cortisol post film was associated with decreased vividness of intrusive memories and with increased frequency of intrusive memories, but that the latter was specific to individuals with more sympathetic activations only (Chou, La Marca, Steptoe & Brewin, 2014a). An elegant study combined the trauma film paradigm with aspects of fear conditioning paradigms to test the relationship between fear conditioning susceptibility or conditionability (as measured by physiological responses) and aversive memories (Wegerer et al., 2013). Traumatic film clips were paired with a neutral audio stimulus (for example the sound of a typewriter) resulting in the neutral audio clip becoming a conditioned stimulus (CS) such that its presence in isolation elicited a fear response in the absence of the film. Findings indicated that participants who reported greater levels of conditionability had more traumatic memories of the film both immediately and two days after film viewing. Finally, the neural correlates of intrusive memory development have been investigated by combining the trauma film paradigm with functional magnetic resonance imaging (fMRI; Bourne et al., 2013). Brain activation at the time of viewing traumatic film material that later returned as an intrusive memory was characterised by widespread increases in activity across the brain compared to those parts of the film that were classified as potentially traumatic (i.e. they had returned as an intrusive memory for other participants), but that did not return as an intrusive memory for that particular participant.

3.3.3. Individual differences in cognitive abilities and intrusive memory development

Intrusive memory frequency has been examined in relation to various cognitive abilities, such as (autobiographical) memory functioning. For example, more intrusions have been associated with reduced specificity of remembering the past and imagining future events (Belcher & Kangas, 2014), reduced efficiency of temporal lobe based spatial configuration learning (Meyer et al., 2013), as well as higher recall accuracy of the trauma film, but not to greater levels of susceptibility to misinformation (Monds, Paterson, Kemp & Bryant, 2013).

Additionally, Bisby et al. (2010) found that for participants who received a placebo or low dose of alcohol (rather than high dose), higher intrusive memory frequency was associated with lower scores for a spatial memory task (shifted view point recognition. See also 'other methods' section in, *manipulations of cognitive processes before and during film viewing*, for additional findings which relate to this study).

Recent findings furthermore suggest that there may cultural differences in the relation between autobiographical remembering style and trauma processing. In this study by Jobson and Dalgleish (2014), East Asian and British participants were compared on measures of memory integration, where poorer memory integration of a trauma film was predicted to be associated with an increase in intrusive memories. For Western cultures, a 'well integrated' memory is typically autonomously orientated and self focused. In line with this, British participants with *lower* autonomous orientation and self focus in their narrative of the trauma film reported greater numbers of intrusions. In contrast, East Asian participants, for whom a well integrated memory typically focuses on others, reported a greater number of intrusions if they had *higher* autonomous orientation and self focus in their narratives of the trauma film (Expt. 1; Jobson & Dalgleish, 2014).

Another cognitive ability investigated in relation to intrusive memory is cognitive control; however, the pattern of findings has been somewhat inconsistent. Cognitive control has been found to be a buffer against intrusive memory development in participants with high spontaneous peri trauma film immobility responses, e.g. freezing during or near the time of the film (Hagenaars & Putman, 2011). Another study reported an association between higher resistance to pro active interference and fewer intrusive memories (Verwoerd, Wessel, de Jong, Nieuwenhuis & Huntjens, 2011). In contrast, while the ability to update and inhibit information (measured with a proactive interference task) was associated with less interference from negative film related words, it was associated with *more* diary reports of intrusive memories (Wessel, Overwijk, Verwoerd & de Vrieze, 2008). With regard to working memory capacity, findings have revealed a negative or positive relation with intrusion frequency, depending on the time of day and depending on whether participants were tested during their individually defined 'optimal' (in comparison to 'non optimal') period of the day (Wessel, Huntjens & Verwoerd, 2010).

3.3.4. Gender differences and intrusive memory development

Finally, given that (female) gender is a risk factor for the development of stress related psychopathology, studies have looked at the role of gender in how individuals respond to trauma film viewing. Indeed, in one study Wessel et al. (2008) found an effect of gender on the Impact of Movie Scale (IMS; an adaption of the IES that focuses on the trauma film), but not on the number of intrusive memories in the diary. In a relatively large sample ($n = 79$), Kamboj et al. (2014) examined gender differences with regard to voluntary and involuntary memory of the trauma film. Involuntary memory recall was assessed using an online diary, and did not reveal an overall effect of gender. However, a gender effect was found in the relation between gender associated personality traits and intrusion frequency, such that higher communality (femininity) was associated with fewer intrusions in male participants. In female participants, higher communality was associated with worse performance on the voluntary recognition task. Though not predicted, these findings suggest that communality is a risk factor for the development of maladaptive emotional memory, with over encoding of sensory/perceptual information in men and reduced encoding of contextualised, voluntary memory in women (Kamboj et al., 2014). None of the other studies that used correlational designs reported any effects of gender on involuntary or voluntary memory of the trauma film.

3.4. Studies that have used the trauma film paradigm to investigate analogue trauma responses other than intrusive memories (see appendix Table A4)

Of the 87 studies identified that used the trauma film paradigm, 21 did not have intrusive memories as a main outcome, but rather focussed on other symptoms in response to trauma such as mood, cognition and physiological responses.

A series of studies used the trauma film to explore potential mechanisms involved in changes in mood and emotion response following trauma, with an emphasis on investigating negative mood and affect. Three studies were within the same article (Schartau, Dalgleish & Dunn, 2009) investigating the impact of computerised CBM on mood changes before (Expt. 1) and following (Expt. 1 and 2) an experimental trauma. The series of studies showed that training individuals to develop a 'perspective broadening' (i.e. that bad events are rare and there are many positive things happening all the time) approach to thinking about negative events, either before or after viewing traumatic material led to less negative affect associated with viewing the traumatic material. A separate study examined the impact of a CBM package designed to manipulate cognitive errors (biased cognitions such as arbitrary inference and overgeneralisation) on negative affect following a stressor. It was shown that error bias modification (conducted prior to film viewing) resulted in less negative affect experience for the film relative to non error bias modification (Lester, Mathews, Davison, Burgess & Yiend, 2011). Another study investigated the impact of imagery rescripting on changing emotions in response to a stressor (Seebauer, Froß, Dubaschny, Schönberger & Jacob, 2014). Participants were asked to watch three trauma film segments depicting interpersonal violence. After each segment they were asked to use a different imagery rescripting strategy. One strategy involved imagining violent revenge, another strategy involved no violence, and a third involved safe place imagery. Results suggested that the safe place image was most effective at reducing self reported aggression and promoting positive emotions, but that revenge imagery was not inherently harmful as a strategy.

The paradigm has also been used to specifically study voluntary memory of a trauma film. One study investigated the robust findings relating to cognitive biases of collective memory, that is the counterintuitive finding that when several individuals work together to produce a memory account they report fewer items than would have been produced if they had recalled the items separately (for a review see, Rajaram and Pereira-Pasarin (2010)). Results indicated that collaborative recall of details of the trauma film resulted in the recall of fewer details, as compared to individual recall, however individual recall tended to result in more recall errors. These results point to social influences that may impact on memory for emotional information (Wessel, Zandstra, Hengeveld & Moulds, 2014). Another study involved participants viewing trauma film footage and then answering several sets of questions related to the film clips interspersed with performing a secondary working memory task that was designed to provoke emotion (either viewing neutral, negative or positive IAPS pictures) relative to no secondary task. Memory for details of the trauma film was not as good for those participants who undertook a positively valenced secondary task relative to a negative task (Tsai & McNally, 2014).

The relationship between exposure to an experimental analogue of trauma (e.g. film), relative to neutral or no film exposure, and other cognitive outcomes has also been investigated. A study by Verwoerd and colleagues investigated attentional processes following an experimental trauma event (Verwoerd, Wessel & de Jong, 2010). Participants (who had either watched or not watched the trauma film) were presented with a stream of images that contained targets to be detected (rotated landscapes), neutral reminders of the film (film stills taken from the trauma film but that were neutral in valence) or visual distractors unrelated to the film. Results suggested an attentional bias towards neutral reminders of the film (as assessed by performance deterioration when neutral reminders preceded a target trial) for those participants that had previously viewed the trauma film. This suggests that participants

exposed to a traumatic film can develop a film specific attentional bias. Finally, cognitive flexibility (indexed by performance on a Remote Associate Task), declined following trauma film viewing compared to viewing a neutral film (Renner & Beversdorf, 2010), implicating that negative emotional responses (to trauma) may impact negatively on different facets of cognitive resources.

The trauma film paradigm has also been utilised as a method to investigate biological responses to traumatic or stressful events. For instance, one study used electroencephalographic (EEG) to investigate frontal activation in the brain during and after film viewing (Meyer et al., 2014). Left frontal activation during film viewing predicted a dampened startle response to reminders of analogue trauma in the form of a road traffic accident, but a trend towards an increase in startle response (suggesting a greater fear response) following reminders of genocide trauma reminders (Meyer et al., 2014). This suggests that different types of trauma film(s) may impact differentially on symptom development. Measures of EEG and cardiac response were taken in another study in order to understand mechanisms underlying individual differences in emotion perception for others (Papousek et al., 2013). Higher self rated ability to detect the emotions of others was associated with greater cardiac acceleration response to traumatic film materials showing the suffering of others, as well as decreases in functional coupling between prefrontal and posterior cortices, measured by EEG coherences, indicating heightened perceptual processes. Two further studies (Geracioti et al., 2008, 2013) explored physiological response (norepinephrine and corticotrophin releasing hormones) to a trauma film in individuals who already suffered from PTSD. Findings showed that norepinephrine increased during and following trauma film viewing, while corticotrophin releasing hormones decreased. Finally, a traumatic film was used to prevent pre sleep de-arousal in order to investigate mechanisms underlying insomnia (Richardson, Gradisar & Pulford, 2014) of which inhibition of de-arousal is thought to be one. Participants who viewed a traumatic film relative in comparison to those who viewed a positive film prior to sleep experienced significant increase (worsening) in sleep latency (the time it takes to fall asleep) and an increase in attentional bias for sleep related words. Taken together, these studies demonstrate that while the trauma film paradigm has been widely used to study intrusive memory development, it is also a useful method for eliciting other (analogue) responses to trauma, and provides a platform to understand other cognitive, affective and neural processes implicated in the aetiology and development of distressing emotional responses following traumatic events.

Importantly, the trauma film paradigm has also been employed as a method to explore the effects of potential psychological treatments in the immediate aftermath of trauma. Critical Incident Stress Debriefing is a psychological trauma treatment which has been met with concern (Rose et al., 2002). Findings using the trauma film paradigm indicated that, when given after trauma film viewing, group debriefing either did not offer any benefits on trauma type symptomatology (as measured by the Posttraumatic Stress Diagnostic Scale; Foa, 1995) compared to a non facilitated interaction (Devilly & Annab, 2008), or led to greater levels of self-reported film related distress (Devilly & Varker, 2008), corroborating Cochrane Reviews which suggest that it is not an effective treatment in the early aftermath of experiencing a trauma (Rose et al., 2002). Varker and Devilly (2012) investigated whether resilience training (in which individuals are given strategies aimed at reducing the negative effects of experiencing a trauma, such as creating an increased sense of controllability, reducing unexpectedness and training strategies such as thought stopping) might unintentionally increase posttraumatic symptomatology. Either resilience training or control 'pragmatic' training (consisting of information on what to do in a road traffic accident) was administered prior to experimental trauma. Statistically, levels of posttraumatic stress symptoms were not significantly different between groups at 1 month follow up, suggesting that in this study there was not enough evidence that resilience training improved posttraumatic symptomatology for an analogue trauma (Varker & Devilly, 2012).

Finally, two studies showed the use of the paradigm in clinical participants. One study used emotional film clips to test the effects of worry on emotional responses. Participants (Generalised Anxiety Disorder [GAD] versus non anxious control) engaged either in worry, relaxation or a neutral induction prior to film viewing (Llera & Newman, 2014). Results indicated that GAD participants found worry more helpful (as indicated by higher scores on the Contrast Avoidance Questionnaire; Newman & Llera, 2011) to cope with other negative exposures, whereas non anxious individuals found that engaging in worry made them feel less able to cope (Llera & Newman, 2014), supporting the hypothesis that individuals with GAD may use worry as a way to avoid considerable shifts in negative emotion. Another study used the paradigm to explore dysfunctional avoidant emotion regulation in Borderline Personality Disorder (BPD; Linehan, 1993). This was tested by Evans, Howard, Dudas, Denman, and Dunn (2013) in individuals with varying degrees of BPD severity following two negative mood inductions (using a trauma film) interpolated by a neutral film. In the first mood induction, participants reported on the types of emotional regulation strategies used during film viewing, including internal suppression, expressive suppression or emotional acceptance. In the following mood induction, participants were either instructed to suppress their emotions to the film, or to accept them. During film viewing, readings of electrodermal activity (EDA; measure of sweat secretion reactivity as a gauge of emotional arousal) were also taken. Trait emotional avoidance was associated with greater negative affect recovery post film, whereas state emotional avoidance predicted greater positive affect recovery post film, indicating that such strategies in individuals with BPD may be beneficial for some (Evans et al., 2013).

4. Discussion

The current review built upon previous reviews of the trauma film paradigm, (Brewin, 2014; Clark & Mackay, 2015; Clark et al., 2015; Holmes & Bourne, 2008; Krans, Näring & Becker, 2009a) to examine how the paradigm has been used as an experimental psychopathology model for psychological trauma. Seventy-four articles were included in the current review yielding 87 studies using the paradigm over the past 7 years (since the earliest review by Holmes & Bourne, 2008). Studies have modelled processes related to exposure to trauma (i.e. experimental manipulations of processes before, during and after film watching; individual differences).The majority of the studies, $n = 68$ (57 articles) have modelled intrusive memories as a reaction to trauma, with 17 articles having a different main outcome measure, modelling other responses to trauma, e.g., physiological arousal, negative cognitions and mood.

We now discuss the utility of the trauma film paradigm as an experimental psychopathology model of both exposure and reactions to psychological trauma in terms of its strengths and weaknesses; the paradigm's ability to test causal hypotheses related to mechanisms underlying intrusive memory development, and its use in understanding associated trait and peritraumatic factors in response to trauma. We also discuss the paradigm's use as a platform to develop proof of concept new interventions and to test elements of established psychological interventions. Finally, future directions for the paradigm as an experimental psychopathology model are explored.

4.1. The trauma film paradigm: strengths and weaknesses as an experimental psychopathology model of trauma

4.1.1. Analogue methodology: the use of an experimental trauma

The trauma film paradigm provides an experimental analogue for studying both exposure and reactions to viewing events with traumatic content. A common critique levied at the paradigm is the ecological validity of this approach, potentially limiting the extent to which research

can be extrapolated to 'real' trauma. Film content is typical of real events involving actual or threatened death and serious injury in line with those listed as 'trauma' events in the context of PTSD and ASD (American Psychiatric Association, 2013). However, film viewing itself clearly does not meet criteria for a traumatic event.

In the recent 5th Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013), a new inclusion to the definition of trauma was the addition of *indirect* trauma exposure through electronic media, television and movies when viewed repeatedly in the line of work (American Psychiatric Association, 2013, p.271). Previously, posttraumatic stress symptoms were only considered clinically meaningful if they occurred as a result of *direct* personal exposure (which included experiencing and witnessing, and learning that the traumatic event happened to family member or close friend, American Psychiatric Association, 2000). However, the types of clinical example that DSM-5 now covers might include, for example, a policeman reviewing CCTV footage and repeatedly being exposure to details of real murder, or a customs officer repeatedly viewing confiscated DVD footage of horrific child abuse. The inclusion of *indirect* exposure, through electronic media, television, and movies as a current criterion for a traumatic event does indicate that there is a shift in what is understood to bring about clinically significant distress or impairment resulting in a diagnosis of PTSD in the modern world, and underscores the need for continuing investigation into the different ways in which individuals can be 'exposed' to trauma. It additionally makes understanding reactions to film footage with traumatic content relevant to clinical groups traumatised via indirect exposure.

