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## Is it mere distraction? Peri-traumatic verbal tasks can increase analogue flashbacks but reduce voluntary memory performance<sup>☆</sup>

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### ABSTRACT

Several experiments have shown that we can reduce the frequency of analogue flashbacks with competing tasks presented during a trauma film (i.e. peri-traumatically). A “distraction” hypothesis suggests that any competing task may reduce flashbacks due to distraction and/or a load on executive control. Alternatively, a “modality” hypothesis based on clinical models of PTSD suggests that certain tasks will not protect against intrusions (Experiment 1) and could actually increase them (Experiment 2). Experiment 1 contrasted two concurrent tasks, Verbal Interference (counting backwards in threes) and Visuospatial tapping, against a no-task Control condition during trauma film viewing. The Visuospatial group had significantly fewer intrusions of the film over 1-week than the Control group. Contrary to a distraction account, the Verbal Interference group did not show this effect. Using a larger sample, Experiment 2 showed that the Verbal Interference group (counting backwards in sevens) had more intrusions (and inferior voluntary memory) than no-task Controls. We propose that this is in line with a modality hypothesis concerning trauma flashbacks. Disrupting verbal/conceptual processing during trauma could be harmful for later flashbacks.

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### 1. Introduction

‘Flashbacks’ are a hallmark symptom of post-traumatic distress disorder (PTSD; American Psychiatric Association, [APA], 1994). In PTSD, vivid, intrusive, negative images of excerpts from a traumatic event “pop” into consciousness, apparently spontaneously, causing distress. The encoding stage has been deemed critical for the subsequent occurrence of flashbacks (for a review see Brewin & Holmes, 2003). Both contemporary theories of PTSD and cognitive memory models conceptualise flashbacks and intrusive memories as reflecting instances of ‘faulty information processing’ at the time of the trauma i.e. peri-traumatically. Such models include Ehlers and Clark’s (2000) cognitive theory of PTSD, dual representation theory (DRT; Brewin, 2001, 2003; Brewin, Dalgleish, & Joseph, 1996), and Conway’s model of autobiographical memory

(Conway, Meares, & Standart, 2004; Conway & Pleydell-Pearce, 2000), see also Dalgleish (2004). Whilst these theories differ in other respects, in relation to intrusion formation they make similar predictions (see Holmes, Brewin, & Hennessy, 2004; Holmes & Bourne, 2008): that is, extreme emotional responses at points in a traumatic event can cause a shift in processing style away from “conceptual” or “verbal” processing of events (focussing on the situation’s meaning) towards more “data-driven”, “sensory-perceptual”, or “visuospatial” processing (focussing on sensory impressions). This peri-traumatic shift in processing style is theorized to cause those events encoded relatively more perceptually/visuospatially to become intrusive.

The view we describe above leads to two interesting predictions, which we shall refer to as the “modality” hypotheses. First, peri-traumatic disruptions to conceptual/verbal processing should increase later flashbacks. Second, peri-traumatic disruptions to sensory/visuospatial processing should reduce later flashbacks. While there is now accumulating evidence for the latter prediction, evidence for the former is sparse.

The experimental method used to investigate the impact of peri-traumatic processing on subsequent flashbacks is the trauma film paradigm (for a review see Holmes & Bourne, 2008). Healthy individuals are exposed to an event analogous to trauma, namely

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a film depicting stressful or traumatic events such as actual or threatened death or serious injury (PTSD Criterion A; APA, 1994). Any analogue flashbacks to the film (that is, intrusive image-based memories) are recorded in a diary. Participants sometimes find that verbal thoughts about the film may also intrude (Hagenaars, Brewin, van Minnen, Holmes, & Hoogduin, in press). However our primary interest concerns intrusive images, as an analogue of the vivid, sensory nature of clinical flashbacks. It is the image-based memories in the diary that are analysed accordingly in this study, and referred to henceforth as intrusions. Predictions about impact on intrusion frequency can be tested by manipulating conditions at encoding, for example by using modality specific dual tasks.

Several studies have shown that peri-traumatic visuospatial tasks reduce the frequency of later intrusions. Complex spatial key tapping was used in Holmes et al. (2004, Expts. 1 & 2) and Brewin and Saunders (2001), and clay modelling in Stuart, Holmes, and Brewin (2006). Moreover, such tasks have also been shown to be effective soon post-trauma (Holmes, James, Coode-Bate, & Deeptose, 2009). In contrast, only one study has shown that a peri-traumatic verbal-interference task can increase later intrusions. Holmes et al. (2004, Expt. 3) found that counting out-loud backwards in threes increased the number of intrusions relative to a no-task control group. However, Krans, Naring, and Becker (2009) found that a similar task decreased rather than increased intrusions. According to a general attention and memory approach, it is possible that any dual task at encoding will interfere with film processing and thereby simply reduce intrusions by distraction (see Gunter & Bodner, 2008; Krans et al., 2009). This alternative account we shall refer to as the “distraction” hypothesis.

It should be noted that Gunter and Bodner (2008) used a different experimental paradigm in which (non-clinical) participants were asked to recall unpleasant autobiographical memory concurrent to eye movements (see also: Andrade, Kavanagh, & Baddeley, 1997; Kavanagh, Freese, Andrade, & May, 2001; van den Hout, Muris, Salemink, & Kindt, 2001). Two visuospatial tasks (eye movements as well as a drawing task) and an auditory shadowing task led to reductions in vividness and emotionality. Gunter and Bodner suggested that any distractor task that taxes the central executive could produce benefits when simultaneously holding a memory in mind irrespective of the specific modality of the task. In contrast, results in PTSD patients indicated that modality may be important since concurrent eye movements reduced emotionality and vividness of recalled trauma images relative to no task whereas a verbal counting task did not (Lilley, Andrade, Turpin, Sabin-Farrell, & Holmes, 2009). In the current paper we are interested in the encoding rather than the recall stage, but a similar argument can be posited for distraction versus modality views (Baddeley & Andrade, 2000; Kempes & Tiggemann, 2007).

