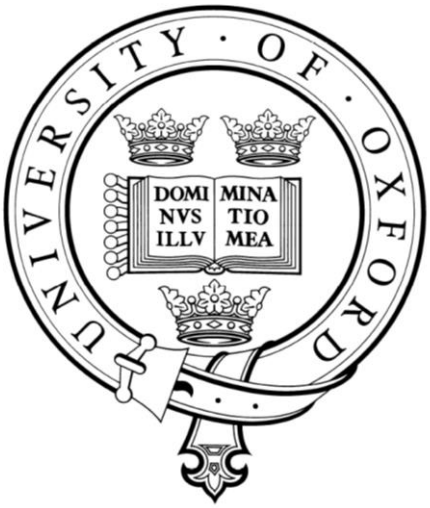
Exploring the Use of Tetris as a Post-Trauma 'Cognitive Vaccine': From Memory Consolidation to Reconsolidation



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Ella James, Lincoln College, Doctor of Philosophy, Trinity Term, 2013

Abstract

Re-experiencing trauma in the form of intrusive, image-based memories (here referred to as flashbacks) is a hallmark symptom of Post-Traumatic Stress Disorder (PTSD). There are successful treatments available for full-blown PTSD; however, these can only be administered one month post trauma. There are limited interventions that can be administered to reduce flashbacks in the early aftermath of trauma. The overarching aim of this thesis was to use an experimental psychopathology approach, the trauma film paradigm, to investigate the reduction of flashbacks post-trauma using the cognitive task, Tetris.

Chapter 1 provides a literature review of experimental research that has used the trauma film paradigm. Chapter 2 reviews experimental work on disrupting memory *reconsolidation* in humans. Chapter 3 details pilot work on the development of an experimental protocol based upon these literature reviews.

Experiment 1 (Chapter 4) investigated disrupting reconsolidation for a 24 hour old analogue trauma (aversive film material) using the cognitive task, Tetris. A procedure designed to disrupt flashback reconsolidation (a memory reactivation task for the film followed by playing the computer game Tetris) was compared with a no-task Control. Compared to Control, those in the Tetris condition reported fewer flashbacks to the film in an intrusion diary across the subsequent week and on convergent measures of flashback frequency. Experiment 2 (Chapter 5) provided a test of replication for findings from Experiment 1, in addition to extending findings by dismantling the procedure's component parts. Participants who underwent Tetris only (without memory reactivation) or memory reactivation (without Tetris) did not demonstrate a reduction in flashbacks and were comparable to the no-task control condition. Both a memory reactivation task plus Tetris in combination were critical for reducing subsequent flashbacks for a consolidated memory for a trauma film.

Experiment 3 (Chapter 6) tested whether playing Tetris could help disrupt flashback memories for an analogue trauma (film) if administered *prior* to film viewing, relative to a no-task control condition. Results showed that playing Tetris before a trauma film did not reduce flashbacks, as demonstrated via an intrusion diary and convergent flashback measures.

Chapters 7 reviews email feedback relating to playing Tetris after experiencing real-life adversity from members of the public. Chapter 8 explores a form of treatment for trauma in a NHS, complex patient setting. Chapter 9 discusses the findings from all chapters with reference to their implications and limitations, and new directions for future research. Overall, findings using analogue trauma suggest that memory reactivation followed by playing Tetris may be promising for development as a post-trauma 'cognitive vaccine' to disrupt the both the consolidation and potential *reconsolidation* of flashback memories.

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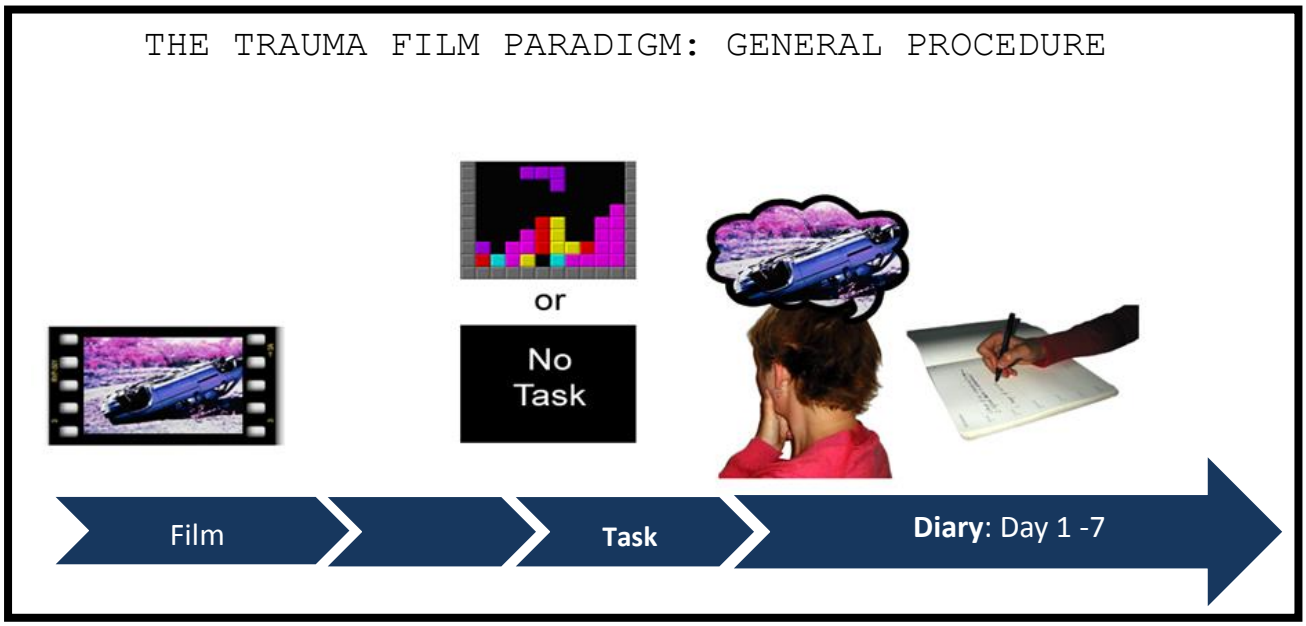
List of Key Abbreviations in Text