The role of media based exposure to traumatic events has been investigated in two recent studies, which sought to understand the impact of viewing media footage and public health consequences. A correlational study compared direct exposure vs. media exposure of the Boston bombings on acute stress symptoms (Holman et al., 2014). Repeated indirect exposure of viewing of media footage of the bombings (6 h or more daily) was associated with higher acute stress symptoms relative to direct exposure (i.e. being at the scene of the bombings and directly witnessing the event). Findings remained robust when prior mental health, or prior television viewing habits were controlled for (Holman et al., 2014). Prospective longitudinal data suggested that, after adjusting for pre 9/11 mental health and prior television viewing habits, early television exposure of 9/11 (1 to 4 h daily, in the 3 weeks after the event) was associated with posttraumatic stress symptoms up to 2 to 3 years later (Silver et al., 2013). While there are limitations to these studies, e.g. the data is correlational, taken together these studies suggest that media based exposure as a form of trauma would be a worthwhile focus for future research, particularly given the ubiquitous nature of media in everyday life (Silver et al., 2013). Greater examination of mass, indirect exposure to traumatic events via the media is required. In conjunction with the inclusion of trauma exposure through media sources in the line of work in the DSM-5, we need to better understand these forms of traumatic event exposure. The use of film footage represents a worthwhile experimental tool in this regard.

Just as viewing film footage is an experimental analogue and not 'real' trauma per se, it can also be argued that the symptoms evoked by such a film are not 'real' trauma symptoms, again potentially making it difficult to generalise beyond the results gained from studies using the trauma film paradigm. The phenomena of intrusive memories (a hallmark symptom of ASD and PTSD, American Psychiatric Association, 2013) occur across a range of events. According to some views, intrusive memories can be thought as on a continuum with non clinical involuntary memories in daily life up to 'flashbacks' in PTSD (Berntsen & Rubin, 2008). Other continuum theorists support a more moderate approach, suggesting there may be qualitative differences (Kvavilashvilli, 2014). The continuum view assumes that both involuntary and voluntary retrieval of the trauma are drawn from the same underlying trauma memory representation. Other authors (Brewin, 2014; Brewin et al., 2010) make a more explicit distinction between involuntary retrieval in the form of 'intrusive memories found in clinical disorders' versus involuntary retrieval in the form of 'flashbacks', the latter argued to be specific to ASD/PTSD. Specifically, they suggest that for ASD/PTSD, abnormal processing of trauma leads to a distinct, non contextualised memory representation of the trauma that supports involuntary retrieval of the trauma in the form of 'flashbacks', with such representation being distinct and separate from the memory representation underlying voluntary retrieval of the same trauma memory. The opposing theoretical perspectives highlight the importance for experimental psychopathology to bridge both clinical and nonclinical literature in the study of basic and emotional memory phenomena.

Alternative approaches to traumatic film footage have been used to model negative emotion and trauma experimentally. International Affective Picture Series (IAPS) are a standardised set of still images which have been shown to elicit various emotional responses and include images with traumatic content (Lang, Bradley & Cuthbert, 2008). Still pictures have some research advantages such as being standardised and offering experimental control. On the other hand, film clips of emotional real life experiences (or of simulations of such experiences) offer richer and dynamic visual complexities, containing narrative elements within a continuous context (Furman, Dorfman, Hasson, Davachi & Dudai, 2007; Gross & Levenson, 1995; Hasson, Furman, Clark, Dudai & Davachi, 2008). The use of films also offers the possibility to study responses over time as the story unfolds (e.g. Hagenaars, Roelofs & Stins, 2014) and the role of context or narrative (e.g. Jobson & Dalgleish, 2014). However, it is noted that context and narrative manipulations have also been studied from intrusions generated from using IAPS pictures (Krans, Pearson, Maier & Moulds, in press; Pearson, Ross & Webster, 2012). Films typically generate a higher number of intrusions than do picture stimuli – which may be an advantage in terms of sample size and power, particularly for experiments seeking to test a *reduction in* the frequency of intrusive memories – a key aim of treatment related research.

Virtual reality offers an extension to the use of picture stills or films, potentially making the stimuli even closer to real world experiences (Dibbets & Schulte-Ostermann, 2015). Potential advantages to using virtual reality include that it is likely to increase the immersive nature of the stimuli and offers detailed exposure to an event with traumatic content, including interactions and self paced exploration. However, these may also become its weaknesses, as control over stimulus presentation can be reduced with participant-controlled interactions.

Other approaches have taken alternative steps towards ecological validity, such as using novice skydivers who were about to undertake their first jump (e.g. Fenz & Epstein, 1965; Sterlini & Bryant, 2002). Such studies are resource intensive, requiring an aeroplane for example. Further, participants who choose to go skydiving may not be a representative sample, since they have chosen to be exposed to the 'traumatic' event, which could be experienced as a recreational activity.

The choice of stimuli/analogue trauma experience is clearly a matter for individual researchers to decide with a particular experimental purpose in mind. An interesting angle for future research remains to contrast the different advantages of the various paradigms directly.

4.1.2. Analogue methodology: the use of a diary as a measure to 'capture' intrusive memories

The commonly used pen and paper diary methodology used extensively within the trauma film paradigm to capture intrusions of the experimental trauma is advantageous in that it may be kept over long periods of time, with participants able to record intrusions as and when they occur over the course of their daily lives. As such, it confers a more ecologically valid insight into intrusion development, compared to more laboratory-based methods of capturing intrusion frequency or

retrospective self report questionnaires. We note that diary compliance and accuracy may be difficult to assess using a measure completed away from the laboratory, particularly using pen and paper formats (although electronic formats can record time stamped entries and check for daily compliance; Stone, Shiffman, Schwartz, Broderick & Hufford, 2003). Relatedly, recent research using the trauma film paradigm indicates individuals are often not aware that they have been engaging in spontaneous trauma film related thoughts, unless specifically probed (Takarangi, Strange & Lindsay, 2014) leading the authors to suggest that self report methods may likely provided an underestimation of intrusion symptom frequency. As intrusions were measured soon after film viewing while still in the laboratory, it remains to be determined whether results generalise to intrusions measured for other time periods, such as those generally covered by the diary methodology. Despite this however, within the current review several experiments were able to demonstrate effects of experimental manipulation using a diary methodology, highlighting it as a valid and useful tool in which to capture intrusion frequency and their features. In addition, several studies adopted a convergent measure approach (e.g. experimenter delivered questionnaires, laboratory-based intrusion monitoring tasks) to investigate intrusion symptom frequency following a trauma film, mitigating issues which may arise from using self report and naturalistic approaches alone. Further, advances in technology have meant that diaries are no longer reliant on pen and paper formats, instead mobile devices can be used, which can be formatted to prompt individuals to note their intrusive memories (for example, via mobile phone text messaging services; Malik et al., 2014). This is an area for future development, where there is an unmet need for such diary advances both in analogue and clinical populations. We advocate for the use of converging measures within the same study, particularly because different methods of measuring intrusions can yield opposing patterns of results. Brewin (2014) found that while the majority of studies revealed a lack of significant relationships between involuntary intrusions, measured with intrusion diaries and voluntary memory tests, a small number of studies found that intrusions measured with retrospective measures, such as that of Ferree and Cahill (2009), have instead found a significant correlation. Such discrepancy highlights methodological differences, such as whether images and thoughts were distinguished, the period of time for monitoring, and the order of different memory measures. More research is needed to understand how such methodological differences are linked to differential patterns of findings across studies.

4.2. The trauma film paradigm: ethical considerations

For obvious reasons, to study trauma it is unethical to expose people to real trauma, and this is clearly not the aim of the trauma film paradigm. Yet, given that this paradigm uses aversive film material to investigate processes relevant to trauma-related psychopathology, the paradigm may, if only briefly, cause distress. It is therefore critical to carefully consider ethical issues related to trauma film viewing, and to implement appropriate safeguarding measures beforehand. For example, one may consider excluding participants with (a history of) treatment for mental health problems. Also, it is critical to inform participants about the nature of the film, at the time of recruitment and to obtain written informed consent prior to testing. Researchers may want to consider excluding participants if they had experienced trauma of the kind shown in their films. It is important for participants to understand that they can withdraw at any point during the experiment, and for researchers to be sensitive to distress. After film viewing, one may think about strategies to undo disproportional distress, such as offering psychological support. In that regard, it may be helpful to have clinically qualified professionals available for guidance throughout the research process and for contact details to be available after the study has ended. A further consideration may be selecting a film: it is not necessarily the aim to find the most aversive film that the ethical committee will allow; instead, researchers should aim to find a film that is just sufficiently aversive to successfully model trauma (e.g. generate some intrusive memories), which may depend more on the entire experimental protocol than on the severity of the film itself. Each laboratory setting should carefully consider the setup of experiments, the training and monitoring of testing personnel, and the type of participants who will take part on a study-by-study basis.

4.3. The trauma film paradigm: testing cognitive models of psychopathology and memory

Clinical models of PTSD (e.g. Brewin, 2001, 2003; Brewin, Dalgleish & Joseph, 1996; Ehlers & Clark, 2000) highlight the importance of peritraumatic processes on development of intrusive memories, and of distinguishing them from pre and posttraumatic processes. For instance, this review has revealed that specific emotional (Clark, Mackay & Holmes, 2013; Clark et al., 2015), neural (Bourne et al., 2013; Clark, Mackay, Woolrich & Holmes, 2016) and physiological responses (Chou et al., 2014b) at the time of film viewing can predict later intrusive memories. Critically, specific brain activation at the time of viewing particular film segments can predict that such segment would later become an intrusive memory for a given individual (Clark et al., 2014). Therefore, the trauma film paradigm confers exciting possibilities for gaining insights into peritraumatic processes which may not be achieved otherwise during real life trauma.

A key cognitive aspect implicated in the development of intrusive memories highlighted by clinical models of PTSD is the 'faulty information processing' shift (Brewin & Holmes, 2003) at the time of experiencing a traumatic (highly emotional) event. This processing shift involves enhanced sensory perceptual processing paralleled with a reduced conceptual processing of the event (Holmes & Bourne, 2008). The current review found that multiple studies have tested these putative processes employing a 'competition for resource' rationale with interfering cognitive tasks. The majority of studies (Bourne et al., 2010; Deeprose et al., 2012; Krans et al., 2010; Logan & O'Kearney, 2012) demonstrated that visuospatial tasks during/soon after film viewing reduce intrusive memory development, in line with clinical models that such tasks compete with sensory perceptual resources needed to form intrusive memories.

The effect of different verbal tasks during/soon after film viewing on intrusive memory frequency was less consistent, in that one study showed a reduction (Krans, Näring & Becker, 2009a) and other studies showed an increase (Expt. 2; Bourne et al., 2010; Nixon et al., 2007) in intrusive memory frequency. An exception to this seems to be verbal tasks involving counting backward, which consistently led to more intrusive memories (see Brewin, 2014). These findings raise intriguing questions regarding the precise role of peritraumatic verbal processing on intrusive memory development and which specific verbal processes were targeted by the variety of verbal tasks employed across studies (e.g. phonological, linguistic, semantic, conceptual). In clinical models, conceptual processing refers broadly to a focus on the meaning of the situation, organising the information, and placing it in context (Ehlers & Clark, 2000). Conceptual processing has been linked initially to verbal processing (e.g. Brewin et al., 1996) and is therefore expected to be disrupted by concurrent verbal tasks such as counting backwards. However, more recent theoretical developments link conceptual processing with abstract, context independent representations (Brewin et al., 2010), placing less emphasis on verbal information per se. Delineating the precise nature of conceptual processing, and its relation to verbal information, is important for further theoretical developments on intrusive memories and trauma processing.

Critically, the differential task effects on intrusive memory development are linked to a wider debate regarding the importance of task modality. For example, one study (Pearson & Sawyer, 2011) found that only

high executive load tasks at the time of encoding reduced subsequent intrusions of aversive IAPS pictures, with no effect of task modality. This has led to the alternative proposal that general load, as opposed to task modality, modulates intrusive memory frequency (e.g., Pearson & Sawyer, 2011). Similar principles may apply to processes during memory retrieval (e.g. Gunter & Bodner, 2008), when consolidated memories have the ability to re enter a labile state (Nader & Einarsson, 2010). For example, it is well documented that various demanding tasks, undertaken whilst recalling memories of distressing events, can reduce the vividness and/or emotionality of the memory. Such tasks include eye-movements (van den Hout, Muris, Salemink & Kindt, 2001), Tetris game play (Engelhard, van Uijen & van den Hout, 2010), counting backwards (van den Hout et al., 2010), mental arithmetic (Engelhard, van den Hout & Smeets, 2011), attending to bilateral beeps (Van den Hout, Engelhard, Rijkeboer, et al., 2011) and mindful breathing (Van den Hout, Engelhard, Beetsma, et al., 2011). What all these tasks have in common is their ability to tax the central executive of working memory, not necessarily modality specific resources (Gunter & Bodner, 2008). Following this line of argument, it could be argued that visuospatial versus verbal tasks employed within the studies discussed in the current review differ in load instead of modality (Pearson & Sawyer, 2011). Future research should more precisely disentangle the resources taxed by such interfering tasks which may explain their modulatory effect on intrusive memory frequency. It is possible that both load and modality contribute independently and/or interactively.

4.4. The trauma film paradigm: identifying individual differences and vulnerability factors

The current review highlights a number of correlational studies which identify trait and other (peritraumatic) factors associated with intrusive memory frequency. For example, trait anxiety, dysphoric mood, hypomania, dissociation, data driven and referential processing, disgust propensity, trait rumination, and resistance to proactive interference were all associated with greater intrusive memory frequency. Developmental trajectories and rates of PTSD highlight that a significant minority of individuals develop PTSD after trauma, while more individuals experience symptoms of PTSD but do not qualify for a full diagnosis (e.g. Bonanno & Mancini, 2012; Breslau et al., 1998; Dickstein, Suvak, Litz & Adler, 2010; Steenkamp, Dickstein, Salters-Pedneault, Hofmann & Litz, 2012). Using the trauma film paradigm, the study of individual differences such as those described above can help identify individuals who are most vulnerable to developing intrusive memories to traumatic and highly emotional events. Such approach can also take the opposite direction: as not all participants develop intrusive memories, we may be able to begin to understand possible protective factors against intrusive memories (e.g. Clark et al., 2015; Meyer et al., 2014). From a public health perspective, focusing efforts on those who are more vulnerable, while developing strategies to improve resilience, could be beneficial when resources are scarce. The study of individual differences has clear relevance for intervention; several studies within this review have shown that the effectiveness of a therapeutic strategy may vary according to important individual differences. For example, certain manipulations were most effective for participants with high trait rumination (abstract versus concrete thinking styles; Schaich et al., 2013) and participants with high trait anxiety (imagery re-experiencing versus imagery rescripting; Hagenaars & Arntz, 2012). Much experimental research on trauma memory is initially performed in student (or at least, young and relatively homogeneous) populations. While this type of research is very useful for obtaining insights in basic emotional memory processes and the development of 'proof of principle' strategies, the research in these populations may potentially limit the generalizability of the findings. It is important for future studies to consider a wider range of populations, and to first test experimental interventions in representative populations before taking them to the clinic.