Other research appears relevant to this debate. A more perceptual encoding style predicted increased intrusions after a film relative to a more conceptual encoding style (Halligan, Clark, & Ehlers, 2002), with related results via a manipulation of these processing styles post-trauma (Kindt, van den Hout, Arntz, & Drost, 2008). A verbal distraction condition post-film (a semantic naming task which could be thought of as interrupting conceptual processing) led to more intrusions than concrete thinking (Ehring, Szeimies, & Schaffrick, 2009). Also, increased conceptual processing has been related to improved outcome in PTSD patients following therapy (Kindt, Buck, Arntz, & Soeter, 2007). However, studies are lacking which compare manipulations of both perceptual versus conceptual processing at encoding to test impact on later intrusions.

Returning to trauma encoding, according to a “distraction hypothesis”, the modality of the peri-traumatic dual task would be irrelevant to its effect on intrusions. However, in contrast, our

formulation of PTSD theories suggests that peri-traumatic tasks interfering specifically with sensory/visuospatial processing would selectively protect against later intrusions, whereas other tasks would not. We therefore sought to test, within the same experiment, whether a visuospatial, but not a non-visuospatial task, would reduce later intrusions of a trauma film. In a second study, we sought to test the stronger prediction that a verbal/conceptual interference task rather than being distracting would actually increase (not decrease) intrusions.

## 2. Experiment 1

Three peri-traumatic experimental groups were compared for their impact on later intrusions of a traumatic film: (1) a complex visuospatial tapping task; (2) a verbal counting task and (3) a no-task control condition. Identical tasks were used as in Holmes et al. (2004). However, rather than the impact of each task being tested separately against a control condition, in the current study they were compared within a single experiment. It was predicted first, that the visuospatial group would experience fewer intrusions than controls during the week immediately post-film. Second, and against the “distraction hypothesis”, we predicted that the verbal interference group would not experience a corresponding reduction in intrusions over the week.

### 2.1. Method

#### 2.1.1. Design

Using a between-subjects design participants were randomly assigned to one of three conditions: Visuospatial dual task, Verbal Interference dual task, or no-task Control group.

#### 2.1.2. Participants

Forty participants ( $M$  age = 29.05 years;  $SD$  = 8.09; 23 male) were recruited via advertisements and paid a nominal reimbursement for their participation. Due to ethical considerations, all recruitment material provided information about the nature of the film, specifically that it contained scenes of a traumatic or potentially distressing nature including for example scenes of the aftermath of real-life road traffic accidents.

#### 2.1.3. Trauma film

Participants were shown a 13 min film of real-life footage of the aftermath of road traffic accidents (compiled by Steil, 1996). This film has been used extensively in studies using the trauma film paradigm (e.g. Brewin & Saunders, 2001; Hagenaars, van Minnen, Holmes, Brewin, & Hoogduin, 2008; Halligan et al., 2002; Holmes et al., 2004; Holmes, Oakley, Stuart, & Brewin, 2006; Holmes & Steel, 2004; Stuart et al., 2006). It consists of five separate scenes each introduced by a short commentary providing context for the scene. The trauma film was displayed on a 15 inch colour monitor via a video tape recorder. Viewing distance was approximately 50 cm.

#### 2.1.4. Dual tasks

**2.1.4.1. Visuospatial task.** As in Holmes et al. (2004), participants were instructed to use their dominant hand to tap a specified spatial pattern on a keypad with a  $5 \times 5$  array of buttons (Moar, 1978). The spatial pattern used was identical to Holmes et al. (2004). A methodological refinement was the removal of lettered button labels from the keypad. This was done to avoid the potential confound that participants might use verbal memory resources for the letter string that constituted the spatial pattern, rather than visuospatial memory resources to encode the actual spatial pattern. Participants were trained in tapping the pattern with the keypad in

view for up to 1 min before they practiced the sequence with the keypad out of sight for 10 s. The key pad remained hidden from view during the film.

2.1.4.2. *Verbal interference task.* As in Holmes et al. (2004), participants counted out-loud backwards in threes from a three digit number (958) through-out the film. Articulations were recorded using an audio voice recorder.

## 2.1.5. Measures

### 2.1.5.1. Baseline measures

2.1.5.1.1. *Self-relevance of car crashes.* A single item self-report Visual Analogue Scale (VAS) ranging from 0 “Not at all” to 10 “Extremely relevant”.

2.1.5.1.2. *Traumatic experience questionnaire (TEQ).* A 12-item check list adapted from the criterion A list of the Posttraumatic Diagnostic Scale (PDS; Foa, 1995). Participants indicated whether they had experienced or witnessed each of the trauma events listed (“Yes” or “No” response for each event). “Yes” scores were summed, and could range from 0 (no traumatic events experienced or witnessed) to 12 (each and every type of traumatic event experienced or witnessed).

### 2.1.5.2. State measures

2.1.5.2.1. *Mood and distress measures.* These comprised VAS for 5 emotions: fearful, horrified, and helpless (based upon DSM-IV criteria; APA, 1994) plus depressed, and angry (based upon Davies & Clark, 1998). Each emotion was rated from 0 “Not at all” to 10 “Extremely” for feelings “right now” both pre- and post-film. A similar VAS was used to evaluate participants' distress post-film. A composite mood score was computed by calculating the mean score across each of the five emotions both pre- and post-film.

### 2.1.5.3. Memory measures

2.1.5.3.1. *Involuntary intrusion diary.* Participants were given a diary to record any image-based intrusions of film content (analogue flashbacks) during the 7 days following the experimental session. Participants were advised (both verbally and via written instructions in the diary) that intrusions were defined as “any memory of the film (or part of the film) that appeared apparently spontaneously in their minds. Do not include any memories of the film that you deliberately or consciously bring to mind”. The diary was similar to that used in our previous studies (Hagenaars et al., 2008; Holmes et al., 2004, 2009, 2006; Krans et al., 2009; Stuart et al., 2006). Participants were asked to record all intrusions immediately after they occurred (whenever possible) and to set aside a regular time slot each day to check that their diary was up-to-date as a way of ensuring intrusions were not omitted if it had been impractical to write an intrusion down immediately. If participants had experienced no intrusions during any period they were also asked to make this explicit in the diary. Participants were also given instructions about the different forms intrusions can take: “What goes through our minds can either take the form of words and phrases (‘verbal thoughts’), or it can be like mental images. Although mental images often take the form of pictures they can actually include any of the five senses, so you can imagine sounds or smells too.” Participants were therefore asked to specify in their diary whether each intrusion experienced was a thought or image intrusion and to describe its content (e.g. “a fireman carrying a baby”) so as to ensure that the intrusion related to the film. As mentioned earlier, intrusive image-based memories (“intrusions”) were analysed in this study (not verbal thoughts).