APA	American Psychiatric Association
BDI	Beck Depression Inventory
BLA	Basolateral amygdala
CAPS	Clinician-Administered PTSD Scale
CBM	Cognitive Bias Modification
CMT	Configural Movement Task
CT	Conscious Thought
CVLT	California Verbal Learning Task
DEL-NM	Deliberate Non-Movement
DISS-NM	Dissociative Non-Movement
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders – 4th Edition
DSM-V	Diagnostic and Statistical Manual of Mental Disorders – 5th Edition
DV	Dependent Variable
ED	Emergency Department
EMDR	Eye Movement Desensitisation and Reprocessing
EPQ-N	Eysenck Personality Questionnaire - Neuroticism scale
fMRI	Functional Magnetic Resonance Imaging
HVPT	Hyperventilation Provocation Test
IBM	International Business Machines, a computer manufacturer
IES	Impact of Event Scale (contains 2 subscales)
IES-R	Impact of Event Scale Revised (contains 3 subscales)
IMQ	Intrusive Memory Questionnaire
IPT	Intrusion Provocation Task
IRE	Imagery Re-Exposure
IRS	Imagery Rescripting
IV	Independent Variable
LA	Lateral nucleus of the amygdala
MRC	Medical Research Council
MTL	Medial Temporal Lobe
NICE	National Institute for Health and Clinical Excellence
NMDA	N-methyl-D-aspartate
PI	Positive Imagery
P-I	Proactive Interference
PICS	Proneness to Intrusive Cognitions Scale
PSS-I	PTSD Symptom Scale – Interview version
PTCI	Post traumatic Cognitions Inventory

PTSD	Post-traumatic stress disorder
RAT	Remote Associate Task
RTA	Road Traffic Accident
SPSS	Statistical Package for Social Scientists
STAI-T	State Trait Anxiety Inventory – Trait version
SUIS	Spontaneous Use of Imagery scale
TEQ	Traumatic Experiences Questionnaire
TF-CBT	trauma-focused cognitive behavioural therapy
UT	Unconscious Thought
VAS	Visual Analogue Scale
VCL	Verbal Cognitive Load
VCL&S	Verbal Cognitive Load and Suppression
VDU	Visual Display Unit

CHAPTER 1

Studying Post-Traumatic Flashback Memories in the Laboratory: A Review of Studies since 2008



Procedural overview adapted from Holmes et al., 2009

Studying Post-Traumatic Flashback Memories in the Laboratory: A Review of Studies since 2008

Post-Traumatic Stress Disorder and Flashback Memories in Experimental Medicine

Prevalence of trauma and PTSD

Over the course of a lifetime most people will experience a traumatic event of the kind defined by Post Traumatic Stress Disorder (PTSD) diagnostic guidelines (Table 1.1, DSM-V - Criteria A) such as interpersonal violence, natural disasters, war and terrorism (WHO, 2003). However, relatively few people will go on to develop the full-blown disorder (multiple reviews suggest approximately 5 to 12%; Bernat, Ronfeldt, Calhoun, & Arias, 1998; Breslau, 2009; Breslau et al., 1998; de Vries & Olff, 2009; Kessler, 2000; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995; Vrana & Lauterbach, 1994).

Different kinds of trauma are associated with different rates of PTSD. Interpersonal trauma such sexual assault and rape have the highest levels of PTSD associated with their occurrence (Foa & Riggs, 1993) whereas other forms of trauma such as witnessing accidents or being involved in a natural disaster are associated with lower rates of PTSD. Further, many individuals who are routinely exposed to events that are stressful and traumatic; for example in the work place (e.g. emergency services, military personnel), or in hostile environments (e.g. war zones), may be at an increased risk of developing PTSD. Contrary to common assumptions, PTSD symptoms are not confined to individuals who experience a one-off traumatic incident that is out of the ordinary. Indeed it has been shown that repeated exposure to traumatic events, even in the work-place, increases the likelihood of developing PTSD (Breslau et al., 1998; Laposa & Alden, 2003).