4.5. The trauma film paradigm as a method to develop proof of concept treatments

The trauma film paradigm might also be used as a platform to develop proof of concept for new psychological interventions for clinical posttraumatic distress, and as such the experimental control afforded by this paradigm may derive findings that are of clinical significance. For example, this review highlights procedures that reduced intrusive memories during processing the trauma film, but also those presented before an experimental trauma (Woud et al., 2013) which suggests avenues for developing 'prophylactic' strategies that can influence the later encoding of a traumatic event. The review also revealed studies that have successfully modulated intrusive memories using procedures delivered soon after encoding of the experimental trauma, capitalising on neurobiological accounts of memory which indicate that new memories are sensitive to disruption whilst they undergo the process of consolidation and that this stabilisation process may take several hours (McGaugh, 2000). For example, simple cognitive tasks (such as playing the computer game Tetris) were effective at reducing later intrusive memories when given up to 4h after film viewing (Holmes, James, et al., 2010). Other studies tested a variety of appraisal training techniques, for example training to elicit positive reappraisals of coping ability (Woud et al., 2012) or learning to think in concrete as opposed to abstract thinking styles (Ehring et al., 2009; Zetsche et al., 2009). Together these studies show that relatively low intensity tasks and procedures may be used to ameliorate clinical posttraumatic distress symptoms when given before and/or soon after a traumatic event. Therefore, the trauma film paradigm provides highly controlled context in which to investigate the time frame whereby manipulations can be delivered relation to an experimental trauma, which can then be corroborated in other more complex settings. This approach drives clinical innovation in areas with huge unmet needs, including preventative measures and therapeutic strategies in the early aftermath of trauma (National Institute for Health and Clinical Excellence, 2005; Roberts et al., 2010).

Other studies identified in the review used the paradigm to systematically test more established psychological interventions, such as imagery rescripting (Hagenaars & Arntz, 2012; Seebauer et al., 2014). Importantly, the paradigm has been used to understand why certain treatment techniques, such as debriefing, are *not* helpful when given following trauma (e.g., Devilly & Varker, 2008). Undoubtedly, lines of enquiry which seek to understand why certain procedures do not work, or may be harmful post trauma (e.g. psychological debriefing; see, Rose et al., 2002) are critical in evaluating new treatment techniques.

4.6. Future directions

We suggest a number of future directions which are currently underexplored and which, if pursued, may further inform both treatment and clinical research. First, while intrusive memories have been the main focus of the trauma film paradigm (and are a hallmark symptom of ASD and PTSD), it is also important to extend the paradigm to study other emotional psychopathologies. Intrusive imagery is present across a range of psychological disorders, for example bipolar disorder (Holmes et al., 2011) and social phobia (Hackmann, Clark & McManus, 2000; Hirsch, Clark, Mathews & Williams, 2003). While such imagery is striking to patients, it has been relatively neglected in talking therapies and research alike. The paradigm therefore provides a method in which to investigate the development of intrusive imagery in individuals who may be particularly vulnerable to developing such disorders, and to assess their susceptibility to experiencing intrusive imagery following emotional events and stressors. Within the current review we detail two studies that have investigated increased intrusive memories following exposure to experimental trauma, one with individuals scoring high on schizotypy (Marks et al., 2012), and another with individuals scoring high on hypomania (Malik et al., 2014). Also,

given that involuntary memories during elated moods have been implicated in the maintenance of manic experiences (Holmes, Geddes, Colom & Goodwin, 2008), the trauma film paradigm has also been adapted to investigate overtly positive films and subsequent intrusive imagery, and whether positive intrusive memories could be modulated using cognitive tasks similar to those used for intrusive imagery of negative material (Davies, Malik, Pictet, Blackwell & Holmes, 2012), and likewise similarities in the increase in frequency of positive memories following a larger emotional response (Clark et al., 2013). Further adaptations of the paradigm have already been demonstrated in combination with neuroimaging (Bourne et al., 2013; Clark, Niehaus et al., 2014; Clark, Mackay, Woolrich & Holmes, 2016) and fear conditionability (Wegerer et al., 2013). The bridging of such approaches between clinical and basic domains can help open avenues to advance our understanding of intrusive memory formation and modulation, an area that has received little attention in mainstream cognitive research.

The current review emphasises the utility of the trauma film paradigm as a method to investigate involuntary intrusive memories. However, the relationship between intrusive memories and other aspects of memory, such as voluntary retrieval of the same event, remain unclear. The reviewed studies suggest a possible discrepancy between the impact of cognitive tasks on involuntary versus voluntary aspects of memory for the experimental trauma. For example, visuospatial tasks (such as the computer game Tetris) have been shown to be effective at reducing intrusive memory frequency but at the same time leave recognition memory intact (Holmes, James, et al., 2010). This selective pattern of interference, although frequently replicated within the experimental psychopathology literature using the trauma film paradigm (Brewin, 2014), stands in contrast to theories from the mainstream memory literature (Tulving, 2002), which assume that task effects on consolidation of involuntary and voluntary retrieval are the same. For example, fewer involuntary intrusions of the film reported in an intrusion diary would reflect an impaired memory and thus be associated with poorer scores on subsequent voluntary memory tests for the film. Across studies, although involuntary aspects of memory have been mostly measured using the diary methodology, there has been evidence that these do not always converge with other measures of involuntary memory, such as laboratory-based monitoring tasks or self reported questionnaires. Similarly, voluntary aspects of the trauma film have been assessed using a variety of tests, from recognition and sequential memory to free or cued recall. Each of these tests potentially measures a different aspect of deliberate recall which could be affected in different ways. Future research needs to further elucidate these compelling dissociations, and systematically examine whether differences across such variety of memory measures could account for apparent dissociations. Nevertheless, it is interesting to find that studies of intrusive emotional memories raise questions for mainstream memory models. This paradox is also clinically relevant, as an intervention that could reduce intrusions, yet preserves memory for facts and events about the trauma, may be desirable: in a legal context trauma survivors may need to testify about their experience and thus be able to deliberately recall it, yet wish to be free of intrusions (Holmes, Sandberg, et al., 2010). Given the theoretical and clinical importance of distinguishing involuntary from voluntary retrieval, better assessments of voluntary memory for film material are needed. For example, visual films may be better assessed with measures involving visual rather than verbal stimuli, with some recent studies using both (e.g. James, Bonsall, et al., 2015). Future research should aim to establish the validity, reliability, and sensitivity of memory measures, particularly those measuring voluntary memory of film material which has received relatively little attention within this paradigm.

An important area for future research of theoretical and clinical significance is the time course of intrusive memory formation and the timeframe in which interventions may be most effective. The current review highlights that, beyond peritraumatic processing, studies have started to explore and harness cognitive mechanisms pre and post traumatic processing which could modulate later intrusions, such as the idea of memory consolidation, i.e. a hypothesised time window post encoding during which the memory remains labile before transfer into longer term memory (Nader, Schafe & LeDoux, 2000). The review highlighted a gap in the literature concerning the use of competing visuospatial cognitive ask before trauma to reduce subsequent intrusions; although a recent study (James, Lau-Zhu, Tickle, Horsch & Holmes, in press) indicates that administering a visuospatial task before experimental trauma is unlikely to proactively interfere with intrusive memory development. Therefore, administering cognitive tasks during or after trauma stimuli may be a better focus for intrusive memory amelioration.

Furthermore, recent research suggests that consolidated memories for negative, emotional events are not fixed, but can still be modified under certain conditions. The 'memory reconsolidation hypothesis' postulates that a memory may be rendered transiently labile and vulnerable to disruption following its retrieval (Nader & Einarsson, 2010). This raises the exciting possibility that intrusive aspects of an *old trauma memory* (a clinically relevant target) can be weakened while they are in this transient labile state by means of interventions that interfere or compete with the processes that are necessary to restabilise the memory. Research using fear conditioning paradigms shows promise for modifying reactivated fear memories (Kindt, Soeter & Vervliet, 2009; Schiller et al., 2010), although there seem to be many 'boundary conditions' which may prevent reconsolidation processes from occurring (and thus meaning memory modification is not possible). The trauma film paradigm provides the potential to test and describe in more detail the types of procedures that promote reactivation and subsequent reconsolidation of memory for traumatic events (e.g. James, Bonsall, et al., 2015). Further, it provides an ethically appropriate method to test out procedures and interventions that utilise the processes involved in memory consolidation and reconsolidation before attempting to implement them in real world settings.

The direct assessment of the clinical utility of the trauma film paradigm warrants further investigation. While the paradigm has propelled research relevant to trauma given its procedural flexibility to model exposure and reactions to trauma, its generalizability to real life trauma and real symptoms post trauma requires more empirical work. We argue that such line of research in the future can be guided by experimental medicine/psychopathology frameworks such as those developed for anxiety disorders (Bailey et al., 2011; Guttmacher et al., 1983) which propose several criteria for establishing the validity of an experimental medicine model for preclinical research.

Finally, within the current review several different traumatic films were used that successfully induced involuntary memories. In order to optimise interpretations of results and encourage replication, the paradigm may benefit from an international database of validated films, similar to the International Affective Picture System (Lang et al., 2008) that can be used by all researchers.

5. Conclusion

The current systematic review builds upon an earlier review of the trauma film paradigm literature in this rapidly moving field (Holmes & Bourne, 2008). Research using the trauma film paradigm continues to support the possibility of visuospatial cognitive tasks as a preventative intervention soon after trauma to reduce intrusive memory frequency, and identifies other cognitive processes that could be trained post trauma to reduce intrusive memories. It has also suggested a number of factors that may be useful in identifying those individuals most at risk following a traumatic event. However, while substantial progress has been made, reviewing the literature highlights a number of areas where further research is still required. The trauma film paradigm remains an invaluable tool since the 1960s (Horowitz, 1969) within an experimental psychopathology

approach to understanding intrusive memories and other reactions to psychological trauma. By understanding the basic mechanisms underlying symptom development, we can begin to translate findings from the laboratory to the clinic, test potential interventions and hopefully in the future reduce the debilitating effects of psychopathology following stressful or traumatic events.

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Appendix A

Table A.1
Experimental details of studies that use manipulations before/during film viewing.

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
Hawkins and Cougle (2013)	*N* = 54 2 condition, between groups; *n* = 27 per group. Film duration: 10 min	Nicotine in the body: Nicotine lozenge Placebo lozenge	Manipulation administered prior to film	Intrusive images and thoughts:- Frequency *Day 1:* 5-min monitoring *Days 1 to 7:* Diary method Dispositional rumination:- PTQ score Memory for analogue trauma:- *Day 7:* FR memory test score VR memory test score	Intrusive images and thoughts:- Frequency *Day 1:* Monitoring Nicotine > Placebo *Days 1 to 7*: Diary Nicotine = Placebo Dispositional rumination:- Low PTQ score: Nicotine > Placebo intrusions Memory for analogue trauma:- *Day 7:* FR and VR scores No group differences
Woud et al. (2013)	*N* = 76 2 condition, between groups; *n* = 37 per group Film duration: 20 min	Computerised appraisal training using scripted vignettes targeting self-efficacy beliefs: Positive = vignettes resolve positively Negative = vignettes resolve negatively	Manipulation administered prior to film	Intrusive images and thoughts:- Frequency and distress *Days 1 to 7*: Diary method *Day 1 pre- and post-film; Day 7* PTCI score change Trauma cognitions:- *Day 1: baseline to post film* PTCI score change (lower scores = improvement) *Day 7: baseline to Day 7* PTCI score change	Intrusive images and thoughts:- Frequency *Days 1 to 7*: Diary Positive = Negative Distress *Days 1 to 7*: Diary Positive < Negative Trauma cognitions:- *Day 1:* PTCI No group differences *Day 1 Baseline to Day 7:* PTCI Positive = decrease score Negative = no change score
Schaich et al. (2013)	*N* = 66 2 condition, between groups; Abstract: *n* = 32 Concrete: *n* = 34 Film duration: 14 min	Processing style in relation to trait rumination (on RRS): Abstract = general, decontextualised, analytical, and evaluative processing Concrete = specific, non-evaluative, and experiential processing	Manipulation training administered prior to film	Intrusive memories:- Frequency, vividness, and distress *Day 1: post film and reminders of the film* IQ score sum post film + post exposure to reminders of the film Frequency, vividness, and distress *Days 1 to 7: every evening* IQ score sum of each day Physiological reaction:- *Day 1(during film viewing):* HR SCL	Intrusive memories:- Frequency *Day 1:* IQ score (sum) Abstract = positive association Vividness and distress: *Day 1* IQ score No associations Frequency *Days 1 to 7:* IQ score (sum) Abstract = positive association trend level Vividness and distress *Days 1 to 7:* IQ score (sum) Abstract = positive association Physiological Reaction:- *Day 1(during film):* HR Abstract training = positive association Concrete training = negative association *Day 1(during film):* SCR Abstract = positive association (trend level) Concrete = negative association (trend level)
Pearson (2012)	*N* = 40 2 condition, between groups; *n* = 20 per group Film duration: 13 min 40 s	Influence of contextual information: Contextual = audio commentary provided with film Context Free = no audio commentary provided with film	Manipulation administered concurrently with film	Intrusions:- Frequency *Days 1 to 7*: Diary method Memory for analogue trauma:- *Day 7:* Cued recall memory test score Forced choice recognition	Intrusions:- Frequency *Days 1 to 7*: Diary Contextual > Context Free Memory for analogue trauma:- *Day 7:* cued recall and recognition memory test scores Contextual = Context Free

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Table A.1 (*continued*)