2.1.5.3.2. *Recognition and recall voluntary memory tests.* Two memory tests evaluated voluntary memory for the film: a 16 item, ‘yes/no’, forced choice Recognition Test; and a 14 item Cued Recall Test for specific film details (as in Holmes et al., 2004). Examples of

items from the Cued Recall Test are: “What colour was the car that was on fire in Scene 1?” and “How many people were put in coffins in Scene 4?”. Examples of items from the Recognition Test are: “Scene 1: A distraught teenager is led away from the scene by a member of the public.” and “Scene 3: Rescue workers put up a yellow and blue police incident tape in order to keep the crowd back from the scene”.

### 2.1.5.4. Check measures

2.1.5.4.1. *Diary compliance.* A single item VAS measured the extent to which participants forgot or omitted to record intrusions. The omissions scale ranged from 0 “Not at all true of me” to 10 “Completely true of me” at the other (as in Holmes et al., 2004).

2.1.5.4.2. *Demand characteristics.* A single item, three answer (“less”, “same”, or “more”), forced choice question: ‘Do you think you have had more, less, or the same number of intrusions if you had not performed the task?’ assessed whether participants in either dual task group endorsed responding based on experimental demand (as in Holmes et al., 2004).

### 2.1.6. Procedure

Participants were tested individually in a quiet, darkened testing room fitted with blackout blinds.

2.1.6.1. *Pre-film phase.* Once informed consent was obtained, participants completed the self-relevance of car crashes VAS, the TEQ, and baseline mood ratings.

2.1.6.2. *Film phase.* Participants were asked to view the film “as if they were there, a bystander at the scene of the events, and to pay attention to the film as later there may be questions about film content”. The Verbal Interference group were asked to count down, out-loud, in threes starting from 958 through-out the film and told that counting should be as continuous and accurate as possible (they were being audio-recorded). The Visuospatial group was asked to repeat the pattern sequence they had practiced on the concealed keypad whilst watching the film and further instructed that tapping should be as continuous and accurate as possible as the computer would record their responses.

2.1.6.3. *Post-film phase.* Participants recompleted the mood ratings. They also rated their distress rating at the film. Finally, participants were instructed in how to complete the one-week intrusion diary and an appointment made for the follow-up session.

2.1.6.4. *Follow-up session.* Participants returned their intrusion diary. They completed the diary compliance rating, the demand item (in both task conditions), and the Recognition and Cued Recall memory tests. Finally, participants were debriefed and thanked for their participation.

## 2.2. Results

The mean values (standard deviations) for the main variables for each group are shown in Table 1. All analyses were conducted with alpha set at 0.05 and were 2 tailed.

### 2.2.1. Randomisation and manipulation checks

2.2.1.1. *Randomisation checks.* There were no significant group differences in age, number of traumatic events, or self-relevance of car crashes [all  $F$ 's < 1]. The composite VAS mood measure showed no significant group differences in pre-film mood [ $F(2,37) < 1$ ]. There was also no significant group difference in gender

**Table 1**  
Means and standard deviations for baseline measures, outcome measures and manipulation checks per condition in experiment 1.

	Verbal interference (n = 15)		Control (n = 14)		Visuospatial (n = 11)	
	M	SD	M	SD	M	SD
<b>Baseline measures</b>						
Age	30.53	12.18	27.71	3.43	28.73	5.16
Self-relevance of car crashes	2.20	1.90	1.86	1.66	2.45	2.98
Number of prior traumatic events	2.87	2.03	2.93	1.49	3.18	1.66
<b>State measures</b>						
VAS mood						
Pre-film	0.99	1.33	1.11	0.93	0.58	0.95
Post-film	1.68	1.46	2.60	1.46	1.13	1.36
Distress at film	3.60	2.41	5.29	1.90	3.00	2.05
<b>Dual task compliance checks</b>						
Total number of key presses					848.09	330.09
Number of correct key sequences					137.18	52.35
Total numbers counted	231.27	70.36				
Number of counting errors	31.13	23.43				
	6.33	4.97	3.79	2.91	1.45	1.86
Recognition memory	8.73	2.63	10.29	2.23	11.00	3.90
Cued recall memory	6.20	2.24	9.07	2.81	9.81	2.23
<b>Check measures</b>						
Diary compliance						
Omissions	1.53	1.30	1.00	0.96	1.09	1.37
Demand check (% within condition)						
Less intrusions		7.10 %				9.10 %
Same		0.00 %				9.10 %
More intrusions		92.90 %				81.80 %

$[\chi^2(2, N = 40) = 4.73, p = .09]$ . Number of males in each group was: Control = 5; Verbal Interference = 5; Visuospatial = 8.

**2.2.1.2. Dual task compliance.** The Visuospatial group performed the tapping task accurately and consistently through-out the film. Mean key presses were approximately 70 per min and the correct 5-key sequence was tapped on 81% of occasions, similar rates to Holmes et al. (2004; Expts. 1 & 2). The Verbal Interference group performed the counting task accurately and consistently. Mean numbers counted were approximately 20 per min and correct numbers were counted on 85% of occasions, similar rates to Holmes et al. (2004; Expt. 3).

## 2.2.2. Effects of experimental condition

**2.2.2.1. Intrusive images.** The total number of intrusive images from the film was calculated from the diaries for each participant (for means per condition see Fig. 1). There was a main effect of condition on number of intrusive images [ $F(2,37) = 5.78, p = .007, \eta_p^2 = 0.24$ ]. Planned comparisons between groups showed that the Visuospatial group had significantly fewer intrusions than both Controls [ $t(23) = 2.30, p = .031, d = 0.80$ ] and the Verbal Interference group [ $t(24) = 3.09, p = .005, d = 1.30$ ]. The difference between the Verbal Interference group and Controls did not reach significance [ $t(27) = 1.67, p = .11, d = 0.87$ ].