Evidence-based, clinical guidelines for the treatment of PTSD (National Institute for Health and Clinical Excellence, 2005) report that early symptoms experienced from between 2 and 4 weeks following trauma may forecast the need for treatment at 1 month. In addition, research has shown that re-experiencing symptoms (see Table 1.1) in the initial 8-days (on average) following a trauma can predict the subsequent occurrence of PTSD (O'Donnell, Elliott, Lau, & Creamer, 2007; Shalev, 1996). Thus, early re-experiencing symptoms *may* have an etiological role in PTSD and its trajectory, and represent a worthwhile target for further investigation.

PTSD symptoms

Intrusive flashback memories are a key component of PTSD and are considered hallmark symptom of the disorder (American Psychiatric Association, 2000; Muravieva & Alberini, 2010). Flashbacks are "re-experiencing symptoms"; the other three components

of PTSD are "avoidance" (e.g. avoiding reminders of the trauma); "negative cognitions and mood" (persistent negative beliefs, inability to experience positive emotions) and "arousal" (e.g. jumpiness, exaggerated startle response, poor concentration; Table 1.1, Criterion B, C, D and E respectively).

Clinical psychology models of PTSD (Brewin, 2001; Ehlers & Clark, 2000) put flashbacks at the hub of symptomatology - driving the symptoms. For example, if seeing cars triggers flashbacks for a road traffic accident victim, then that individual will do everything they can to avoid cars (avoidance); further, the victim of a road traffic accident may have lots of flashbacks to the event and as such find it extremely difficult to concentrate on anything else (arousal). The primary aim of the intervention task proposed within this thesis is to reduce flashback memories to trauma. It does not seek to address the full syndrome of PTSD *per se*.

Table 1.1 *Summary of the Diagnostic Criteria for PTSD [DSM-V; APA, 2013]*

Criteria A. The person has to be exposed to a traumatic event in which the following were present
A1. Exposure to an event(s) that involved actual or threatened death or serious injury, or sexual violation, as follows: *i)* direct exposure; *ii)* witnessing in person; *iii)* indirectly (e.g. learning that a close friend of relative was exposed to trauma); *iv)* Repeated or extreme exposure to aversive details of traumatic event(s) (through media, pictures, television or movies if exposure is work related)
Symptoms *(> 1 month)*
Criteria B: **Re-experiencing** - includes: *B1)* Involuntary, intrusive memories; sensory, emotional or physiological components *B2)* Distressing dreams *B3)* Dissociative reactions - acting or feeling as if the event is reoccurring *B4)* Intense or prolonged distress after exposure to traumatic reminders *B5)* Marked physiological reaction to cues resembling aspects of the trauma event Criteria C: Avoidance Criteria D: Negative Cognitions and Mood Criteria E: Arousal Criteria F. Symptom duration over 1-month Criteria G: Symptom related distress and impairment Criteria H: Disruption is not due to medical condition, medication, drugs or alcohol

Re-experiencing symptoms: Flashback memories

Clinical evidence suggests that re-experiencing of a traumatic event commonly takes the form of visual sensory-perceptual fragments (images) which are involuntary or intrusive (e.g. they can occur without deliberate recall or advance warning; Ehlers et al.,

2002). 'Intrusions' may be vivid with a sense of 'now-ness'(Hackmann, Ehlers, Speckens, & Clark, 2004) and take the form of worst moments during the traumatic event (Holmes, Grey, & Young, 2005) referred to as 'hotspots' (Grey, Holmes, & Brewin, 2001; Nijdam, Baas, Olff, & Gersons, 2013). The term "flashback" will be used throughout the thesis to refer to 'distressing, sensory-based involuntary memories of trauma' (p. 1521; Bourne, Mackay, & Holmes, 2013). Flashbacks are sometimes used to describe only those intense periods of re-experiencing associated with profound dissociation reactions (Table 1.1, symptom B3); however, such experiences are rare in clinical practice (Grey & Holmes, 2008; Holmes et al., 2005). Therefore, the term flashback will be used to cover the more common clinical memory feature that patients (at least in British English) refer to as their "flashbacks" and "flashback memories".

Why do we need to study flashbacks in the laboratory?

Early, evidence-based interventions to reduce the build-up of symptoms in the early aftermath of trauma are lacking (Agorastos, Marmar, & Otte, 2011; National Institute for Health and Clinical Excellence, 2005; Rose, Bisson, Churchill, & Wessely, 2002). Current interventions (psychological, not pharmacological) are recommended for use only after full-blown disorder has been established, e.g. from one month (NICE; National Institute for Health and Clinical Excellence, 2005).