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
				memory test (written statements)	
Brown et al. (2012)	$N = 33$ 2 condition, between groups; HSE: $n = 17$ LSE: $n = 16$ Film duration: 10 min	Efficacy (perceived self-control) induction training: HSE = verbal feedback told participants they were able to cope well LSE = verbal feedback told participants they were not able to cope well	Manipulation administered prior to film viewing	Intrusive images:- Frequency and distress *Day 1:* 3 min monitoring *Days 1 to 2 (24 h.):* Retrospective estimates on Day 2 Memory for analogue trauma:- *Day 2:* Cued recall memory test: -Peripheral film details -Central film details	Intrusive images:- Frequency *Day 1 and Days 1 to 2:* LSE > HSE Distress *Day 1 & Day 2:* LSE > HSE Memory for analogue trauma:- *Day 2:* Cued recall memory test score Peripheral LSE = HSE Central LSE > HSE
Marks et al. (2012)	$N = 49$ Mixed design; 2 condition (LS vs. AE) within group (VST vs. NT): LS: $n = 26$ AE: $n = 23$ Film duration: 2 films both 5 min 30 s	VST = complex sequence tapping on keypad held out of sight NT = no task Trait measures High vs. low schizotypal traits (measured using *O-LIFE*) LS AE	Manipulation administered concurrently with film	Intrusive memories:- Frequency *Day 1*: 4 min monitoring (30-min post film) *Days 1 to 7*: Diary method Characteristics *Day 7:* TMQ score Processing style:- *Day 1*: T-CPQ score	Intrusive memories:- Frequency *Day 1:* 4 min monitoring AE > LS *Days 1 to 7:* Diary AE > LS No effect of VST Characteristics *Day 7:* TMQ score AE > LS Processing style:- *Day 1*: T-CPQ: Data driven style AE > LS
Logan and O'Kearney (2012)	$N = 105$ 3 condition, between groups; Film duration: 9 min	VIT = counting backwards in 3's SIT = clay modelling geometric shapes NT = No task	Manipulation administered concurrently with film	Intrusive images:- Frequency *Day 1 over 24 h*: Diary method *Days 1 to 7*: Diary method *Day 7:* IES Intrusions subscale score	Intrusive images:- Frequency *Day 1 over 24 h:* Diary VIT = NT/SIT < NT *Days 1–7:* Diary VIT = NT/SIT = NT *Day 7:* IES-Intrusion score VIT = NT/SIT = NT
Bourne et al. (2010)	Expt. 1. $N = 60$ 3 condition, between groups; VIT: $n = 15$ VST: $n = 11$ NT: $n = 14$ Film duration: 13 min Expt. 2. $N = 38$ 2 condition, between groups; $n = 19$ per group Film duration: 21 min	Expt. 1. VIT = counting backwards in 3's; VST = complex sequence tapping on keypad held out of sight Expt. 2. VIT = counting backwards in 7's NT = No Task	Expt. 1. Manipulation administered concurrently with film Expt. 2. Manipulation administered concurrently with film	Expt. 1. Intrusive images:- Frequency *Days 1 to 7*: Diary method Memory for analogue trauma:- *Day 7:* Forced choice recognition memory test (written statements) Cued recall memory test Expt. 2. Intrusive images:- Frequency *Days 1 to 7*: Diary method Memory for analogue trauma:- *Day 7*: Forced choice recognition memory (written statements)	Expt. 1. Intrusive images:- Frequency *Days 1 to 7*: Diary VST < NT and VIT; VIT = NT Memory for analogue trauma:- *Day 7:* Recognition memory score No group differences *Day 7:* Cued recall memory score VIT < NT and VST Expt. 2. Intrusive images:- Frequency *Days 1 to 7*: Diary VIT > NT Memory for analogue trauma:- *Day 7*: Recognition memory score VIT < NT
Krans et al. (2010)	$N = 54$ 3 condition, between groups; Film duration: 8.45 min	VST = complex sequence tapping on keypad held out of sight CMT = chewing gum in specific configurations NT = *No task*	Manipulation administered concurrently with film – 1-min practice pre-film	Intrusive images:- Frequency *Days 1 to 7*: Diary method Memory for analogue trauma:- *Day 7:* -Cued recall memory test -Forced choice recognition memory test (written statements)	Intrusive images:- Frequency *Days 1 to 7*: Diary VST < NT and CMT CMT = NT Memory for analogue trauma:- *Day 7:* Cued recall score VST < NT CMT = NT and VST - Cued recall score positively related to intrusion frequency *Day 7:* Recognition memory score No group differences
Hagenaars et al. (2010)	Expt. 1. $N = 79$ 3 condition, between groups; DEL-NM: $n = 25$ DISS-NM: $n = 27$	Expt. 1. DEL-NM = Deliberate non-movement DISS-NM = Dissociative non-movement FM = Free Movement	Expt. 1. Manipulation administered concurrently with film for 10 min duration	Expt. 1. Intrusive images and thoughts:- Frequency *Days 1 to 7*: Diary method Peri-traumatic emotion:- *Day 1:* Self-report Anxiety, Horror, Anger	Expt. 1. Intrusive images:- Frequency *Days 1 to 7*: Diary DEL-NM > FM DISS-NM > FM DEL-NM = DISS-NM Intrusive thoughts:-

Table A.1 (*continued*)

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
	FM: $n = 27$ Film duration: 10 min			& Sadness	Frequency *Days 1 to 7*: Diary DEL-NM and DISS-NM: Images > thoughts FM: images = thoughts Peri-traumatic emotion *Day 1:* No between group differences. Greater levels of Anxiety, Horror, Anger correlate with greater numbers of image intrusions
	Expt. 2. $N = 52$ 2 condition, between groups; TF: $n = 29$ NF: $n = 23$ Film duration: 10 min	Expt. 2. Film type: Traumatic Film [TF] Neutral Film [NF]	Expt. 2. The type of film watched was manipulated	Expt. 2. Intrusive images and thoughts:- Frequency *Days 1 to 7*: Diary method Peri-traumatic emotion:- *Day 1:* Self-report Anxiety, Horror, Anger & Sadness	Expt. 2. Intrusive images:- Frequency *Days 1 to 7*: Diary TF > NF Intrusive thoughts:- Frequency *Days 1 to 7*: Diary TF: Images > Thoughts NF: Images = Thoughts Peri-traumatic emotion:- *Day 1:* Higher scores on Anxiety, Horror and Sadness = more image intrusions
Bisby et al. (2010)	$N = 48$ Between-group	Low dose = 0.04 g/kg alcohol High dose = 0.08 g/kg alcohol Placebo control	Manipulation administered prior to film for 30 min followed by 10 min break	Intrusive images:- Frequency *Days 1 to 7*: Electronic 'online' diary method Memory for analogue trauma:- *Day 7:* Cued recall memory test score	Intrusive images:- Frequency *Days 1 to 7*: Diary *Day 7:* Cued recall memory score Placebo > 0.08 g/kg 0.04 g/kg > 0.08 g/kg Placebo = 0.04 g/kg Memory for analogue trauma:- *Day 7:* Cued recall memory score Placebo > 0.08 g/kg 0.04 g/kg > 0.08 g/kg Placebo = 0.04g/kg
Krans, Näring, and Becker (2009a)	$N = 76$ Within-group. Film duration: 6 min 48 s	VIT = counting backwards in 3's VET = verbalise emotion and sensory experience of film NT = No task	Manipulation administered concurrently with film	Intrusive memories:- Frequency *Days 1 to 7*: Diary method Memory for analogue trauma:- *Day 7*: Cued recall memory test Forced choice recognition memory test	Intrusive memories:- Frequency *Days 1 to 7*: Diary VET = NT VIT < NT (trend level) VET = VIT Memory for analogue trauma:- *Day 7*: Cued recall memory score VIT < VET and NT *Day 7*: Recognition memory score No group differences
Ferree and Cahill (2009)	$N = 48$ Within group. TF and NF consisted of 6 separate clips each	Film type TF = Traumatic film content NF = Neutral film content	The type of film watched was manipulated	Intrusions (SIR):- Frequency *Days 1 to 3:* Retrospective self-report on Day 3 Memory for analogue trauma:- *Day 3:* Subjective memory strength Self-report rating per clip Free recall memory test - number of film clips recalled - number of details per clip recalled - film clip order accuracy	Intrusions (SIR):- Frequency *Day 3:* Retrospective self-report TF > NF Memory for analogue trauma:- *Day 3:* Subjective memory strength TF > NF *Day 3:* Free recall memory score - number of film clips recalled TF > NF - number of details per clip TF > NF - film clip order accuracy TF = NF Correlation: free recall number of details per clip and intrusion frequency Positive correlation = TF and NF positive correlation = TF
Bisby et al. (2009)	$N = 48$ 3 condition, between groups; $n = 16$ per group Film duration: 12.5 min	Low dose = 0.04 g/kg alcohol High dose = 0.08 g/kg alcohol Placebo control	Manipulation administered 40 min prior to film; 30 min alcohol consumption followed by 10-min	Intrusive images:- Frequency *Days 1 to 7*: Electronic 'online' diary method Physiological response:-	Intrusive images:- Frequency *Days 1 to 7*: Diary 0.04 g/kg > 0.08 g/kg 0.04 g/kg > placebo

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Table A.1 (*continued*)

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
			break	*Day 1:* SCR Memory for analogue trauma:- *Day 7:* - Cued recall memory test score - Forced choice recognition memory test (written statements) with subscores for *Gist* and *Detail*	0.08 g/kg < placebo Physiological response:- *Day 1:* SCR increase for parts of the film that intruded most frequently Memory for analogue trauma:- *Day 7:* Cued recall memory score Placebo > 0.08 g/kg 0.04 g/kg > 0.08 g/kg Placebo = 0.04 g/kg Day 7: Recognition memory scores - Gist: Placebo > 0.08 g/kg Placebo = 0.04 g/kg 0.04 g/kg = 0.08 g/kg - Detail: Placebo > 0.08 g/kg Placebo = 0.04 g/kg 0.04 g/kg > 0.08 g/kg (trend level)
Nixon et al. (2007)	$N = 65$ 3 condition, between groups; VCL: $n = 22$ HVPT: $n = 22$ NT: $n = 21$ Film duration: 5 min	VCL = Hold 9-digit number in mind HVPT = Instruction to break every 2 s NT = No task	Manipulation administered concurrent with film viewing	Intrusive memories:- Frequency *Day 1:* 5-min monitoring *Day 7*: IES-R score Working memory capacity:- OSPAN performance	Intrusive memories:- Frequency *Day 1*: 5-min monitoring VCL and HVPT > NT *Day 7*: IES-R score [Arousal] VCL > NT Working memory capacity:- OSPAN performance and intrusion frequency = no correlation

Note. AE = Anomalous Experiences; BRT = Block Rehearsal Task; CMT = Configuration Movement Task (intended to recruit proprio-spatial unconscious perception of movement); CT = Conscious Thought; DEL-NM = Deliberate Non-Movement (self-regulated non-movement); DISS-NM = Dissociative Non-Movement (a cataleptic state induced by the experimenter); DPT = Dot Probe Task (intended as a measure of attentional bias for (negative) stimuli; MacLeod, Mathews, & Tata, 1986); FM = Free Movement; FR = Free Recall; HR = Heart Rate; HSE = High self-efficacy; HVPT = Hyperventilation Provocation Test (the HVPT is designed to simulate physiological arousal; Spinhoven, Onstein, Sterk, & Le Haen-Versteijnen, 1992); IES = Impact of Event Scale (2 subsales, Intrusions and Avoidance; Horowitz et al., 1979); IES-R = Impact of Event Scale – Revised (3 subscales, Intrusions, Avoidance, Hyperarousal; Weiss & Marmar, 1997); IQ = Intrusion Questionnaire (Hackmann, Ehlers, Speckens, & Clark, 2004; Michael et al., 2005); LS = Low Schizoptype; LSE = Low Self Efficacy; MD = Mere Distraction; NS-SCR = Nonspecific Skin Conductance Response; NT = No Task (No manipulation for the equivalent duration as the other experimental conditions, unless stated otherwise); NF = Neutral Film; O-LIFE = Oxford–Liverpool Inventory of Feelings and Experiences (Mason & Claridge, 1995); OSPAN = Operation Word Span Task (a measure of working memory capacity; Turner & Engle, 1989); PTCI = Posttraumatic Cognition Inventory (Foa et al., 1999); PTQ = Perseverative Thinking Questionnaire (Ehring et al., 2011); RMT = Recognition Memory Test; S = Suppression; RRS = Ruminative Response Scale; SCR = Skin Conductance Response (also known as electrodermal activity or galvanic skin response; An index of the skins ability to conduct electricity due to sweat gland activity, a physiological response to affect); SCL = Skin Conductance Level; SIT = Sensory/perceptual Interference Task; T-CPQ = Trait-Cognitive Processing Questionnaire (Halligan, Clark, & Ehlers, 2002); TF = Traumatic Film; TMQ = Trauma Memory Questionnaire (Halligan et al., 2003); UT = Unconscious Thought; VCL = Verbal Cognitive Load; VET = Verbal Enhancement Task; VIT = Verbal Interference Task; VR = Visual Recognition; VST = Visuospatial Task; WM = Working Memory; WST = Word-Stem Task (intended to assesses implicit priming effects).

Table A.2
Experimental details of studies that use manipulations after film viewing.

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
Jobson and Dalgleish (2014)	Expt. 2. $N = 53$ East Asian: n = 32 British: n = 21 Film duration: 10 min	Influence of culture on autobiographical remembering (intrusions and voluntary memory): East Asian culture British/Western culture Compare with Expt. 1 [Table A.3]: no narrative immediate post-film, only delayed i.e. at 1 week.	Post film narrative of film content was obtained from participants1-week post film (delayed).	Expt. 2. Intrusive images:- Frequency *Days 1 to 7:* Diary method Narrative of the trauma film 7 days post-film - Memory focus (personal or others) - Autonomous memory orientation Memory for analogue trauma:- *Day 7:* Forced choice recognition memory test (written statements) Cued recall memory test	Expt. 2. [compare with Expt.1, see Table A.3] Intrusive images:- Frequency, contrast with Expt. 1 *Days 1 to 7:* Diary > Expt. 1 for both groups Narrative (at 1 week only, not immediate as in Expt. 1) East Asian: higher level of autonomous orientation = more intrusions British/Western: lower level of autonomous orientation/lower levels of other/self = more intrusions Memory for analogue trauma:- *Day 7:* -Forced choice recognition memory test East Asian = British/Western -Cued recall memory test East Asian = British/Western
Takarangi et al. (2014)	Expt. 1. $N = 78$	Expt. 1. Self-caught only = A key	Expt. 1. Manipulation administered	Expt. 1. Intrusive thoughts:-	Expt. 1. Intrusive thoughts:-

Table A.2 (*continued*)

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
	2 condition, between groups; Film duration: 3 min 29 s	was pressed every time an intrusion was experienced Self-caught-plus probes = Same as self-caught only group with additional probes (multiple) prompting awareness of intrusions	post-film, concurrent with a secondary reading task	Frequency: *Day 1:* -self-caught intrusions -probe-caught intrusions [yes or no response as to whether experiencing intrusion at time of probe]	Frequency: *Day 1:* self-caught intrusions No group difference *Day 1:* probe-caught intrusions: yes responses 28.86% of probes
	Expt. 2. $N = 154$ 4 condition, between groups; Film duration: 8 min	Expt. 2. Self-caught only = A key was pressed every time an intrusion was experienced Multiple-probes = same as Self-caught-plus probes from Expt. 1. Single-probe-early = one early presentation of probe (54 s from start) Single-probe-late = one late presentation of probe (2 min 51 s from start)	Expt. 2. Manipulation administered post-film with secondary reading task Participants were not told about the presence of probes	Expt. 2. Intrusive thoughts:- Frequency: *Day 1:* -self-caught intrusions -probe-caught intrusions [yes or no response as to whether experiencing intrusion at time of probe]	Expt. 2. Intrusive thoughts:- Frequency: *Day 1:* self-caught intrusions No group difference *Day 1:* probe-caught intrusions: yes responses Multiple probes = 39.48% Multiple-probes = single-early-probe Multiple-probes = single-late-probe Single-early-probe = single-late-probe
Wegerer et al. (2013)	$N = 66$ 2 condition, between groups; Film duration: 1 min 10 s	CS+ = (neutral sound followed by aversive film clip) CS− = (neutral sound not followed by aversive film clip)		Intrusive memories:- Frequency, distress, and duration *Day 1:* IMQ score post memory triggering task 30 min after extinction training *Days 1 to 3:* Ambulatory assessment: IMQ score for each day [correlation analysis] *Day 3:* IES-R [correlation analysis] Physiological response:- *Day 1:* SCR post memory triggering task 30 min after extinction training Memory contingency awareness:- Rating of which CS (neutral sound) was paired with aversive clip	Intrusive memories:- Frequency: *Day 1*: IMQ score CS+ > CS- Distress: *Day 1*: IMQ score CS+ > CS- Duration: *Day 1*: IMQ score CS+ > CS− Physiological response:- Day 1: SCR CS+ > CS− Memory contingency awareness:- Whole sample: 18.6% unable to correctly identify which CS paired with aversive film clip
Krans et al. (2013)	$N = 78$ 3 condition, between groups; Film duration: 8 min 42 s	UT = 2-back task CT = deliberate thinking about film MD = 2-back task All except MD instructed of a memory test for the film prior to undertaking the IV task	Manipulation administered 12 min post-film for a 4-min duration	Intrusive images:- Frequency *Day 1*: IES Intrusions subscale score following exposure to images from film Characteristics *Day 1*: IQ: vividness, arousal & 'nowness' scores Memory for analogue trauma:- *Day 1*: Sequential memory recall test	Intrusive images:- Frequency *Day 1*: IES-I UT < CT and MD Characteristics *Day 1*: IQ-vividness UT = CT and MD *Day 1*: IQ-arousal CT > MD *Day 1*: IQ-'nowness' CT > MD and UT Memory for analogue trauma:- *Day 1:* Sequential memory test score No group differences
Luo et al. (2013)	Expt. 1. $N = 92$ 3 condition, between groups; Film duration: 14 min 43 s	Expt. 1. Narration group = - *What focus* (immediate experience - 'what am I feeling'?) - *Why focus* (rationale behind experience - 'why am I feeling like this'?) Non-narration group = no instructions	Expt. 1, 2&3 Manipulations administered for a 3-min duration, post-film	Expt. 1. Intrusive images:- Frequency *Days 1 to 3:* Diary method (48 h) Reaction time:- Stroop test for word lists: *Film words*: trauma vs. non-trauma vs. disease control words	Expt. 1. Intrusive images:- Frequency *Days 1 to 3:* Diary Narration Why focus > Non-Narration and Narration What focus Stroop Reaction time:- *Film words*: Film-trauma > Film non-trauma Film-trauma > Disease-control Film non-trauma > Neutral-control
	Expt. 2. $N = 93$ 3 condition, between groups; Film duration: 14 min 43 s	Expt. 2. Narration group = - *First person vantage* (bodily sensations, psychological states)		Expt. 2. Intrusive images:- Frequency *Days 1 to 3:* Diary method (48 h) Stroop Reaction time:-	Expt. 2. Intrusive images:- Frequency: *Days 1 to 3:* Diary No group differences Stroop Reaction time:-