Interestingly, within the Verbal Interference group the number of errors in the counting task was negatively correlated with number of image intrusions ( $r = -0.54, p = .038$ ), that is the better participants performed the counting task, the more intrusions they developed. Performance on the Visuospatial task was not significantly related to number of intrusions ( $r = -0.23, p = .51$ ).

The randomisation check suggested that there were no significant differences in gender between the groups, however given the number of males in the visuospatial condition and that gender has been suggested as a risk factor for developing PTSD (Brewin, Andrews, &

Valentine, 2000), the intrusive image data were re-analysed using gender as a covariate. The results of this analysis confirmed a similar pattern to results without gender as a covariate. The main effect of condition on number of intrusive images remained [ $F(2,36) = 7.53, p = .002, \eta_p^2 = 0.30$ ] and the same pattern of differences between the groups were found using planned (simple) comparisons: Visuospatial versus Controls [ $p = .043$ ]; Visuospatial versus Verbal Interference [ $p < .001$ ]; and Verbal Interference versus Controls [ $p = .06$ ].

**2.2.2.2. Voluntary memory for film.** Cued Recall memory scores showed a group difference [ $F(2,37) = 8.25, p = .001, \eta_p^2 = 0.47$ ] with a decomposition analysis suggesting that the Verbal Interference group scored more poorly than both the Control group [ $t(27) = 3.05, p = .01, d = 1.02$ ] and the Visuospatial group [ $t(24) = 4.08, p = .002, d = 1.62$ ]. There was no significant difference between the Visuospatial group and Controls [ $t(23) = 0.72, p > .99$ ].

Recognition memory scores did not show a significant group difference [ $F(2,37) = 2.11, p = .14$ ]. However, only Controls [ $t(13) = 3.83, p = .002, d = 1.03$ ] and the Visuospatial group [ $t(10) = 2.55, p = .029, d = 0.77$ ] scored significantly above the 50% chance level. The Verbal Interference group failed to score above chance [ $t(14) = 1.08, p = .30$ ].

**2.2.2.3. Mood and distress ratings.** Viewing the trauma film resulted in a predicted deterioration of mood over time [ $F(1,37) = 15.30, p < .001, \eta_p^2 = 0.29$ ] and critically no time by condition interaction [ $F(2,37) = 1.60, p = .22$ ]. There was no main effect of condition [ $F(2,37) = 2.91, p = .067$ ].

There was a group difference in self-rating for distress at film content [ $F(2,37) = 3.96, p = .028, \eta_p^2 = 0.18$ ] with the Visuospatial group experiencing less distress than the Control group [ $t(23) = 2.87, p = .036, d = 1.21$ ] (Bonferroni corrected). The difference between the Verbal Interference group and Controls was not significant after Bonferroni correction [ $t(27) = 2.08, p = .12$ ]. There was also no significant difference between the two dual task groups [ $t(24) = 0.67, p > .99$ ] (Bonferroni corrected).

**2.2.2.4. Diary compliance.** Diary compliance was high with a mean self-rating for diary omissions of 1.23 (SD = 1.21) and no significant group differences [ $F(2,37) < 1$ ].

**2.2.2.5. Demand check.** Eighty-eight percent of participants in the two dual tasks groups predicted that they would have had more intrusions had they not undertaken their respective dual task; 4 % predicted that their dual task did not affect intrusion frequency; and 8% predicted that their dual task caused fewer intrusions. Importantly, there was no significant difference between the Visuospatial and Verbal Interference groups in the anticipated effect of the two dual tasks [ $\chi^2(2, N = 25) = 1.39, p = .50$ ].

## 2.3. Discussion

In line with the first hypothesis, the Visuospatial group experienced a reduced number of intrusions relative to no-task Controls. This finding is consistent with previous studies that have demonstrated the protective effect of peri-traumatic visuospatial dual tasks (e.g. Brewin & Saunders, 2001; Holmes et al., 2004; Stuart et al., 2006). However, a corresponding decrease in intrusions was not found in the Verbal Interference Group. Rather, mean scores indicated that compared to the control condition, this group showed an increase, not a decrease, in intrusions. Further, the Verbal Interference group had significantly more intrusions than the Visuospatial group. These later findings are not consistent with the predictions drawn from the distraction hypothesis.

These findings suggest that the two peri-traumatic dual tasks do not exert the same effect on intrusions. This is consistent with our

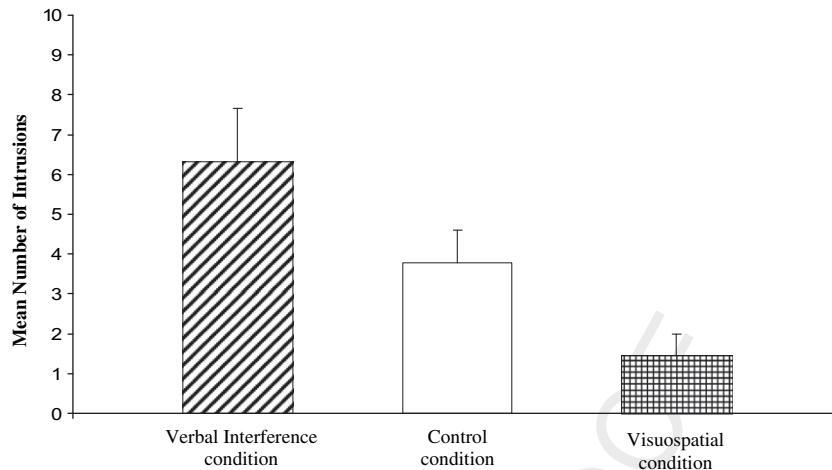


Fig. 1. Mean number of intrusive images of the trauma film over one-week per experimental group.

proposal that the impact of visuospatial dual tasks in reducing intrusions is unlikely to be due to mere distraction away from film encoding.