Previous interventions for use in the early aftermath of trauma have been shown to be ineffective and for one a strategy termed 'psychological debriefing', possibly even harmful (Roberts, Kitchiner, Kenardy, & Bisson, 2010; Rose et al., 2002). One study has recently emerged with an intervention for use following early psychological trauma (e.g. Rothbaum et al., 2012). The intervention, (prolonged exposure therapy; asking individuals to repeatedly imagine their trauma in the absence of threat), while successful in reducing scores of depression and on the PSS-I (PTSD Symptom Scale; Foa & Tomlin, 2000) relies on a trained psychologist to administer and involves three hour-long sessions with homework to be completed by the patient. Such face-to-face treatments might be cumbersome and difficult to administer efficiently and effectively to individuals who have just experienced trauma, e.g. they require language compatibility between the provider and receiver of the treatment as well as additional resources that may be difficult to produce with efficiency following a large-scale traumatic event (such as a natural disaster that might be experienced by many people).

Treatments for use in the aftermath of trauma have also been investigated using pharmacological approaches, some examples of which are discussed further. Adrenergic

stimulation following an emotional event plays a mediating role in enhancing the 'over-consolidation' of memory for the event and is implicated in PTSD symptom development (Cahill, Prins, Weber, & McGaugh, 1994; Hoge et al., 2012; Pitman et al., 2002). Blocking adrenergic responses pharmacologically, using the beta adrenergic receptor antagonist propranolol, has been investigated as a treatment option to be administered shortly after a trauma incident. Findings in clinical populations have had mixed results. Early studies demonstrated participants given an oral dose of propranolol (*n* = 18) compared to a placebo (*n* = 24) over the course of 10 days, (and within 6 hours post traumatic event) had lower scores on the Clinician-Administered PTSD Scale (CAPS) at one month, as well as lower indices of physiological fear responding (Pitman et al., 2002). However, later tests of replication were largely unsuccessful and did not find such beneficial effects of taking the drug compared to control conditions (Hoge et al., 2012; Stein, Kerridge, Dimsdale, & Hoyt, 2007). Studies have tested the use of propranolol in patients with established PTSD, rather than in the early aftermath of trauma. In one study (n = 19; n = 9 propranolol administration; n = 10 placebo) results indicated that one single dose of propranolol prior to script-driven retrieval of traumatic memory reduced physiological responding (skin conductance and eye startle response) to subsequent mental imagery of the index trauma event (Brunet et al., 2008). Subsequent studies (Brunet et al., 2011) demonstrated that a dose of propranolol prior to script-driven retrieval (study 1: n = 28 - all participants were administered propranolol; Study 3: n = 32; n = 7 propranolol administration; n = 25 no treatment control) or oral retrieval (study 2 n = 7 - all participants were administered propranolol) of a trauma memory led to a reduction in mean scores from pre-to post-treatment (at 6 months) on the Clinician Administered PTSD Scale (CAPS). However in these studies there is an absence of adequate control conditions in which memory was **not** reactivated prior to the administration of propranolol or a placebo (Brunet et al, 2008; Brunet et al., 2011) meaning that it is not possible to infer whether propranolol served as a blockade to memory reconsolidation or whether findings were the result of non-specific effects.

A limitation cited within studies that have used propranolol in the early aftermath of trauma is that of low sample sizes. Drug administration was administered daily over the course of several weeks (e.g. 14 days in Stein et al., 2007; 19 days in Hoge et al., 2012). Perhaps the repeated requirement of taking a form of medication on a daily basis following a trauma was not conducive to the intervention. This may suggest that very simple, non-

invasive intervention approaches may be more likely to be taken up in patient populations following a traumatic experience.

PTSD symptom severity has been linked to the impaired extinction (the natural reduction of a fear response) to a traumatic event (Amstadter, Nugent, & Koenen, 2009). The partial antagonist D-cycloserine has been shown to enhance N-methyl-D-aspartate (NMDA) receptor functioning in the amygdala that has the consequence of facilitating fear extinction (Steckler & Risbrough, 2012). Research in animal models and in humans presenting with anxiety disorders demonstrates that D-cycloserine in combination with exposure therapy may offer an avenue to attenuate PTSD symptoms (Norberg, Krystal, & Tolin, 2008). This pharmacological approach, while suitable as part of a treatment package for existing trauma symptoms for which there is impaired extinction, correspondingly may or may not be suitable in the very early aftermath of trauma and remains to be tested further (Graham, Langton, & Richardson, 2011).

The use of medication either in the early aftermath of trauma as a treatment, or following a diagnosis of PTSD, is not recommended in the NICE guidelines for the treatment of PTSD (National Institute for Health and Clinical Excellence, 2005). Current recommendations for PTSD are psychological treatments, trauma-focused cognitive behavioural therapy (TF-CBT) and *Eye Movement Desensitization and Reprocessing* (EMDR; Shapiro, 1995; Shapiro & Laliotis, 2010. EMDR involves holding a distressing trauma memory in mind and undertaking eye-movements to reduce the intensity and subsequent distress of the trauma memory). Both treatment approaches involve multiple sessions with a clinician. Pharmacological approaches are only advised in special circumstances, for example if an individual will not engage in psychological trauma-focused treatment (National Institute for Health and Clinical Excellence, 2005). A recent Cochrane review has highlighted the need for the continued development of psychological interventions for use in the early aftermath of trauma to;

> "*…explore potential benefits of other forms of intervention and to identify the most effective ways of providing psychological help in the early stages after a traumatic event"*
>
> (p.2; Roberts et al., 2010).