(continued on next page)

Table A.2 (*continued*)

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
		- *Third person vantage* (general actions, objective environment) Non-narration group = no instructions		Stroop test for word lists: - *Film words*: trauma vs. non-trauma vs. disease control words	*Film words:* Film-trauma > non- film
	Expt. 3. $N = 31$ 2 condition, between groups; Film duration: 14 min 43 s What-first group: $n = 16$ What-third group: $n = 15$	Expt. 3. Narration group = - What focus first person - What focus third person		Expt. 3. Intrusive images:- Frequency *Days 1 to 3:* Diary method (48 h) Stroop Reaction time:- Stroop test for word lists: - *Film words*: trauma-film vs. non-trauma film vs. disease control words EEG Analysis:- Amplitudes and latency at electrode points	Expt. 3. Intrusive images:- Frequency *Days 1 to 3:* Diary No group differences Stroop Reaction time:- *Film words:* Film-trauma > non-trauma film Disease-control > non-film What-first focus > what-third focus EEG Analysis:- amplitude at the left hemisphere film trauma < non-film
Krans and Bos (2012)	$N = 149$ 3 condition, between groups; Film duration: 8 min 42 s	UT = 2-back task CT= deliberate thinking about film MD = 2-back task All except MD instructed of a memory test for the film prior to undertaking the IV task	Manipulation administered 12 min post-film for a 4-min duration	Intrusive images:- Frequency *Day 1*: Intrusion Monitoring task Memory for analogue trauma:- *Day 1*: Sequential memory recall test	Intrusive images:- Frequency *Day 1*: Intrusion monitoring task UT < CT and MD CT = MD Memory for analogue trauma:- *Day 1:* Sequential memory test score No group differences
Woud et al. (2012)	$N = 76$ 2 condition, between groups; $N = 37$ per group Film duration: 20 min	Computerised appraisal training using scripted vignettes targeting self-efficacy beliefs. Positive = vignettes resolve positively Negative = vignettes resolve negatively	Manipulation administered immediately post-film	Intrusive images and thoughts:- Frequency *Days 1 to 7*: Diary method *Day 7:* IES-R Intrusion subscale score Trauma cognitions:- *Day 7:* PTCI total score	Intrusive images and thoughts:- Frequency *Days 1 to 7*: Diary Positive < Negative *Day 7:* IES-R score Positive < Negative Trauma cognitions:- *Day 7:* PTCI score Positive < Negative
Hagenaars and Arntz (2012)	$N = 76$ 3 condition, between groups; IRS: $n = 24$ IRE: $n = 25$ PI: $n = 27$ Film duration: 10 min	Imagery technique training facilitated by experimenter: Picture in the first person and in as much sensory detail as possible the film then; IRS = create and imagine a positive resolve IRE = talk in first person about the film PI = think about recent positive event	Manipulation administered 30 min post film, for 9 min duration	Intrusive images:- Frequency *Days 1 to 7*: Diary method Trauma Cognition:- *Day 7:* PTCI total score Memory for analogue trauma:- *Day 7:* Cued recall memory test	Intrusive images:- Frequency *Days 1 to 7*: Diary IRS < IRE and PI IRE = PI Trauma cognition:- *Day 7:* PTCI score IRS < IRE PI < IRE IRS = PI Memory for analogue trauma:- *Day 7:* Cued recall test score IRS and IRE > PI IRS = IRE
Hagenaars (2012)	$N = 73$ Mixed design; 2 condition (Anxious vs. Non-anxious) within group (IRE vs. IRS): Non Anxious: $n = 40$ [IRS; n = 18] Anxious: $n = 33$ [IRS; n = 16]	Imagery technique training facilitated by experimenter: Picture in the first person and in as much sensory detail as possible the film then; IRS = create and imagine a positive resolve IRE = talk in first person about the film	Manipulation administered 30 min post film	Intrusive images:- Frequency *Days 1 to 7*: Diary method Intrusive thoughts:- Frequency *Days 1 to 7*: Diary method	Intrusive images:- Frequency *Days 1 to 7*: Diary IRS < IRE IRE Anxious group > non-anxious IRS Anxious = non anxious Intrusive thoughts:- Frequency *Days 1 to 7*: Diary IRS < IRE Anxious = non-anxious
Verwoerd et al. (2012)	$N = 45$ 2 condition between groups; Training: $n = 22$ Control: $n = 23$ Film duration: 5 min	Attentional bias modification using ECT; Training = 100% of invalid cued trials (probe not in location of cue) were film reminders Control = no relationship between cue type and probe position	Manipulation administered immediately post-film	Intrusive memories:- Frequency *Day 1:* 3-min monitoring *Days 1 to 3*: Diary method *Day 3:* IMS Attention bias:-	Intrusive memories:- Frequency *Day 1:* monitoring Training < Control *Days 1 to 3*: Diary Training < Control *Day 3:* IMS Training < Control Attention bias:-

Table A.2 (*continued*)

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
				Day 1: RSVP performance (error frequency and RT for analogue trauma footage)	*Day 1:* RSVP error performance Training < Control *Day 1:* RSVP RT (for previously seen film scenes) Training > Control
Deeprose et al. (2012)	Expt. 1. $N = 60$ 3 condition, between groups; $n = 20$ per group Film duration: 9 min	Expt. 1. VIT = counting backwards in 3's VST = complex sequence tapping on keypad held out of sight NT = No task	Expt. 1. Manipulation administered immediately post-film for 10 min duration	Expt. 1. Intrusive images:- Frequency *Days 1 to 7*: Diary method	Expt. 1. Intrusive images:- Frequency *Days 1 to 7*: Diary VST < NT and VIT VIT = NT
	Expt. 2. $N = 75$ 3 condition, between groups; Film duration: 22 min	Expt. 2. VIT = counting backwards in 7's VST = complex sequence tapping on keypad held out of sight NT = No task	Expt. 2. Manipulation administered 30 min post-film	Expt. 2. Intrusive images:- Frequency *Days 1 to 7*: Diary method Memory for analogue trauma:- *Day 7*: Forced choice recognition memory test	Expt. 2. Intrusive images:- Frequency *Days 1 to 7*: Diary VST < NT and VIT VIT = NT Memory for analogue trauma:- *Day 7*: recognition memory test score No group differences
Ball and Brewin (2012)	$N = 60$ 3 condition, between groups, $n = 20$ per group Film duration: 12.5 min	Given 6 prompt questions to aid rumination: - Film-related rumination on aspects related to film but not the film specifically - Non-film related rumination on aspects not related to film (financial crisis) - No-task control	Manipulation administer post film (prompts were read and heard for first 5 min on day 1 (post-film), then completed daily for next 6 days	Intrusive images:- Frequency *Days 1 to 7*: Diary method	Intrusive images:- Frequency *Days 1 to 7*: Diary Film rumination and no film rumination > no task Film rumination = no film rumination
Holmes, James et al. (2010)	Expt. 1. $N = 60$ 3 condition, between groups; $n = 20$ per group Film duration: 21 min	Expt. 1. & Expt. 2. VST = Tetris computer game VIT = Pub Quiz computer game NT = No task	Expt. 1. Manipulation administered 30 min post-film for 10 min duration.	Expt. 1. Intrusive images:- Frequency *Day 1:* Monitoring during task [10 min] *Days 1 to 7*: Diary method Memory for analogue trauma:- *Day 7*: Forced choice recognition memory test	Expt. 1. Intrusive images:- Frequency *Day 1:* Monitoring VST < NT VIT = NT *Days 1 to 7*: Diary VST < NT and VIT VIT > NT Memory for analogue trauma:- *Day 7*: recognition memory score No group differences
	Expt. 2. $N = 78$ 3 condition, between groups $n = 26$ per group; Film duration: 12 min		Expt. 2. Manipulation administered 4 h. post-film for 10 min duration.	Expt. 2. Intrusive images:- Frequency *Day 1:* Monitoring during task [10 min] *Days 1 to 7*: Diary method Memory for analogue trauma:- *Day 7*: Forced choice recognition memory test	Expt. 2. Intrusive images:- Frequency *Day 1:* Monitoring VST < NT VIT < NT *Days 1 to 7*: Diary VST < NT and VIT VIT = NT Memory for analogue trauma:- *Day 7*: recognition memory score No group differences
Pruitt and Hazlett-Stevens (2010)	$N = 174$ 5 condition, between groups; Worry 15 min): n = 36 Worry next wk.: n = 37 Worry within year.: n = 37 Worry only: n = 34 Visual imagery: n = 30 Film duration: 10 min	Adapting the future-orientation of worry: Instructed to worry about personally relevant topics time constrained Worry: outcomes within next 15 min Worry: within the next week Worry: within the next year Worry only: Told to worry about what they usually would (no time constraint) Visual imagery: picture the	Manipulation administered post-film for 14 min duration	Intrusive cognitions:- Frequency *Days 1–3:* Daily Intrusion form Change in anxiety scores STAI self-report measure taking pre to post film	Intrusive cognitions:- Frequency *Days 1–3:* Intrusion form Visual imagery > all other groups Change in anxiety scores No group differences

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Table A.2 (*continued*)

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
		film in your mind			
Zetsche et al. (2009)	$N = 101$ 3 condition, between groups; Rumination: $n = 32$ Memory Integration: $n = 35$ DC: $n = 34$ Film duration: 17 min 30 s	Thinking style modification: Rumination: Promotes dwelling on '*why*' and '*what if*' relating to film content Memory Integration = Promotes chronological and self-referential thoughts relating to film Distraction = Non-film related quiz questions. For all groups a series of questions were displayed on the VDU. Questions vary to promote guided thinking styles	Manipulation administered 2 min post-film for 12-min duration	Intrusions:- Frequency *Day 1:* Monitoring for 2 min post film - IMQ score *Day 1:* Monitoring for 2 min following 3-min reminder of film [TT] - IMQ score *Days 1 to 7*: - IMQ score taken daily Mood:- *Day 1:* PANAS score change [Pre to post manipulation]: - Sad - Fearful	Intrusions:- Frequency *Day 1:* IMQ Score No group difference *Day 1:* IMQ Score [after TT] Rumination > Memory Integration and Distraction *Days 1 to 7*: Daily IMQ No main effects Mood:- *Day 1:* PANAS sadness score Rumination > Distraction *Day 1:* PANAS fearful score No group differences
Ehring et al. (2009)	$N = 83$ 3 condition, between groups; ART: $n = 28$ CT: $n = 28$ DC: $n = 27$ Film duration: 17 min	Thinking style modification: ART = Read manuscript of a RTA survivor then view ruminative thoughts displayed on VDU CT = Read manuscript of a RTA survivor then view concrete thoughts displayed on VDU DC = Read non-RTA related manuscript and view non-related RTA questions displayed on VDU	Manipulation administered post film for a 10-min duration	Intrusive thoughts and images:- Frequency *Day 1:* Pre-film, post-film and post-TT IQ score Day 3: IQ score Physiological response:- HR change pre to post manipulation	Intrusive thoughts and images:- Frequency *Day 1:* Pre- and post-film IQ score No group differences Day 1: Post-TT IQ Score IQ score CT < DC ART = CT *Day 3*: IQ score No differences on IQ score Physiological response:- HR pre to post manipulation CT & DC = decrease
Holmes et al. (2009)	$N = 40$ 2 condition, between groups; $n = 20$ per group Film duration: 12 min	VST = Tetris computer game NT = No task	Manipulation administered 30 min post-film for 10 min duration	Intrusive images:- Frequency *Days 1 to 7*: Diary method *Day 7:* IES Intrusions subscale score Memory for analogue trauma:- *Day 7*: Forced choice recognition memory test	Intrusive images:- Frequency *Days 1 to 7*: Diary VST < NT *Day 7:* IES score VST < NT Memory for analogue trauma:- *Day 7*: recognition memory score No group differences
Krans, Näring, and Becker (2009a)	$N = 57$; Within-group Film duration = 12 min 50 s Film in 2 blocks [block A = 8 min 53 s, and block B = 2 min 45 s]. Blocks A and B were matched for comparable number of intrusions from prior studies	RMT = Recognition Memory Test given for one block of the film No-RMT = Block of film with no subsequent RMT	Manipulation administered immediately post-film	Intrusive images:- Frequency *Days 1 to 7*: Diary method Memory for analogue trauma:- *Day 7*: Cued recall memory test	Intrusive images Frequency *Days 1 to 7*: Diary RMT < no-RMT Memory for analogue trauma:- *Day 7*: Cued recall memory score For block A of film RMT for block A > RMT for block B For block B of film RMT for block B > RMT for block A
Nixon et al. (2009b)	$N = 80$ 4 condition, between groups; $n = 20$ per group Film duration: 5 min	VCL&S = Hold 9-digit number in mind (VCL) whilst deliberately trying to suppress/not think about film (S) VCL = Hold 9-digit number in mind S = Deliberately suppress/not think about the film Control = Co competing tasks '*let the mind wander and think of anything*'	Manipulation administered immediately post-film for 5 min duration (concurrently with intrusion monitoring on Day 1)	Intrusive thoughts:- Frequency *Day 1: immediate post film* 5-min monitoring *Days 1 to 7*: Diary method *Day 7*: *1 week post film* 5-min monitoring Implicit memory for film:- *Day 1:* DPT performance WST performance Memory for analogue trauma:- *Day 7*: Sequential memory test Cued recall memory test Forced choice recognition memory test	Intrusive thoughts:- Frequency *Day 1:* 5 min monitoring post film No group difference *Days 1 to 7*: Diary VCL&S > VCL, S and NT *Day 7:* 5min monitoring at 1 week No group difference *Day 1 compared to Day 7:* Day 1 > Day 7 Implicit memory for film:- *Day 1:* DPT performance No group difference *Day 1:* WST performance VCL&S > VCL, S and NT Memory for analogue trauma:- *Day 7*: sequential memory score