There did not appear to be other differences between the experimental groups that could have accounted for these findings. The groups showed no differences pre-film on a variety of trait and state measures, and there were no time by group interactions on the state mood measure pre to post-film. Further, the groups did not differ on diary omission scores suggesting that all groups diligently maintained their intrusion diaries. Responses to the demand question suggest that participants believed that both dual tasks would reduce the number of intrusions. This finding is in keeping with a lay-perception that all dual tasks are distracting and thereby reduce intrusions relative to no-task controls. On balance it appears that the group differences found with respect to intrusions are most likely to be attributable to the experimental tasks.

In addition to assessing involuntary intrusions, we assessed voluntary memory for the film at one week. Interestingly, the Verbal Interference group showed the poorest performance on tests of their voluntary memory of the film (below chance levels on the Recognition test and significantly below the other two groups on the Cued Recall test). This may have been due to greater distraction away from the film by the Verbal Interference task than the Visuospatial task. However, this is hard to reconcile with general models of attention and memory as this 'distracted' Verbal Interference group also had the highest number of involuntary intrusions. However, such a pattern of memory related data is consistent with clinical findings in PTSD patients i.e. vivid involuntary re-experiencing that persists alongside reduced voluntarily recalled memory (see Brewin, 2007; Herlihy, Scragg, & Turner, 2002; Herlihy & Turner, 2007).

In conclusion, this experiment provides evidence that not all peri-traumatic tasks given during a traumatic film will simply 'distract' the viewer and thereby reduce later intrusions. Findings are thus more consistent with our formulation of clinical models of PTSD flashbacks (Holmes & Bourne, 2008) than general attention and memory accounts (Cowan, 1995; Gunter & Bodner, 2008; Rubin, 2006). Interestingly, our alternative task, the Verbal Interference task, rather than leading to less intrusions, if anything, had the opposite effect. Existing evidence on this point is mixed and requires further investigation. One study has found such a task increased intrusions relative to control (Holmes et al., 2004) whilst another found the reverse (Krans et al., 2009).

In the next experiment, we sought to test whether a different Verbal Interference task would result in an increase in intrusions relative to Controls, by using a more demanding task and increasing the sample size to better power the comparison. The rationale for

using a more demanding Verbal Interference task was derived from the finding in Experiment 1 that performance in counting backwards in threes was correlated with the number of intrusions. Thus, the more participants were engaged in the concurrent Verbal Interference task, the more film intrusions they developed. We interpret this in line with clinical theories (rather than a distraction hypothesis) – the less participants are able to process the film verbally/conceptually peri-traumatically (due to competition for the specific resources by the concurrent task), the more intrusions they will develop (Holmes & Bourne, 2008). While we found the above described correlation, the overall difference in intrusions between the Verbal Interference and Control conditions did not reach significance. Thus, it is possible that in Experiment 1, counting backwards in threes was not sufficiently demanding of verbal/conceptual cognitive resources for the effect on the Verbal Interference group (relative to Controls) to reach significance. A similar task to counting backwards in threes but thought to be more demanding is backwards counting in sevens.

### 3. Experiment 2

This experiment compared a new Verbal Interference condition with a no-task Control condition. The Verbal Interference dual task required participants to count out-loud backwards in sevens, a cognitive load task used by Wegner and Ansfield (1993) (as cited in Wegner, 1994). This is thought to be incrementally more demanding than counting backwards in threes. We extended the trauma film from 13 to 21.5 min and projected it on a video screen (rather than via TV) to maximise the impact of the analogue trauma experience. To include further checks that groups were matched at baseline we added depression (Beck, Steer, & Brown, 1996) and trait anxiety (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) measures. In addition to mood VAS, a standardised state anxiety scale (Spielberger et al., 1983) was used pre- and post-film. It was predicted that performing the Verbal Interference task during film viewing would result in a *greater* number of intrusions than Controls in the subsequent week.

#### 3.1. Method

##### 3.1.1. Design

Using a between-subjects design participants were randomly assigned to one of two conditions: the Verbal Interference dual task group or the no-task Control group.

### 3.1.2. Participants

Thirty-eight participants ( $M$  age = 19.68 years;  $SD$  = 2.63; 26 female) were recruited by posters and electronic advertisements from the general population and paid a nominal time-reimbursement for their participation. Two additional participants (one from each group) withdrew part-way through the study as they did not wish to view the film.

### 3.1.3. Trauma film

The trauma film was extended to 10 scenes which lasted 21.5 min. The first five scenes were identical to those used in Experiment 1 i.e. Steil's (1996) real-life footage of the aftermath of road traffic accidents. Five short new scenes were added which previous work had shown to have a relatively high intrusion frequency (Holmes et al., 2009). The trauma film was displayed on a 1.4 m × 0.8 m screen approximately 2 m from the viewer via a data projector connected to a computer.

### 3.1.4. Tasks

**3.1.4.1. Verbal interference task.** Participants counted out-loud backwards in sevens, a cognitive distraction task used by Wegner and Ansfield (1993) (as cited in Wegner, 1994). Participants counted down from each of 4 different 3 digit numbers (958, 845, 969, and 927) presented between scenes. Counting was logged using an audio voice recorder.

### 3.1.5. Measures

The measures used were identical to Experiment 1, with the following changes:

**Self-relevance of film content:** Because the extended film contained non-car accident material, a second single-item VAS was added. Participants were asked to indicate on a scale (ranging from 0 "Not at all" to 10 "Extremely relevant") how personally relevant they found the overall content of the film.

**Depression and trait anxiety:** The Beck Depression Inventory-II (BDI-II; Beck et al., 1996) is a widely used scale in clinical settings and comprises 21-items with high internal consistency ( $\alpha$  = 0.90) and a one-week test-retest reliability of  $r$  = 0.93. Each item consists of a choice of four statements relating to a particular symptom of depression ranging from 0 "I do not feel X", through 1 "I feel X much of the time", and 2 "I feel X all of the time" to 3 "I feel X so much that I can't stand it". Summed scores can therefore range from 0 to 63. The trait sub-scale of the Spielberger State – Trait Anxiety Inventory (STAI; Spielberger et al., 1983) comprises 20-items with an alpha coefficient of 0.9 and test-retest reliability of  $r$  = 0.71 over 30 days. Responses to each item on both the Trait and State scales are selected from 1 "Almost never", 2 "Sometimes", 3 "Often", and 4 "Almost always". Summed scores therefore range from 20 to 80.