As such, this thesis follows a psychological approach to investigate flashback reduction in the early aftermath of (analogue) trauma.

Initial steps towards developing preventative interventions against flashbacks

The research presented within this thesis uses an experimental psychopathology approach to inform the early-stage development of simple task intervention to target one of the

core features of PTSD – re-experiencing in the form of sensory-perceptual flashbacks. The Medical Research Council (MRC) guidelines for the development and evaluation of complex interventions for mental health (Figure 1.1; Medical Research Council, 2008) identifies a phased approach with four stages; Development, Feasibility and Piloting, Evaluation and Implementation. As such this thesis will focus on parts of the Development stage (see Figure 1.1; grey box). Chapter 1 and Chapter 2 relate to the first phases of the Development stage by identifying the evidence base and understanding theory behind findings from the trauma film paradigm and memory reconsolidation, in order to inform early-stage intervention design. It accomplishes this though literature reviews. Chapters 3 through to 6 model the processes behind flashback development through the lens of memory consolidation and reconsolidation (based on Chapters 1 and 2) in experiments which test a method for reducing flashbacks. Whilst the majority of work within the thesis covers analogue, experimental work, Chapters 7 and 8 explore a broader, clinical context in relation to PTSD and trauma symptoms in order to help widen the perspective of experimental research within the thesis.