Table A.2 (*continued*)

Research group	Design	Independent variable(s)	IV Details	Dependent variable(s)	Result(s)
					No group differences *Day 7*: Cued recall memory score No group differences *Day 7*: recognition memory score Control < S, VCL and VCL&S Recognition scores were not correlated with intrusion frequency
Nixon et al. (2009a)	*N* = 120 5 condition, between groups; *n* = 20 per group Film duration: 5 min	VCL&S = Hold 9-digit number in mind (VCL) whilst deliberately trying to suppress/not think about film (S) HVPT&S = break every 2 s (HPT) & suppress film (S) BRT&S = pattern sequence tapping on keypad (BRT) & suppress (S) S = Deliberately suppress/not think about the film NT = No task	Manipulation administered immediately post-film for a 5min duration (concurrently with intrusion monitoring on Day 1)	Intrusive thoughts:- Frequency *Day 1: immediate post film* 5-min monitoring *Days 1 to 7*: Diary method *Day 7: 1 week post film* 5-min monitoring Memory for analogue trauma:- *Day 7*: Sequential memory test Cued recall memory test Forced choice recognition memory test	Intrusive thoughts:- Frequency *Day 1*: 5-min monitoring post-film No group difference *Days 1 to 7*: Diary No group difference *Day 7:* 5-min monitoring at 1 week No group difference Memory for analogue trauma:- *Day 7*: sequential memory score No group differences *Day 7*: Cued recall memory score No group differences *Day 7*: recognition memory score No group differences
Buck et al. (2009)	*N* = 90 3 condition between groups; CPC: *n* = 31 SC: *n* = 29 NT: *n* = 30 Film duration: 19 min	Processing styles: CPC = elaboration of film context and meaning aided by written statements and followed-up questions SC: RIR task NT: Left laboratory with no other instruction	Manipulation administered 45 min post-film	Intrusive images and thoughts:- *Day 1: Over 4 h.* Characteristics - Frequency - Duration - Vividness - Distress - Memory fragmentation All assessed using VAS	Intrusive images and thoughts:- *Day 1: Over 4 h.* Characteristics - Duration (thoughts) CPC > SC NT = CPC and SC No difference for other measures

Note. APT = Affective Picture Task; ART = Abstract Ruminative Thinking; BDI-II Becks Depression Inventory (Beck & Steer, 1987); BRT = Block Rehearsal Task; CBM = Cognitive Bias Modification (a computerised procedure used to modify cognitive biases which are thought to contribute to emotional disorders; MacLeod & Holmes, 2012); CISD = Critical Incident Stress Debriefing (a 7-staged model of Psychological Debriefing administered soon after trauma by a trained psychologist. The procedure consists of two main features 'normalisation' and 'ventilation'; Everly, Flannery & Eyler, 2002; Mitchell & Everly, 1997); CPC = Conceptually-driven Processing Condition; CS = Conditioned Stimulus; CT = Concrete Thinking; DPT = Dot Probe Task (intended as a measure of attentional bias for (negative) stimuli; MacLeod et al., 1986); ECT = Exogenic Cueing Task (intended as a measure of attentional bias for (negative) stimuli); DC = Distraction Control; EA = Emotion Acceptance; EDA = Electrodermal Activity (also known as skin conductance response or galvanic skin response; an index of change in the skins ability to conduct electricity due to sweat gland activity, a physiological response to affect); EEG = Electroencephalography (the recording of electrical activity along the scalp); ES = Emotion Suppression; GAD; Generalised Anxiety Disorder; GSR = Galvanic Skin Response (also known as skin conductance response or electrodermal activity; an index of change in the skins ability to conduct electricity due to sweat gland activity, a physiological response to affect); HR = Heart Rate; HSE = High Self-Efficacy (efficacy as a measure of perceived self-control); IAPS = International Affective Picture Set (Lang, Greenwald, Bradley & Hamm, 1993); IES-R = Impact of Event Scale - Revised (contains 3 subscales, Intrusions, Avoidance and Hyperarousal; Weiss & Marmar, 1997); IMS = Impact of Movie Scale (an adapted version of the Impact of Event Scale anchored to the traumatic film material); IMQ = Intrusive Memory Questionnaire (Michael & Ehlers, 2007); IQ = Intrusions Questionnaire (Hackmann et al., 2004; Michael et al., 2005); IRE = Imagery Re-experiencing; HSE = High self-efficacy; IRS = Imagery Rescripting; PI = Positive Imagery; LSE = Low self-efficacy; NT = No Task (No manipulation for the equivalent duration as the experimental conditions, unless stated otherwise); PANAS = Positive and Negative Affect Scale (Watson, Clark & Tellegen, 1988); PDS = Post-traumatic Stress Diagnostic Scale (Foa, 1995); PSS-SR = PTSD Symptom Score – Self Report (Foa, Riggs, Dancu & Rothbaum, 1993); PTCI = Posttraumatic Cognition Inventory (Foa et al., 1999); RIR = Random Interval Repetition (task involved discriminating between two different tones every time an involuntary memory was experienced); RMT = Recognition Memory Test; RSVP = Rapid Serial Visual Presentation task (intended as a measure of attentional bias for [negative] stimuli); RT = Reaction Time; RTA = Road Traffic Accident; S = Suppression; SC = Suppression Condition; SIR = Spontaneous Intrusive Recollections; TT = Trigger Task (a laboratory-based task which uses stimuli to induce intrusions of a previously experienced traumatic event. Also called Intrusion Provocation Task; see Michael et al., 2005); UT = Unconscious Thought; VAS = Visual Analogue Scale (Zealley & Aitken, 1969); VCL = Verbal Cognitive Load; VDU = Video Display Unit; VSSP = Visuospatial Sketch Pad.

Table A.3
Experimental details of studies using correlational designs that investigate response(s) to trauma film viewing.

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
Jobson and Dalgleish (2014)	Expt. 1. *N* = 45 East Asian: n = 22 British: n = 23 Film duration:	Influence of culture on autobiographical remembering (intrusions and voluntary memory): East Asian culture British/Western culture Post film narrative of film content was retrieved from participants immediately post	Expt. 1. Intrusive images:- Frequency *Days 1 to 7:* Diary method Autobiographical remembering Narrative of the trauma film immediately	Expt. 1. Intrusive images:- Frequency *Days 1 to 7:* Diary East Asian = British/Western Narrative (immediate post film) East Asian = British/Western

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Table A.3 (*continued*)

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
	10 min	film, and 1-week post film (delayed)	post-film (Expt. 1. only) Narrative of the trauma film 7 days post-film - Memory focus (personal or others) - Autonomous memory orientation Memory for analogue trauma:- *Day 7:* Forced choice recognition memory test (written statements) Cued recall memory test	Narrative (at 1 week) East Asian: higher level of autonomous orientation/higher levels of other/self = more intrusions British/Western: lower level of autonomous orientation/lower levels of other/self = more intrusions Memory for analogue trauma:- *Day 7:* - Forced choice recognition memory test East Asian = British/Western - Cued recall memory test East Asian = British/Western
Malik et al. (2014)	*N* = 110 Within group Film duration: 17 min 48 s	Hypomanic experience assessed using MDQ score: MDQ High MDQ Low	Intrusive images:- Frequency *Days 1 to 6:* Diary method [SMS via mobile phone] *Day 6:* Monitoring using an IPT IES-R [total score] Memory for analogue trauma:- *Day 7:* Forced choice recognition memory test (written statements)	Intrusive images:- Frequency *Days 1 to 6:* Diary MDQ high > MDQ low *Day 6:* Monitoring IPT MDQ high > MDQ low *Day 6:* IES-R Total score MDQ high > MDQ low Memory for analogue trauma:- *Day 7:* Recognition memory test score MDQ high = MDQ low
Chou et al. (2014b)	*N* = 64 Within group Film duration: 13 min 40 s	Relationship between: Intrusive memory for trauma film Physiological HR [ECG] Recognition (non-intrusive) memory for trauma film	Intrusive images and thoughts:- Frequency *Days 1 to 7:* Diary method Physiological ECG response:- sHR: 6-min period pre-film where HR taken after startle probe taken HR: ratings taken before, during and after film viewing HR: for film sequences that did versus did not intrude as reported in the diary Memory for analogue trauma:- *Day 8:* Multiple choice recognition memory test with sub scores for *Gist* and *Detail*	Intrusive images and thoughts:- Frequency *Days 1 to 7: Diary* Intrusive images > intrusive thoughts - HR reduction during intrusive compared to non-intrusive film sequences related to a greater number of intrusive images. Physiological ECG response: - Peri-traumatic HR - No relationship with any memory measure. *Intrusive and non-intrusive film sequences* - Significant drop in HR for intrusive compared to non-intrusive sequences. - HR reduction during intrusive compared to non-intrusive film sequences related to a greater number of intrusive images and better recognition memory score. Memory for analogue trauma:- *Day 8:* Recognition memory test score Gist > Detail *Detail:* Intrusive film sequences > non-intrusive film sequences *Gist:* Intrusive film sequences = non-intrusive film sequences - HR reduction during intrusive compared to non-intrusive film sequences related to better recognition memory score
Chou et al. (2014a)	*N* = 58 Film duration: 13 min 40 s	Relationship between: Prior trauma Cortisol secretion Intrusive memory frequency and cortisol levels *Moderators*: Sympathetic nervous system [SNS] activation (on cortisol's impact on memory) - Salivary alpha-amylase[sAA] - Cardiac Defence Response [CDR] measured by HR response to sudden loud noise	Intrusive images:- Frequency *Days 1 to 7:* Diary method Cardiac Defence Response [CDR] *Accelerators* (n = 20) individuals showing a secondary peak of HR during the 20-to-45-s interval after the noise was presented *Decelerators* (n = 25) individuals showing HR decrease during the 20-to-45-s interval after the noise was presented	*Prior trauma history, cortisol and sAA levels* - more recent trauma predicted lower levels of cortisol during film viewing - subclinical PTSD symptoms were found predictive of lower cortisol levels after film - pre-film sAA levels were predictive of during and post-film sAA levels Cardiac Defence Response [CDR] higher cortisol levels during film

Table A.3 (*continued*)

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
				viewing significantly predicted more intrusions in the diary among the Accelerator group [with no finding in the decelerator group]
Belcher and Kangas (2014)	$N = 101$ Within group Film duration: 14 min	AMT = Autobiographical memory Specificity: = Non prompted [any memory] = Prompted [for a specific memory if only general one given] Future event specificity = Non prompted [picture any future event] = Prompted [picture a specific incident that may take place in the future]	Intrusive memories:- Frequency *Days 1 to 7*: Diary method Self-reported questionnaires:- *Day 7:* Depressive symptoms [BDI-II] Posttraumatic stress symptoms[IES-R] Ruminative symptoms [RRS]	Intrusive memories:- Frequency *Days 1 to 7:* Non-prompted (over general) memory for past memory and future was associated with fewer intrusive memories Self-reported questionnaires:- *Day 7:* Non-prompted over general memory was not associated with BDI-II, IES-R or RRS scores
Clark, Mackay, et al. (2015)	$N = 458$ Meta-analysis of 16 experiments Film duration: varying lengths	Emotional response to trauma film TEQ = Trauma history Recognition memory for film	Intrusive images Frequency *Days 1 to 7:* *Diary Method* Absence of intrusions Memory for analogue trauma:- *Day 7:* Forced choice recognition memory (written statements): 13/16 experiments included in the analysis	Intrusive images:- Frequency *Days 1 to 7:* Diary Absence of intrusions: $n = 71/458$ [15.5%] Absence of intrusions was associated with low emotional response to trauma film Absence of intrusions was not associated with prior trauma history Memory for analogue trauma:- *Day 7*: Recognition memory score Mean percentage correct = 64.49% No relationship between recognition memory score and intrusive image frequency.
Kamboj et al. (2014)	$N = 79$ Female: n = 40 Male: n = 39	Personality traits: Instrumentality ("masculinity") Communality ("femininity") Sex: - Female - Male	Intrusive memories Frequency, Vividness, Distress *Days 1 to 7:* *Online Diary Method* Memory for the analogue trauma:- *Day 7:* Forced choice recognition memory (written statements):	Intrusive memories:- Frequency Men = women Communality in men associated with intrusions Communality in women negatively associated with intrusions Vividness Men = women Distress Women > man Personality traits scores: Instrumentality Men > women Communality Women > men Memory for the analogue trauma:- No differences Communality in women negatively associated with voluntary memory test score No relationship between intrusions and voluntary memory test scores No group differences
Monds et al. (2013)	$N = 109$ M-TF: $n = 26$ M-NF: $n = 27$ NM-TF: $n = 29$ NM-NF: $n = 27$ Film duration: 10 min	Susceptibility to false recall of negative stimuli via misinformation. Film content: TF = Trauma Film NF = Neutral Film Narratives (given one week post film): M = Misinformation NM = No-misinformation	Distress from film:- Frequency *Days 1 and 7:* IES Intrusions subscale IES Avoidance subscale Memory for the analogue trauma:- *Day 7:* Free recall memory test for details of film yielding three measures: - Accuracy [total correct details] - Misinformation [total of misinformation details] - Commission errors [total of fabricated details]	Distress from film:- Frequency *IES – Intrusion subscale score* - Day 1 > Day 7 - Trauma film > Neutral Film - No effect of narratives [misinformation effect] - Higher scores on Day 1 were related to higher recall Accuracy scores *IES – Avoidance subscale score* - Day 1 > Day 7 - Trauma film > Neutral Film No effect of narratives [misinformation effect] Memory for the analogue trauma:- *Days 7:* Free recall test score

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Table A.3 (*continued*)

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
				- Accuracy TF > NF - Misinformation M > NM Differences between M and NM are greatest in neutral film condition compared to trauma film
Morina et al. (2013)	*N* = 67 Film duration: 17 min	CEPQ [post film] = -Data driven processing -peritraumatic negative emotionality scale QMI = General mental imagery ability	Intrusive images:- Frequency, vividness and distress *Day 1:* Intrusions Questionnaire Post-film *Day 1:* 2 min monitoring with Intrusions Questionnaire *Days 1 to 6*: Diary method	Intrusive images:- Frequency CEPQ - Data driven processing positively correlated with intrusions [at all of the time points] QMI – positive correlation with intrusions [at all of the time points] Vividness and distress CEPQ Data driven processing positively correlated with intrusions /IQ score [at all of the time points] QMI – positive correlation with intrusions [at all of the time points] No correlation between CEQP [data driven processing score] and QMI
Bourne et al. (2013)	*N* = 22 Within group fMRI design. Film duration: 21 min	Intruded scenes = film scenes that resulted in image intrusions (in diary) Potential to intrude scenes = film scenes that had the potential to intrude but did not (in diary) Control scenes = scenes that were non-traumatic	Brain activation levels during encoding of traumatic film:- *Day 1:* During film fMRI *Days 1 to 7:* Diary method	Brain activation levels during encoding of traumatic film:- Intruded scenes > potential to intrude scenes and control scenes
Meyer et al. (2012)	*N* = 82 Within group; Film duration: 14 min	Task performance SCCT score	Intrusive images:- Frequency and distress *Days 1 to 7*: Diary method PTSD symptomatology:- *Day 7:* IES intrusion subscale and PSS–SR re-experiencing subscale combined Physiological response:- Eye blink startle response *Day 1: 30 min post film* Response speed to trauma-film related, negative and positive visual images	Intrusive images:- Frequency *Days 1 to 7*: Diary Good learning on SCCT < Poor learning on SCCT Distress *Days 1 to 7*: Diary No association between SCCT performance and levels of distress PTSD symptomatology:- *Day 7:* IES and PSS sum No association between SCCT learning performance and the sum of the PSS–SR and IES scores Physiological response:- Eye blink startle response *Day 1: 30 min post film* No association between SCCT performance and startle potentiation scores
Laposa and Rector (2012)	*N* = 91 Within group Film duration: 9 min	Self-report questionnaires ARQ, RIQ-Rumination subscale, PDEQ-SR, PSQ - Data Driven processing, PSQ – Self-Referent processing	Intrusive images and thoughts:- Frequency *Days 1 to 7*: Diary method *Day 7:* IES intrusion subscale	Intrusive images and thoughts:- Frequency *Days 1 to 7*: Diary and IES All IVs correlated positively with intrusion frequency except ARQ PSQ Self-Referent processing score = strongest predictor of intrusion frequency
Bomyea and Amir (2012)	*N* = 38 Within group	Self-report questionnaire DS-R = state score	Intrusive thoughts:- Frequency *Day 1*: 5-min monitoring post-film	Intrusive thoughts:- Frequency *Day 1:* 5-min monitoring Higher DS-R score > Lower DS-R score
Hagenaars and Putman (2011)	*N* = 43 Within group	Self-report questionnaires ACS TIS-F = Fear subscale TIS-TI = Tonic Immobility subscale	Intrusive images:- Frequency *Days 1 to 7*: Diary method	Intrusive images:- Frequency *Days 1 to 7*: Diary TIS-TI high score > TIS-TI low score TIS-F = no relationship with image frequency ACS = no direct relationship with image frequency ACS = moderated positive correlation between TIS and image frequency
Hagenaars and Krans (2011)	*N* = 43 Within group Film duration: 10 min	Self-report questionnaires DES-C = trait measure DSS = state measure Horror = Likert scale [anchored to film	Intrusive images:- Frequency *Days 1 to 7*: Diary method	Intrusive images:- Frequency *Days 1 to 7*: Diary Greater DES-C > Lower DES-C