**State anxiety:** State scale of the STAI (Spielberger et al., 1983). This 20-item scale was administered immediately pre-film and post-film based upon how participants felt "right now". This questionnaire was added to provide a more refined measure of state anxiety than Experiment 1.

**Recognition deliberate memory test:** Fourteen items were added to accommodate the additional film scenes, resulting in a 30 item 'yes/no' forced choice task. Examples of these new items: "Scene 6: Blood drips on to the man's shoes." and "Scene 10: An old man wearing a hat looks towards the accident in shock."

**Diary compliance:** In addition to the omissions scale in Experiment 1, a second scale (also ranging from 0 "Not at all" to 10 "Extremely") recorded how accurate participants thought their diary was.

**Demand characteristics:** A single item VAS ranging from –10 ("Extreme decrease") through 0 ("No effect") to +10 ("Extreme

increase") was used to assess participants' response to the question: 'How much do you predict counting backwards in 7s during a distressing film would increase or decrease intrusive images of the film of the type you recorded in you diary?'

### 3.1.6. Procedure

The procedure followed was the similar to Experiment 1, with some additional measures, as summarised below:

**Pre-film Phase:** (i) self-relevance of car crashes; (ii) TEQ; (iii) BDI-II; (iv) STAI-T; (v) STAI-S; and (vi) mood ratings.

**Post-film Phase:** (i) mood ratings; (ii) STAI-S; (iii) attention rating for the film; (iv) distress rating; and (v) a rating for self-relevance for film content.

**Follow-up Session:** (i) diary compliance ratings; (ii) demand item; and (iii) recognition memory test.

## 3.2. Results

The mean values (and standard deviations) for the main variables per group are shown in Table 2.

### 3.2.1. Randomisation and manipulation checks

**3.2.1.1. Randomisation checks.** There were no significant differences between groups in age [ $t(36) = 0.93, p = .36$ ], relevance of car accidents [ $t(36) = 0.54, p = .59$ ], relevance of film content [ $t(36) = 1.38, p = .18$ ], number of traumatic events [ $t(36) = 1.15, p = .26$ ], depression [ $t(36) = 0.32, p = .75$ ], trait anxiety [ $t(36) = 1.07, p = .29$ ], pre-film state anxiety [ $t(36) = 0.93, p = .36$ ], or pre-film VAS mood [ $t(36) = 0.07, p = .95$ ]. There was also no group difference in gender [ $\chi^2(1, 38) = 1.95, p = .16$ ] with the Control group having 8 males and the Verbal Interference group 4 males.

**Table 2**

Means and standard deviations for baseline measures, outcome measures and manipulation checks per condition in experiment 2.

Measure	Verbal int. ( $n = 19$ )		Control ( $n = 19$ )	
	$M$	$SD$	$M$	$SD$
<b>Baseline measures</b>				
Age	19.68	2.63	20.33	2.95
Self-relevance of car crashes	3.47	2.48	3.94	2.91
Self-relevance of film content	3.44	2.64	4.56	2.31
Number of prior traumatic events	1.32	1.16	0.94	0.78
Depression	6.31	3.96	5.84	5.08
Trait anxiety	36.89	8.36	34.26	6.77
<b>State measures</b>				
State anxiety				
Pre-film	28.63	6.27	26.74	6.29
Post-film	51.84	12.50	47.95	13.56
VAS mood				
Pre-film	0.73	1.16	0.71	1.01
Post-film	3.11	2.72	3.82	2.58
Self-rated distress at film	5.72	2.55	6.73	1.96
<b>Dual task manipulation checks</b>				
Total numbers counted	216.42	88.45		
Number of counting errors	18.74	10.43		
	18.11	2.35	19.53	1.90
<b>Recognition memory score</b>				
Check measures				
Diary compliance				
Incompleteness	0.95	1.01	0.77	0.72
Accuracy	8.05	1.20	8.07	0.84
Demand check	–3.95	4.17	–3.63	2.83

761 3.2.1.2. *Verbal interference task compliance.* The mean total  
762 numbers counted were 11 per min with correct numbers counted  
763 on 89% of occasions, indicating participants counted accurately and  
764 consistently through-out the film.  
765

### 766 3.2.2. *Effects of experimental condition*

767 3.2.2.1. *Intrusive images.* As predicted, the mean number of intru-  
768 sions for the Verbal Interference group was significantly higher  
769 than the Controls [ $t(36) = 2.45, p = .02, d = 1.54$ ], see Fig. 2. Again,  
770 the data were re-analysed using gender as a covariate. The result of  
771 this analysis was similar to that without gender as a covariate, with  
772 the Verbal Interference group having a significantly higher number  
773 of intrusions than the Controls [ $F(1,35) = 4.49, p = .04, \eta_p^2 = 0.11$ ].  
774

775 3.2.2.2. *Voluntary memory for film.* Both groups scored significantly  
776 above the 50% chance level for the recognition test: Control [ $t$   
777 (18) = 10.40,  $p < .001, d = 2.38$ ]; Verbal Interference [ $t(18) = 5.75,$   
778  $p < .001, d = 1.64$ ]. However, recognition memory scores differed  
779 significantly between groups [ $t(36) = 2.05, p = .048, d = 0.75$ ], with  
780 participants in the Verbal Interference condition scoring lower (i.e.  
781 indicating impaired performance) than in the Control condition.  
782