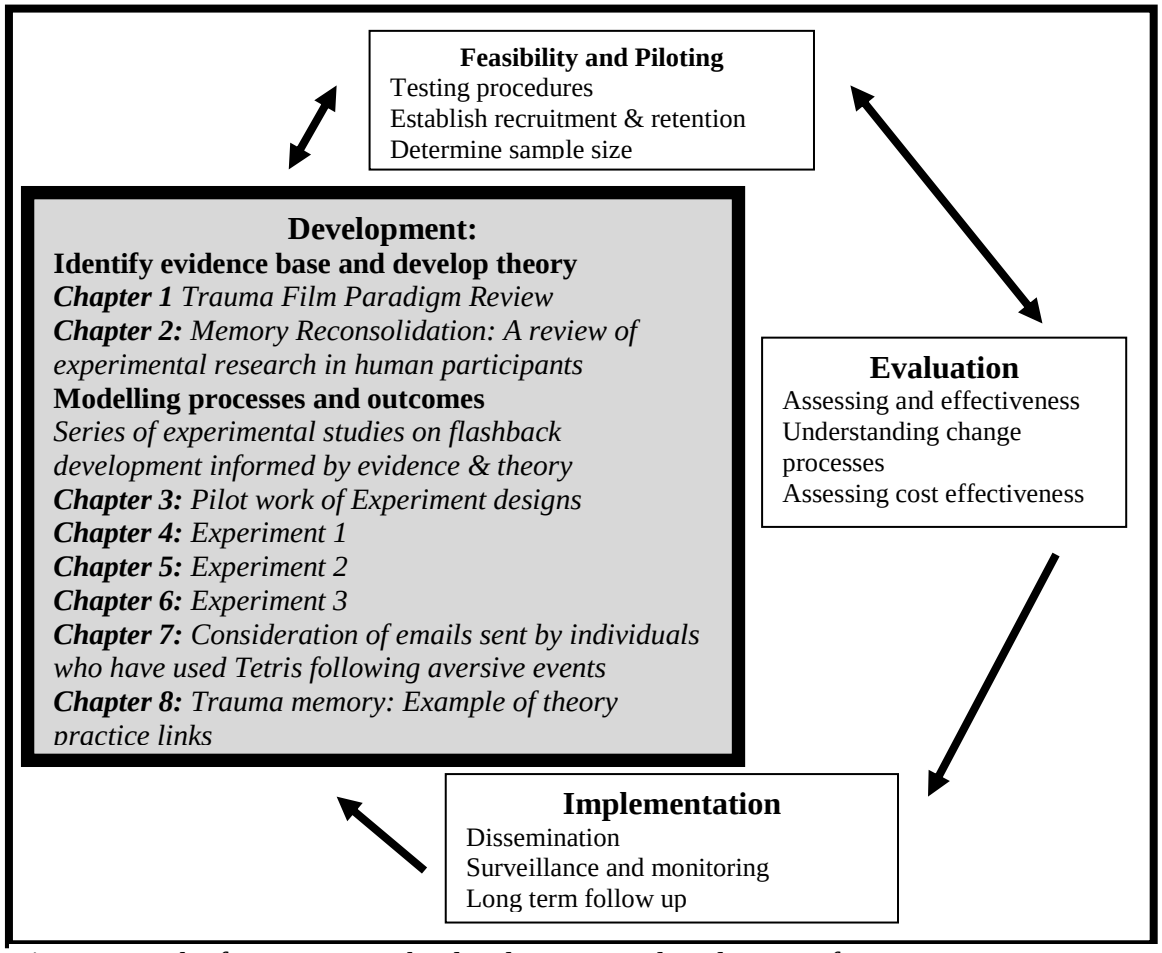


Figure 1.1. The four stages in the development and evaluation of a preventative intervention to target flashbacks in the early aftermath of trauma following MRC guidelines for the development and evaluation of complex interventions in mental health (Medical Research Council, 2008)

The Trauma Film Paradigm: A General Overview

Analogue models: Investigating flashbacks using the trauma film paradigm

One approach to developing interventions and modelling them is through analogue designs. The laboratory-based trauma film paradigm provides an experimental analogue for real-life trauma and the subsequent development of flashback memories (studies reviewed until 2008 in Holmes & Bourne, 2008). Volunteers view a film of traumatic content designed to relate to PTSD diagnostic criteria for a traumatic event, such as graphic scenes of human surgery, death and real injury (see Table 1.1, Criteria A. DSM-V; 2013). Flashbacks for the film are then monitored in the real world, typically using a simple paper and pen diary method for a period of time following film viewing. Thus, as in Figure 1.2 adapted from Holmes and colleagues (2009), participants come to the laboratory and fill in some questionnaire measures before viewing a trauma film. Tasks may be administered during or following film viewing in order to assess their impact on subsequent flashbacks, which are recorded by participants in the diary over the subsequent week. Upon return for the second laboratory session participants return their diaries and may undertake additional measures of memory for the film, e.g. recognition memory tests. The paradigm has been used since the 1960's to study psychological and physiological responses to stress (Lazarus, 1964) and has been shown to elicit a range of responses common to those experienced following actual trauma such as negative mood induction (Clark, Mackay, & Holmes, 2014), flashback development (Holmes, Brewin, & Hennessy, 2004; Holmes, James, Coode-Bate, & Deeprose, 2009), changes in heart rate, increased skin conductance (Bisby, Brewin, Leitz, & Curran, 2009; Ehring, Szeimies, & Schaffrick, 2009; Holmes et al., 2004; Lazarus, 1964; Lazarus & Alfert, 1964) and cortisol levels (Geracioti Jr et al., 2008; Henckens, Hermans, Pu, Joels, & Fernandez, 2009).

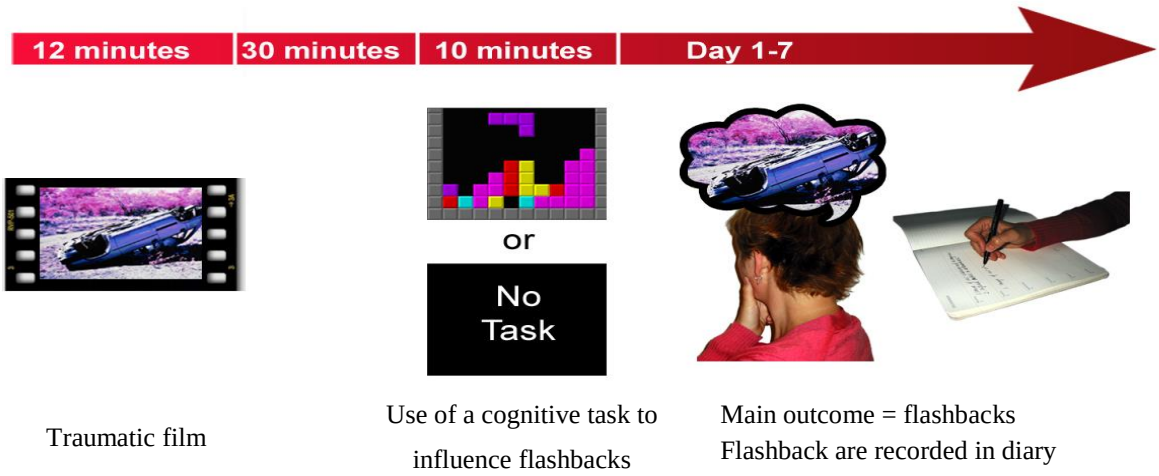


Figure 1.2. The Trauma film paradigm: Procedural overview (Holmes et al., 2009)

The trauma film paradigm and competing tasks to modulate flashbacks: Key research which led to the current thesis

The topic of this thesis is to investigate the use of a cognitive task, 'Tetris' near the time of (analogue) trauma, on the reduction of flashbacks for that trauma. It builds upon earlier studies summarised below, which have shown that competing cognitive tasks can impact on the subsequent build-up of flashbacks for trauma.