Table A.3 (*continued*)

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
		viewing]		DSS and Horror score = not relationship with image frequency
Krans et al. (2011)	*N* = 59 2 condition, between group; Film duration: 11 min 42 s	Stimuli modality: Film group = Seeing trauma film as normal Imagery group = Hearing a verbal report (with emotion and original film audio) about events in film	Intrusive images:- Frequency *Days 1 to 7*: Diary method *Day 7*: IES-R score	Intrusive images:- Frequency *Days 1 to 7*: Diary Film group = Imagery group *Day 7*: *IES-R* Film group = Imagery group
Verwoerd et al. (2011)	*N* = 85 Within group Film duration: 9 min	PI measurement task: CVLT = Performance FFPI = Neuroticism self-report score	Intrusive images:- Frequency *Days 1 to 7*: Diary method *Day 7*: IMS	Intrusive images:- Frequency *Days 1 to 7*: Diary CVLT high performance < CVLT low performance *Day 7:* IMS score CVLT high performance < CVLT low performance
Bisby et al. (2010)	*N* = 48 Between-group	Low dose = 0.04 g/kg alcohol High dose = 0.08 g/kg alcohol Placebo control	Intrusions:- Frequency *Days 1–7:* Diary method *Day 7*: shifted-view point and same-view recognition test scores	Intrusions:- Frequency *Day 7:* shifted-view point recognition test score (spatial memory). Placebo and Low dose alcohol Increased frequency of intrusive memories associated with lower scores on shifted-view recognition memory test No associations with same-view recognition memory test scores and intrusion frequency
Wilksch and Nixon (2010)	*N* = 49 2 condition, between group; HR: *n* = 21 LR: *n* = 28 Film duration: 8 min	Negative interpretation bias of trauma: HR (high risk) = PTCI – 6 items highest 30th percentile LR (low risk) = PTCI – 6 items lowest 30th percentile State Suppression = Likert score	Intrusive thoughts:- Frequency and distress *Day 1:* 5 min monitoring post-film *Days 1–7:* Diary method *Day 7*: 5-min monitoring post-film	Intrusive thoughts:- Frequency *Day 1:* 5-min monitoring HR > LR *Days 1–7:* Diary HR > LR *Day 7:* 5-min monitoring HR > LR Distress *Day 1:* 5-min monitoring HR > LR HR reported higher levels of suppression than LR
Wessel et al. (2010)	*N* = 80 2 condition, between group; *n* = 40 per group Film duration: 112 s	Times of day: Non-Optimal = index of low self-control Optimal = index high self-control	Intrusions:- Frequency *Day 1:* 5-min monitoring during suppression	Intrusions:- Frequency *Day 1:* Non-Optimal = Optimal
Verwoerd, Wessel, de Jong, and Nieuwenhuis (2009)	*N* = 36 Within group Film duration: 9 min	Rapid Serial Visual Presentation (RSVP) task accuracy: Film distractors Neutral distractions	Intrusive memories:- Frequency *Days 1 to 7*: Diary method *Day 7*: IMS	Intrusive memories:- Frequency *Days 1 to 7*: Diary Greater Intrusion frequency correlated with poorer accuracy on RSVP task *Day 7:* IMS IMS score explained 18% variance of RSVP task performance
Laposa and Alden (2008)	*N* = 68 Within groups; Film duration: 9 min	Self-report questionnaires: STAI-T = Trait Anxiety BDI-II = Depression DES = Dissociation	Intrusive thoughts and images:- Frequency *Days 1 to 7*: Diary method *Day 7:* IES-Intrusion subscale score	Intrusive thoughts and images:- Frequency *Days 1 to 7*: Diary High STAI-T score > Low STAI-T score Higher BDI-II score > lower BDI-II score Post film anxiety mediated relationship between trait anxiety, dissociation and depression on intrusion frequency
Wessel et al. (2008)	Expt. 1. *N* = 58 Within group Film duration: 1 min 52 s	Expt. 1. OSPAN performance RNG overall performance	Expt. 1. Cognitive control and P-I resistance:- Day 1: CNI performance for film related words Intrusive Thoughts:- Frequency Day 1 to 2 (48 h):	Expt. 1. Cognitive control and P-I resistance:- Day 1: CNI performance negatively correlated to RNG performance Intrusive Thoughts:- Frequency

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Table A.3 (*continued*)

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
			Diary method	Day 1 to 2 (48 h): Diary Higher scores on RNG task = more intrusive thoughts
	Expt. 2 $N = 104$ Within group Film duration: 1 min 52 s	Expt. 2. RNG inhibition task performance RNG updating task performance AB-AC P-I task performance	Expt. 2. Cognitive control and PI resistance:- Day 2: CNI performance for film related words Intrusive Thoughts:- Frequency Day 1 to 2 (48 h): Diary method	Expt. 2. Cognitive control and PI resistance:- Day 2: CNI performance No correlation between CNI and RNG inhibition and updating subscales. No correlation between CNI and AB-AC PI task Intrusive Thoughts:- Frequency Day 1 to 2 (48 h): Diary Higher scores on AB-AC P-I task = more intrusive thoughts

Note. ACS = Attentional Control Scale (contains 3 subscales; Focusing, Shifting and Control, Derryberry & Reed, 2002); AMT = Autobiographical Memory Test; ARQ = Anxious Rumination Questionnaire (Rector, Martin, Laposa, Kocovski & Swinson, 2008); BDI-II = Beck's Depression Inventory (Beck & Steer, 1987); BP = Blood Pressure; CEPQ = Cognition and Emotional Processing Questionnaire (2 subscales, data driven processing scale and peritraumatic negative emotionality scale); CNI = Colour Naming Interference task; (C)RAT = (Compound) Remote Associate Task (An index of creative thinking; Mednick, 1967; The task requires participants to think of a word which will link together a series of three-word items); CRH = Corticotropin Releasing Hormone (also known as adrenocorticotropic hormone [ACTH] or *corticotropin*-releasing factor [CRF]); CSF = Cerebrospinal Fluid (extraction of CSF is a method of measuring concentration levels of the stress hormone norepinephrine [NE] or Corticotropin Releasing Hormones [CRH]); CVLT = California Verbal Learning Test (intended to assess the ability to resist proactive interference [P-I]; Delis, Freeland, Kramer & Kaplan, 1988); DES = Dissociative Experiences Scale (Bernsten & Putnam, 1986); DES-C = Dissociative Experiences Scale–C (Wright & Loftus, 1999); DS-R = Disgust Scale – Revised (Olatunji et al., 2009); DSS = Dissociative State Subscale (Bremner et al., 1998); DES-II: Dissociative Experience Scale (Carlson & Putman, 1993); ECG = Electrocardiography (the recording of electrical activity of the heart with electrodes placed on the body); EEG = Electroencephalography (the recording of electrical activity along the scalp); FFPI = Five-Factor Personality Inventory (Hendriks, Hofstee & De Raad, 1999); fMRI = Functional Magnetic Resonance Imaging (method which measures changes in blood flow and blood oxygen levels as an index of brain activity); GSR = Galvanic Skin Response (also known as skin conductance response or electrodermal activity; An index of change in the skins ability to conduct electricity due to sweat gland activity, a physiological response to affect); HR = Heart Rate; IES = Impact of Event Scale (2 subsales, Intrusions and Avoidance; Horowitz et al., 1979); IMS = Impact of Movie Scale (an adapted version of the Impact of Event Scale anchored to the traumatic film material); IPT = Intrusion Provocation Task; a laboratory-based task which uses stimuli to induce intrusions of a previously experienced traumatic event, also called a Trigger Task; NE = norepinephrine; NF = Neutral Film; MDQ = Mood Disorder Questionnaire (Hirschfeld, et al., 2000) used to assess hypomanic experience; OSPAN = Operation Word Span Task (a measure of working memory capacity; Turner & Engle, 1989); PDEQ-SR = Peritraumatic Dissociation Experiences Questionnaire-Self Report (Marmar, Weiss & Metzler, 1997); PDS = Posttraumatic Diagnostic Scale (Foa, 1995); P-I = Proactive Interference (when old information interferes with the encoding of new information in memory; the ability to resist PI is thought to reflect larger working memory capacity); PSQ = Processing Styles Questionnaires (see Laposa & Rector, 2012); PSS-SR = PTSD Symptom Scale - Self Report (Foa, Cashman, Jaycox & Perry, 1997); PTCI = Posttraumatic Cognitions Inventory (Foa et al., 1999); QMI = The Questionnaire upon Mental Imagery (Sheehan, 1967); RIQ = Response to Intrusions Questionnaire (Clohessy & Ehlers, 1999); RNG = Random number Generator task (designed to assess updating and interference resources in working memory capacity); RRS: Ruminative Responses Scale (Treynor, Gonzalez & Nolen-Hoeksema, 2003). RIO: Rumination about an Interpersonal Offence scale (RIO; Wade, Vogel, Liao & Goldman, 2008); SCCT = Spatial Contextual Cueing task (also known as a Contextual Cueing Paradigm; a task where a target has to be located in among distractors - half trials have repeated configural contexts thereby quickening response times to targets and demonstrating implicit memory; Chun & Jian, 1998); SIR = Spontaneous Intrusive Recollections; SMS = Short Message Service, via mobile phone; STAI-T = State Trait Anxiety Inventory - Trait (Spielberger et al., 1983); SEAS: The Self-report Emotional Ability Scale (Freudenthaler & Neubauer, 2005); TEQ = Traumatic Experiences Questionnaire; TF = Trauma Film; TIS = Tonic Immobility Scale (adapted version; the TIS has 2 subscales, Fear and Tonic Immobility; Forsyth, Marx, Fusé, Heidt & Gallup, 2000); TT = Triggering Task (a task designed to trigger intrusions consisting of visual still images from the trauma film that were edited out of original viewing); QMI = Questionnaire upon Mental Imagery; VAS = Visual Analogue Scale (Zealley & Aitken, 1969).

Table A.4
Experimental details of studies that have used the trauma film paradigm to investigate response(s) other than intrusive memory.

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
Richardson et al. (2014)	$N = 34$ 2 condition, between groups; $n = 17$ per group Film duration: Negative film = 4 min Positive film = 8 min	Film content: Negative Positive	Sleep latency:- 7-day sleep diary Sleep-related attentional bias:- Dot-probe task	Sleep latency:- Negative > Positive Sleep-related attentional bias:- Negative > Positive
Meyer et al. (2014)	Expt. 1. $N = 64$ Within group. Film duration: 14 min each film	Expt. 1. Film content: Genocide scenes RTA scenes	Expt.1. Physiological response:- *Day 1:* - EEG recording of asymmetric frontal activation of the brain (difference between resting/baseline and trauma film viewing) - Startle response to reminders of the film (seen images [negative and neutral] and unseen images)	Expt. 1. Physiological response:- *Day 1: EEG* No differences between resting and film-viewing frontal asymmetries *Day 1: startle response – potentiation score* - RTA film No group differences - Genocide film Seen film images > unseen film images *Correlation: Frontal asymmetry on startle potentiation for whole sample:* - RTA film Left-sided frontal activation negatively correlated with startle potentiation - Genocide film

Table A.4 (*continued*)

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
				Left-sided frontal activation positively correlated with startle potentiation (trend level)
	Expt. 2. $N = 72$ Within group. Film duration: 14 min	Expt. 2. Written information provided about the film clip (Genocide content from Expt. 1.) to encourage an appraisal style Negative reappraisal Positive reappraisal	Expt. 2. Physiological response:- *Day 1:* - EEG recording of asymmetric frontal activation of the brain (difference between resting/baseline and trauma film viewing) - Startle response to reminders of the film (seen images [negative and neutral] and unseen images)	Expt. 2. Physiological response:- *Day 1: EEG* No differences between resting and film-viewing frontal asymmetries *Day 1: startle response – potentiation score* Positive reappraisal Negative film images > neutral film images *Correlation: Frontal asymmetry on startle potentiation for whole sample:* resting frontal asymmetry positively correlated startle potentiation
Llera and Newman (2014)	*N = 96* 2 (Group) × 3 (Induction) block design; GAD: $n = 48$ Non-anxious: $n = 47$ Film duration: 120 s–165 s for each of the 3 film clips	Group: GAD Non-anxious Induction type: Administered 1 min prior to film viewing (for each film clip) Worry Relaxation Neutral Film clips: Fearful Sad Humorous	Physiological reaction:- *Day 1* Change in NS-SCR following exposure to different film clips Self-report emotional changes:- Likert scales for the emotions: amusement, anger, contentment, disgust, fear, happiness, sadness, and tension	Physiological reaction: - Day 1: change in NS-SCR *Fearful Film Exposure* - GAD and Non-anxious - Worry induction = increase - Relaxation induction = decrease *Sad Film Exposure* - GAD and Non-anxious - Worry = Relaxation = Neutral *Humorous Film Exposure* - GAD and Non-anxious - All inductions ➔ increase Self-report emotional changes: - *Fearful Film Exposure* - GAD: Fear, Sadness, and Tension Relaxation/Neutral > worry *Sad Film Exposure* - GAD and Non-anxious: Increase in Fear, Tension, and Anger Relaxation/Neutral > worry *Humorous film exposure* - GAD and Non-anxious: Decrease in Sadness, Tension, and Anger Worry > relaxation and neutral
Seebauer et al. (2014)	*N = 46* Within group. Film duration: 5 min each [3 separate films – 10 min in between each viewing]	Imagery rescripting strategy [ImRS]: Relaxation instruction followed by reliving worse scene from movie clip with following resolve: ImRS with revenge: imagine punishing perpetrator violently ImRS without revenge: imagine helping victim using any means except violence) Safe place: leave situation and enter a positive or safe place	Emotional response:- *Day 1:*Post ImRS Self-report emotion ratings *Anger:* anger, rage, aggression *Sad/anxious*: sadness, hopelessness, anxiety *Positive:* joy, relaxation, safety *Day 2:* Self-report emotion ratings after viewing images of perpetrators in film clips: *Helplessness* *Rage* *Distress*	Emotional response:- *Day 1:* Post ImRS emotion - Anger: Safe place < ImRS with revenge and ImRS without revenge - Rage: Safe place < ImRS without revenge - Aggression: Safe place < ImRS with revenge and ImRS without revenge - Relaxation: Safe place > ImRS with revenge and ImRS without revenge - Joy: Safe place > ImRS with revenge and ImRS without revenge ImRS with revenge > ImRS without revenge (trend level) *Day 2:* Self-report emotion ratings: No group differences
Tsai and McNally (2014)	*N = 80* 4 condition, between groups; $n = 20$ per group. Film duration: 6 min 9 s.	VSSP taxing task (identify target image in an array of 4): Positive group = images with positive valence Negative group = images with negative valence	Memory for the film:- *Day 1*: post-film Multiple choice memory tests: 2 sets of questions with 1 set given concurrently with VSSP task. Memory reduction score calculated from	Memory for the film:- *Day 1*: memory test reduction score Positive and Negative > Neutral Positive > Negative Positive > Neutral Negative = Neutral