783 3.2.2.3. *Mood and distress ratings.* Pre-film to post-film there was  
784 a significant increase in state anxiety on the STAI [ $F(1,36) = 147.59,$   
785  $p < .001, \eta_p^2 = 0.80$ ] with no main effects of condition [ $F$   
786 (1,36) = 1.09,  $p = .30$ ] or time by condition interaction [ $F < 1$ ]. The  
787 increase in mood VAS was at trend level [ $F(1,36) = 3.06, p = .089$ ]  
788 again with no main effects of condition or time by condition  
789 interaction [ $F_s < 1$ ]. There was no significant group difference in  
790 distress after film viewing [ $t(36) = 1.37, p = .18$ ]. Overall, this  
791 suggests that the film worsened affect but not differentially so  
792 between groups.  
793

794 3.2.2.4. *Diary compliance.* Diary compliance was high with a mean  
795 omission score of 0.86 (SD = 0.87) and no significant group  
796 difference [ $t(36) = 0.63, p = .54$ ]. Similarly, diary accuracy scores  
797 were high ( $M = 8.06, SD = 1.02$ ) with no significant group differ-  
798 ence [ $t(36) = 0.06, p = .95$ ].  
799

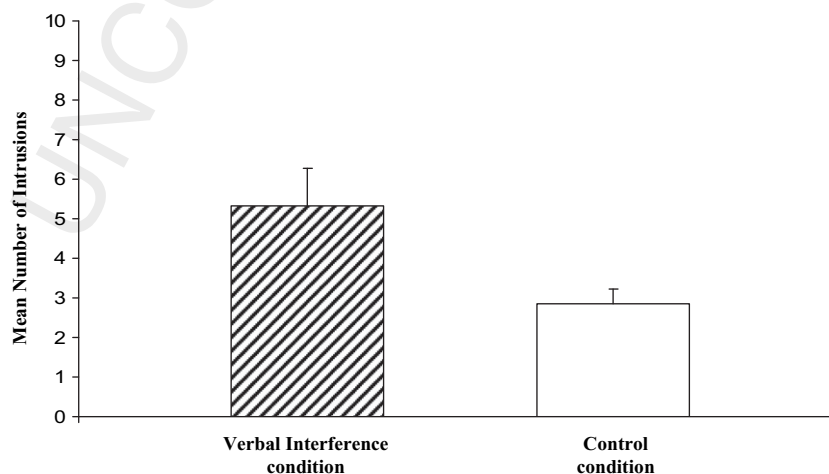
800 3.2.2.5. *Demand check.* There was no significant difference  
801 between groups in the anticipated effect of the verbal interference  
802 task [ $t(36) = 0.27, p = .79$ ] with both groups expecting that the task  
803 would reduce intrusions ( $M = 8.06, SD = 1.02$ ). Notably, this  
804 prediction is opposite to that hypothesised.  
805

### 806 3.3. *Discussion*

807 In line with predictions, the Verbal Interference group had  
808 significantly more intrusions than the Control group. While  
809 parsimonious with our clinical formulation of PTSD models  
810 (Holmes & Bourne, 2008) this does not appear to be consistent  
811 with an alternative “distraction” account (Gunter & Bodner, 2008).  
812 Furthermore, the Verbal Interference group demonstrated poorer  
813 recognition memory performance relative to Controls. This  
814 apparently paradoxical pattern of memory performance (impaired  
815 voluntary memory performance but increased intrusions) is  
816 consistent with Experiment 1 and mirrors phenomenology in  
817 PTSD patients (Brewin, 2007; Herlihy et al., 2002; Herlihy &  
818 Turner, 2007).  
819

820 These results are unlikely to be merely due to demand effects;  
821 responses to the demand question suggested that participants did  
822 not expect the dual task to increase intrusions. Indeed, participants’  
823 predictions were in the opposite direction to that found. Addition-  
824 ally, the groups showed no significant differences in a variety of  
825 trait and state measures prior to film viewing. Finally, the diary  
826 check questions suggest that any group difference in intrusions was  
827 not due to either group being more or less diligent in recording  
828 their intrusions. Thus, it seems likely that the intrusion difference  
829 between conditions was due to the experimental manipulation  
830 rather than these other factors.  
831

832 The current study replicates Holmes et al. (2004, Expt. 3) and  
833 accordingly are in the opposite direction to those found by Krans  
834 et al. (2009). It is difficult to know how to account for this  
835 discrepancy, since a mere distraction hypothesis cannot account for  
836 an increase in intrusions. However, it is suggested that Krans et al.’s  
837 finding that a verbal dual task can decrease intrusions may be  
838 related to a methodological difference associated with film  
839 presentation. Unlike the current study (or Holmes et al., 2004),  
840 Krans et al.’s Dutch study did not use the film’s English language  
841 sound track that provided a conceptual explanation of the scenes  
842 about to be viewed. Neither did they provide this contextual  
843 information via written introduction scenes. Therefore, it is  
844 possible that there was less emphasis on conceptual processing of  
845 the film’s meaning, and less chance for the verbal interference task  
846 to be ‘conceptually-interfering’. It is possible that verbal interfe-  
847 rence dual tasks may only be effective in increasing intrusions if they  
848 are disrupting the type of meaningful verbal/conceptual processing  
849 considered beneficial from a PTSD framework (Brewin & Holmes,  
850 2003; Ehlers & Clark, 2000).  
851



825 Fig. 2. Mean number of intrusive images recorded in the 1 week diary per experimental group.

#### 4. General discussion

The importance of peri-traumatic processing on later PTSD symptoms has long been emphasised (American Psychiatric Association, 2000; Ozer, Best, Lipsey, & Weiss, 2003), but is still little understood at a cognitive level. We propose that what people do cognitively during trauma may be critical for later flashbacks. We tested the impact of differences in peri-traumatic processing using dual task methodology. Our results are in line with a “modality hypothesis” rather than a “distraction hypothesis” concerning the effects of different peri-traumatic tasks on subsequent trauma flashbacks. The “distraction” hypothesis suggests that any competing task during trauma may reduce flashbacks due to distraction and/or a load on executive control. Alternatively, the “modality” hypothesis, derived from clinical models of PTSD, suggests that certain tasks will not protect against intrusions and could actually increase them.