Memory-encoding: Tasks during the trauma film

Cognitive tasks completed *during* the viewing of a traumatic film can influence the development of flashback memories in healthy volunteers. Specifically, completing a visuospatial cognitive task (e.g. complex sequence tapping on a keypad held out of sight or clay modelling) has been found to reduce the number of flashbacks a person experiences in the subsequent week after film viewing (Holmes et al., 2004; Stuart, Holmes, & Brewin, 2006). Visuospatial cognitive tasks were proposed to selectively compete with cognitive resources needed to generate sensory-perceptual-based flashback memories, thus resulting in fewer flashbacks being experienced in the subsequent week following the analogue trauma. By contrast, certain verbal-based tasks (e.g. counting backwards in 7's) have *increased* flashbacks (Bourne, Frasquilho, Roth, & Holmes, 2010; Holmes et al., 2004). Although findings regarding verbal-based tasks increasing flashbacks has not consistently been found (e.g. studies have found that verbal based tasks are the same as no-task control conditions, with only one study demonstrating that a verbal-based task reduced flashbacks; Krans, Naring, & Becker, 2009) visuospatial-based task have regularly been shown to reduce flashbacks (for a review of studies up to 2008 see; Holmes & Bourne, 2008).

Memory consolidation: Tasks soon after the trauma film

Following memory acquisition the brain undergoes a time-dependent process of stabilization (a cascade of molecular processes involving protein synthesis and the development of new synaptic connections) necessary for the memory to persist, referred to as 'consolidation' (e.g. Lee, 2009). The neurobiology of memory suggests there is up to a 6 hour time-frame whilst memory consolidates, during which memory is labile and vulnerable to disruption (e.g. Nader, Schafe, & LeDoux, 2000b; Walker, Brakefield, Hobson, & Stickgold, 2003; See Chapter 2).

Playing the visuospatial computer game 'Tetris' 30 minutes after watching a traumatic film, has been found to lead to a significant reduction in flashback frequency

over one week, compared to a no-task control condition, in healthy volunteers (Holmes et al., 2009). Game play was during the postulated memory consolidation window. Convergent results of analogue symptom reduction were found using a clinical questionnaire the Impact of Event Scale - Revised (Weiss & Marmer, 1997).

Holmes and colleagues (Holmes, James, Kilford, & Deeprose, 2010) replicated these results. They further identified that a verbal-based computer game 'Pub Quiz' when played 30 minutes after an analogue trauma film lead to increased (rather than decreased) frequency of flashback memories despite being rated as equally enjoyable and challenging to play. A second experiment extended the time frame between film viewing and game play to show that the protective effects of Tetris on flashback development were still apparent when it was played 4 hours following film viewing.

Why might cognitive tasks work to reduce flashback memories?

Short term memory (often referred to as working memory; Baddeley, 1986, 1990, 2003) has been investigated using dual-task paradigms, (where individuals are required to undertake two tasks simultaneously). Findings show a deterioration in task performance for tasks undertaken simultaneously that are from the same modality-specific domain. Further, these domains (referred to as the visuospatial sketchpad and phonological loop which are governed by the central executive; Cocchini, Logie, Sala, MacPherson, & Baddeley, 2002) have been shown to have limited capacity with which to process information in that modality (Marois & Ivanoff, 2005).

Trauma film paradigm research has demonstrated that undertaking certain cognitive tasks such as the predominately visuospatial-based computer game Tetris may be preferable to other kinds of tasks (e.g. a non-visuospatial general knowledge computer game, Pub Quiz) in reducing flashbacks of an analogue trauma over the subsequent week. This can be explained using a 'modality-specific hypothesis' which proposes that these findings may be due to visuospatial-based tasks (i.e. Tetris) being capable of *specifically* competing for the brains resources necessary to generate image-based (predominately visual) flashbacks (e.g. a visuospatial tasks interferes specifically with visuospatial sub-system in working memory). Correspondingly, verbal-based task may have the opposite effect and have been shown *not* to decrease subsequent flashbacks relative to a Control condition. Although results have been mixed relating verbal-based tasks, as mentioned previously (with one study finding that verbal-tasks *decreased* flashbacks; Krans et al.,

2009) some studies have also demonstrated that verbal-based tasks may also exacerbate flashbacks (Bourne, Frasquilho, Roth & Holmes, 2010; Expt. 1; Holmes et al., 2010).

The modality-specific hypothesis is by no means conclusive. An alternative theory has been termed the 'distraction' hypotheses (Bourne et al., 2010). This suggests it is a cognitive tasks' ability to tax the central executive in working memory, rather than the modal specificity of the task, which can account for subsequent intrusion development (e.g. Krans, Naring, & Becker, 2009; Krans, Naring, Becker, & Holmes, 2009; Krans, Naring, Holmes, & Becker, 2009b). Additional research which has looked at why some tasks (e.g. Eye Movement Desensitization and Reprocessing - EMDR; Shapiro, 1996) are beneficial in reducing emotionality and vividness of negative memories have also found some support for the distraction hypothesis, in that EMDR may work to reduce symptoms of PTSD by general distraction during traumatic recall in working memory rather than via modality specific memory (Engelhard, van den Hout, & Smeets, 2011; Gunter & Bodner, 2008, 2009; van den Hout et al., 2010). However, such studies do not demonstrate conclusively that the central executive is recruited exclusively; indeed, recent research is now emerging that modality-specific sub-systems may play an additive role in reducing trauma symptoms, although the precise mechanisms behind this are still under investigation (Jeffries & Davis, 2013; Smeets, Dijs, Pervan, Engelhard, & van den Hout, 2012; van den Hout et al., 2011; van den Hout et al., 2012).