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Table A.4 (*continued*)

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
	Manipulation administered 1 min post-film concurrently with 1 of 2 sets of memory test questions for film	Neutral group = images with neutral valence Control group = no task	difference in scores between the 2 sets (larger score = larger decrement in memory for the film)	
Wessel et al. (2014)	$N = 111$ 2 condition, between groups; Collaborative recall: $n = 57$ Individual recall: $n = 54$. Film duration: 1 min, 4 s. Participants tested in groups of 3 for both conditions. Manipulation administered 5 min post-film	Participants tested in groups of 3 for each condition Collaborative recall = Work together to produce 1 list of details recalled from the film Individual recall = Work separately and produce 3 lists of details recalled from the film Nominal condition = The 3 separate lists from each of individual recall groups were pooled to create list with only unique, correct details	Number of details accurately recalled:- *Day 1:* Net accuracy = number of correct details minus number of errors in free recall test Number of errors	Number of details accurately recalled:- *Day 1:* Net accuracy Collaborative recall < nominal condition Collaborative recall >individual recall *Day 1:* Number of errors Nominal condition > collaborative condition Collaborative recall = Individual recall
Evans et al. (2013)	$N = 87$ 2 conditions, between groups [2nd mood induction] Film duration: 2 negative film used for 2 mood inductions 6 min 5 s each Neutral film clip in between 2 negative films: 5 min 30 s	1st negative mood induction Unguided film 2nd negative mood induction instructed film: Suppress: suppress emotional reaction to the film both externally and internally Accept: instructed to observe, accept and not judge their emotional reaction to the film	Comparison of 1st negative mood induction (unguided) and 2nd negative mood induction (instructed strategy) Borderline Personality Disorder (BPD) severity Emotional reactivity to negative stimuli (2nd mood induction) PA: Positive Affect on PANAS NA: Negative Affect on PANAS Electrodermal activity (EDA)	1st negative mood induction (unguided) Trait: Greater BDP severity score associated with trait avoidance (but not suppression) Greater BDP severity score associated with greater NA (baseline and post-film) State: Greater BDP severity score associated with greater internal and external suppression, and reduced acceptance Unguided and Instructed films: Both films: PA (baseline): Suppress < Accept Instruct film: NA (baseline) Accept > suppress Greater BDP was associated with greater EDA reactivity
Papousek et al. (2013)	$N = 122$ Within groups Film duration: 10 min	Mechanisms that explain differences in self-rated emotion perception of others - Functional coupling between prefrontal and posterior cortices (using EEG) - Cardiac response (ECG)	Self-report emotional ability scale:- [SEAS] 4 scales Interpersonal social–emotional behaviour: - *Perception of other persons' emotions* - *Regulation of other persons' emotions* Intrapersonal emotional processes: - *perception of one's own emotions* - *regulation of one's own emotions*	(Self-rated socio-emotional perception and EEG coherences:- Higher SEAS scores associated with stronger decreases in prefrontal-posterior during film viewing Self-rated socio-emotional perception and cardiac response:- Higher 'perception of other persons' emotions' related to more pronounced cardiac response (acceleration, and deceleration) for most horrific events occurring others in the film
Geracioti et al. (2013)	$N = 10$ Within group	Film type: TF = Trauma film content NF = Neutral film content Videos were presented on two occasions (6–9 weeks apart)	Basal cerebrospinal fluid (CSF) dopamine and serotonin metabolite concentrations:- Blood pressure, heart rate and subjective anxiety:-	CSF dopamine and serotonin metabolite concentrations:- TF > NF: Drop in both concentrations Blood pressure, heart rate and subjective anxiety:- TF > NF: drop in mood, increases in blood pressure, subjective anxiety
Varker and Devilly (2012)	*N = 80* 2 condition, between groups; Inoculation: $n = 41$ Control: $n = 39$ Manipulation administered 1 week prior to film	Inoculation = Resilience training; education on physical response to trauma, fainting and negative thoughts reduction technique, RTA desensitisation (via images) and taught about importance of social support Control = Pragmatic training; tips/advice on what to do an RTA and the role of the police		Depression & anxiety:- *Day 1 and 1 month:* DASS 21 Score No group differences PTSD symptomatology:- *Day 1 and 1 month:* PSS-SR score No group differences Memory for analogue trauma:- *Day 1 to 1 month:* Cued recall memory test score over time: Both groups = higher scores for peripheral and central film details on Day 1 relative to 1 month. Self-report memory test confidence *Day 1 to 1 month:* Both groups = Higher scores on Day 1 relative to 1 month

Table A.4 (*continued*)

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
Lester et al. (2011)	$N = 60$ 2 condition between groups; $n = 30$ per group. Film duration: 6 min 19 s Manipulation administered 10 min prior to film	CBM training designed to manipulate cognitive errors: CBM Error modification CBM Non-error modification	Similarity rating test:- *Day 1:* Recognition score as a measure of cognitive errors Mood:- *Day 1: Pre to post film score change* STAI- Trait and State BDI-II PANAS	Similarity rating test:- *Day 1:* Recognition score CBM Non-error modification > CBM error modification Mood:- *Day 1*: PANAS negative score Increase: CBM Non-error modification > CBM error modification No difference for other measures
Renner and Beversdorf (2010)	$N = 20$ Within group Film durations: 30 min	Film type: TF = Trauma film content NF = Neutral film content	Creative thinking:- *Day 1: 30 min post-film* (C)RAT performance Memory for analogue trauma:- *Day 1:* Series recall memory test	Creative thinking:- *Day 1:* (C)RAT performance TF < NF Memory for analogue trauma:- *Day 1:* Series recall memory test score TF = NF
Verwoerd et al. (2010)	Expt. 1. $N = 65$ 2 condition, between group; Film: $n = 33$ No film: $n = 32$ Film duration: 5 min	Expt. 1. Presentation of film: TF = Trauma film content NF = No-film control	Expt. 1. RSVP accuracy:- *Day 1:* Task performance accuracy for film vs neutral distractors RSVP lag [target stimulus appearance in positions]:- Lag 2 Lag 3 Lag 4 Lag 5 RSVP set:- First half Second half	Expt. 1. RSVP accuracy *Day 1:* RSVP first half set [lag 2] NF > TF RSVP accuracy *Day 1:* RSVP second half set [lag 2] No group differences
	Expt. 2 $N = 75$ 2 condition, between group; Film: $n = 36$ No-film: $n = 39$ Film duration: 8 min	Expt. 2. Presentation of film: Non-traumatic film No-Film control	Expt. 2 RSVP accuracy:- Task performance accuracy with trauma-film or neutral distractors	Expt. 2. RSVP accuracy *Day 1:* RSVP first half set [lag 2] No group differences RSVP accuracy *Day 1:* RSVP second half set [lag 2] No group differences
Schartau et al. (2009)	Expt. 1. $N = 41$ 3 condition, between groups; Appraisal: $n = 21$ Watch: $n = 20$ Manipulation administered concurrently with film	Expt. 1. Appraisal = Training Watch = No emotional regulation	Expt. 1. Affect response to film:- *Day 1*: *Pre to post training* Distress and Horror score change Physiological response:- *Day 1*: *Pre- to post-training* HR and GSR change	Expt. 1. Affect response to film:- *Day 1: Pre–post training* Distress and Horror score change Appraisal < Watch Watch = no score change Physiological response:- *Day 1*: *Pre–post training* HR: No group differences GSR: Appraisal < Watch
	Expt. 2. $N = 32$ 3 condition, between groups; $n = 16$ per group	Expt. 2. Appraisal: Training Watch: No emotional regulation	Expt. 2. Affect response to film:- *Day 1*: *Pre to post training* Distress and Horror score change	Expt. 2. Affect response to film:- *Day 1: Pre to post training* Distress and Horror score change Appraisal < Watch Watch - no score change
	Expt. 3. $N = 48$ 3 condition, between groups; $n = 18$ per group Manipulation administered post-film (Expt. 2 and 3)	Expt. 3. Appraisal = As Expt. 1 (see Table A.1) & 2 Watch = As Expt. 1 (see Table A.1) & 2 Detachment = Think about technicalities of making the film	Expt. 3. Affect response to film:- *Day 1*: *Pre to post training* Distress and Horror score change	Expt. 3. Affect response to film:- *Day 1: Pre to post training* Distress and Horror score change Appraisal < Watch Appraisal < Detachment Watch = Detachment
Geracioti et al. (2008)	$N = 8$ Within groups; Clinical population. Film durations: 1 h	Film type: TF = Trauma film content NF = Neutral film content	Physiological response:- *Day 1: concurrent with TF* CSF-CRH concentration level CSF-NE concentration level HR and BP *Day 2: (6–8 weeks after Day 1): Concurrent with NF* CSF CRH concentration level CSF-NE concentration level HR and BP Mood:- *Day 1 and Day 2:*	Physiological response:- *Day 1 to Day 2 comparisons:* CSF-CRH concentration: TF < NF CSF-NE: concentration: TF > NF BP and HR: speed increase and overall level TF > NF Mood:- *Day 1 to Day 2 comparisons:* Higher anxiety VAS score = lower levels

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Table A.4 (*continued*)

Research group	Design	Independent variable(s)	Dependent variable(s)	Result(s)
			Anxiety VAS	of CSF-CRH
Devilly and Varker (2008)	*N* = 119 3 condition, between groups; Video: *n* = 67 Control: *n* = 52	Nature of video: MS = More Stress LS = Less Stress NV = No video Post-video debriefing (immediately post film): debriefed non-debriefed	PTSD Symptomatology:- *4 months follow-up:* PSS-SR score Depression & anxiety:- *4 months follow-up:* DASS-21 score	PTSD Symptomatology:- *4 months follow-up:* PSS-SR score MS > LS > NV Debriefed > Non-debriefed Depression & anxiety:- *4 months follow-up:* DASS-21 score No group differences
Devilly and Annab (2008)	*N* = 61 2 condition between groups PD: *n* = 27 No-PD: *n* = 31 Film duration: 10 min Manipulation administered post film for 40–50 min duration	Group intervention: PD = facilitated CISD No-PD = refreshments and non-facilitated interaction	Perceived social support:- *Day 1 and 1 month:* ISEL-12 score Depression & anxiety:- *Day 1 and 1 month:* DASS 21 score PTSD symptomatology:- *Day 1 and 1 month:* PDS score Behavioural and emotional indicators:- *Day 1 and 1 month:* 16 item questionnaire score	Perceived social support:- ISEL-12 scores No group difference Depression & anxiety:- DASS 21 scores No group difference PTSD symptomatology:- PDS scores No group difference Behavioural and emotional indicators:- No group differences *Day 1 to 1 month:* Reduced scores PD and No-PD

Note. AE = Anomalous Experiences; BDI-II Becks Depression Inventory (Beck & Steer, 1987); BRT = Block Rehearsal Task; CBM = Cognitive Bias Modification (a computerised procedure used to modify cognitive biases which are thought to contribute to emotional disorders; MacLeod & Holmes, 2012); CISD = Critical Incident Stress Debriefing; CMT = Configuration Movement Task (intended to recruit proprio-spatial unconscious perception of movement); (C)RAT = (Compound) Remote Associate Task (An index of creative thinking; Mednick, 1967; The task requires participants to think of a word which will link together a series of three-word items); CT = Conscious Thought; GAD; Generalised Anxiety Disorder; DASS 21 = Depression Anxiety Stress Scale–21(Lovibond & Lovibond, 1995); DEL-NM = Deliberate Non-Movement (self-regulated non-movement); DISS-NM = Dissociative Non-Movement (a cataleptic state induced by the experimenter); DPT = Dot Probe Task (intended as a measure of attentional bias for (negative) stimuli; MacLeod et al., 1986); EDA = Electrodermal Activity (also known as skin conductance response or galvanic skin response; an index of change in the skins ability to conduct electricity due to sweat gland activity, a physiological response to affect); EEG = Electroencephalography (the recording of electrical activity along the scalp); FM = Free Movement; HR = Heart Rate; HVPT = Hyperventilation Provocation Test (the HVPT is designed to simulate physiological arousal; Spinhoven et al., 1992); IES = Impact of Event Scale (2 subsales, Intrusions and Avoidance; Horowitz et al., 1979); IES-R = Impact of Event Scale – Revised (3 subscales, Intrusions, Avoidance, and Hyperarousal; Weiss & Marmar, 1997); ISEL-12 = Interpersonal Support Evaluation List short form (Cohen, Marmelstein, Kamarck & Hoberman, 1985); IQ = Intrusion Questionnaire (Hackmann et al., 2004; Michael et al., 2005); LS = Low Schizoptype; MD = Mere Distraction; NS-SCR = Nonspecific Skin Conductance Response; NT = No Task (No manipulation for the equivalent duration as the other experimental conditions, unless stated otherwise); NF = Neutral Film; O-LIFE = Oxford–Liverpool Inventory of Feelings and Experiences (Mason & Claridge, 1995); OSPAN = Operation Word Span Task (a measure of working memory capacity; Turner & Engle, 1989); PANAS = Positive and Negative Affect Scale (Watson et al., 1988); PD = Psychological Debriefing, using the Critical Incident Stress Debriefing method; PDS = Posttraumatic Diagnostic Scale (Foa, 1995); PTQ = Perseverative Thinking Questionnaire (Ehring et al., 2011); RMT = Recognition Memory Test; RSVP = Rapid Serial Visual Presentation task (intended as a measure of attentional bias for [negative] stimuli); S = Suppression; RRS = Ruminative Response Scale; SCR = Skin Conductance Response (also known as electrodermal activity or galvanic skin response; An index of the skins ability to conduct electricity due to sweat gland activity, a physiological response to affect); SCL = Skin Conductance Level; SIT = Sensory/perceptual Interference Task; STAI-T = State Trait Anxiety Inventory - Trait (Spielberger et al., 1983); T-CPQ = Trait-Cognitive Processing Questionnaire (Halligan et al., 2002); TF = Traumatic Film; TMQ = Trauma Memory Questionnaire (Halligan et al., 2003); UT = Unconscious Thought; VCL = Verbal Cognitive Load; VET = Verbal Enhancement Task; VIT = Verbal Interference Task; VR = Visual Recognition; VST = Visuospatial Task; WM = Working Memory; WST = Word-Stem Task (intended to assesses implicit priming effects).

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