Experiment 1 contrasted two concurrent tasks whilst watching a traumatic film against a no-task Control condition – Verbal Interference (counting backwards in threes) and Visuospatial tapping. The Visuospatial task led to significantly fewer image-based intrusions of the film (i.e. analogue flashbacks) over 1-week relative to the Control group. However, contrary to a distraction account, the Verbal Interference task did not reduce intrusions. Using a larger sample, Experiment 2 showed that a more demanding Verbal Interference task (counting backwards in sevens) led to more film intrusions (and inferior voluntary memory) than a no-task Control condition. Thus overall, the differential pattern of results support the modality hypothesis – a proposition developed from our interpretation of several contemporary clinical accounts of PTSD which appear to make similar predictions about the impact of peri-traumatic processing on later flashbacks (Brewin, 2001, 2003; Brewin et al., 1996; Conway, 2001; Conway & Pleydell-Pearce, 2000; Dalgleish, 2004; Ehlers & Clark, 2000) as summarised in Holmes and Bourne (2008). In contrast, a distraction hypothesis, previously used to explain the reductions in intrusions achieved with some dual tasks during memory recall (see Gunter & Bodner, 2008; Krans et al., 2009), cannot explain the increase in intrusions obtained with the Verbal Interference task employed at encoding.

These results build on several previous experiments which have shown that we can reduce the frequency of analogue flashbacks by competing visuospatial tasks presented during a trauma film (i.e. peri-traumatically) (Brewin & Saunders, 2001; Holmes et al., 2004; Stuart et al., 2006) and also post-traumatically (Holmes et al., 2009; Lilley et al., 2009). This is in line with a growing literature using visuospatial tasks to disrupt problematic imagery not only in relation to PTSD flashbacks but to cigarette cravings (May, Andrade, Pannaboke, & Kavanagh, in press) and flashforwards (Englehard, van den Hout, Janssen, & van der Beek, in press). The overall picture that emerges is that concurrent visuospatial tasks (complex pattern tapping, eye movements, clay modelling and so forth) can have beneficial effects with respect to emotional imagery.

In contrast, a major clinical implication of our findings is that disrupting verbal/conceptual processing during trauma encoding could be harmful for later flashbacks. Our data provides experimental support for current clinical cognitive models of PTSD (Brewin, 2001; Brewin et al., 1996; Ehlers & Clark, 2000) i.e. that disruption of peri-traumatic verbal/conceptual processing (via a sufficiently engaging verbal interference task) leads to increased flashbacks.

Interestingly, our findings indicate that a Verbal Interference task may simultaneously reduce voluntary memory performance (deliberate recall on the recognition test) and yet increase the number of intrusions (involuntary recall). In contrast, the

visuospatial task in Experiment 1 (and in Holmes et al., 2004, Experiment 1) did not reduce voluntary memory performance. It is possible that involuntary and voluntary memory, at least as measured here, involve separable processes. As noted previously, this may mirror the symptomatology of involuntary and voluntary memory in PTSD patients (see Brewin, 2007; Herlihy et al., 2002; Herlihy & Turner, 2007). However, it is also noted that our recognition test was a verbal measure, and a different pattern may have emerged with a visual test. Future studies might examine different types of recall task.

There are several limitations to the studies reported here. The most fundamental relates to the use of an analogue traumatic event to infer mechanisms in the development of symptoms of PTSD. Intrusive memories may be seen as occurring on a continuum with PTSD flashbacks at an extreme (Berntsen, 2001; Berntsen & Rubin, 2008). Moreover, it is clearly impractical and unethical to manipulate peri-traumatic factors *in vivo* in real trauma to test manipulations that may increase real flashbacks. The trauma film paradigm (Holmes & Bourne, 2008) is one of the few ways to manipulate peri-traumatic encoding processes in a controlled environment (see Sterlini & Bryant, 2002 for an alternative approach). While we attempted to assess perceived demand, one cannot rule this out on the basis of self-report. Another criticism is the small sample size used in Experiment 1, however, the effects were sufficient to show that the Verbal Interference task did not protect against intrusions whereas the Visuospatial task did. Further, the issue of whether a Verbal Interference task could actually lead to an increase in intrusions was examined in a larger sample in Experiment 2. However, it would be useful to add a visuospatial dual task to a future replication of Experiment 2.

It is noted that our current data and the modality hypothesis of flashback formation is focussed on the peri-traumatic encoding stage. It may be that effects of concurrent tasks during memory recall rather than encoding may differ. Gunter and Bodner's (2008) argument is based on results from executive function dual tasks when holding an autobiographical memory in mind. Therefore, the data presented here are not necessarily in conflict with a distraction hypothesis at recall, and the difference between the processes involved in peri-traumatic encoding and trauma memory recall warrants further investigation. We note however, that our preliminary findings in PTSD patients may indicate that mere distraction during recall may be insufficient for beneficial effects and that modality is still important (Lilley et al., 2009).

Since processing in the aftermath of trauma is highly important clinically, it will be of interest to test whether our peri-traumatic findings concerning the Verbal Interference task extend to memory consolidation in the post-traumatic period (as they do for a visuospatial task, Holmes et al., 2009). There is some suggestion they may do. Ehrling et al. (2009) compared the effects of engagement in rumination, concrete thinking, and distraction post-film. Contrary to the authors' predictions, participants in the distraction condition (which involved reading a transcript of thoughts unrelated to the film and then answering general knowledge questions) reported higher levels of involuntary memories compared to those in the concrete thinking and rumination conditions. We suggest this particular distraction task impaired conceptual, verbal processing of the film due to competition for these limited resources in the memory consolidation phase, thereby acting as a Verbal Interference task serving to increase involuntary memories (Holmes & Bourne, 2008). Whether our speculation is borne out when other verbally interfering task are used immediately post-trauma should be tested. The scope of possible such deleterious effects soon after trauma requires delineation, and a range of potentially verbally/conceptually interfering post-trauma tasks should be considered (see also for example Butler, Wells, & Dewick, 1995; Nixon, Cain,

Nehmy, & Seymour, 2009; Verwoerd, de Jong, & Wessel, 2008). In the meantime, the current data suggest that verbal/conceptual interference during trauma encoding far from being beneficially distracting may actually have an undesired proliferation effect on flashbacks.

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