In summary, there are inconclusive findings behind whether it is the visuospatial properties of a specific task, or the general attentional demands on working memory capacity, which impact on reducing flashback development. What appears regularly throughout these studies, however, is the ability of visuospatial cognitive tasks to reduce flashback frequency following trauma. Since the use of cognitive tasks to reduce flashbacks to trauma is clinically innovative (such methods to target traumatic flashbacks are relatively new and have not been used clinically) and as the thesis has an overarching translational interest in contributing to a reduction of flashbacks after trauma, the current thesis will concentrate on investigating visuospatial tasks, in particular the computer game Tetris, within the experimental trauma film paradigm.

'Tetris' as a competing visuospatial task

A cognitive task which is to be explored within the thesis as a method for ameliorating the build-up of flashback frequency following an analogue trauma is the computer game Tetris. Tetris is a well-known, visuospatial computer game from the

1980's ("Tetris Zone," 2007). This task has been used previously within the trauma film paradigm and shown to reduce flashbacks across the week following film viewing, compared to a no-task control group and a verbal-based computer game (Holmes et al., 2009; Holmes, James, et al., 2010). Tetris game play has also been shown to reduce image-based intrusions associated with mania in an analogue experiment (Davies, Malik, Pictet, Blackwell, & Holmes, 2012). Tetris has also been shown to decrease emotionality for negative autobiographical memories when played concurrently with negative memory recall as well as reducing subsequent physical arousal, e.g. eye-blink startle responses, compared to an eye movements condition (of the kind used in EMDR) and eye fixation condition (Engelhard, van Uijen, & van den Hout, 2010).

The precise underlying mechanisms by which the Tetris game play may result in reduction in flashbacks and associated trauma responses (e.g. negative affect) are not known. Functional neuroimaging has been used to observe brain activation during Tetris game play and noted Blood Oxygen Level Dependent (BOLD) signal increases in the occipito-parietal cortex (Haier, Karama, Leyba, & Jung, 2009; Haier et al., 1992; Price, Paul, Schneider, & Siegle, 2012), consistent with visuospatial task completion (Shokri-Kojori, Motes, Rypma, & Krawczyk, 2012), and visual areas of the brain (Culham & Kanwisher, 2001), lending support to the competing resources hypothesis. Further, playing Tetris for sustained periods of time has been shown to result in hypnagogic images (spontaneous mental representations which typically take the form of recently seen objects) at sleep onset both during daytime napping (Kusse, Shaffii-Le Bourdiec, Schrouff, Matarazzo, & Maquet, 2012) or regular night time sleep (Stickgold, Malia, Maguire, Roddenbury, & O'Connor, 2000). Moreover, it was also shown that Tetris-themed memory traces interacted with remote autobiographical memories which were not of Tetris (Stickgold et al., 2000).

Additional research indicates that Tetris game play was associated with inhibited activity in the amygdala relative to a 'fixation' condition (Price et al., 2012). The amygdala is implicated in the processing of emotions and memory (Phelps, 2004) with decreased activation in this area being associated with a down regulation or decrease in negative emotion in memory (Ochsner et al., 2004. The hippocampus is implicated in the retrieval of episodic memories (Eldridge, Knowlton, Furmanski, Bookheimer & Engel, 2000). Thus, it is possible that the benefits of playing the game Tetris may also be derived through Tetris' influence on inhibiting amygdala activity (Price et al., 2012) as memories for emotional events are known to be enhanced due to the impact of the amygdala on the

storage site of episodic memories - the hippocampus (Phelps 2004). Further the two memory systems (i.e. the hippocampus and amygdala) can be independent of each other (LeBar & Phelps, 2005; Phelps, 2004), so it may be that Tetris specifically targets the fear memory leaving episodic memory intact. Taken together it may be speculated that the potential avenues through which Tetris modulates flashbacks and reduces emotionality for negative memories may be complex and varied. For example, it might be that Tetris works by competing with resources in brain regions associated with visual representation (described earlier). Furthermore this may be facilitated during sleep (a process known to influence the organisation and strengthening of memories; Walker, 2009; Walker et al., 2003; Walker & Stickgold, 2004). To summarise, a full account of the possible underlying mechanisms by which Tetris game play derives its effects are not within the remit of the current thesis; however, the replicated effect of Tetris on dampening down the build-up of flashback memories to analogue trauma makes it a promising focus for investigation

As such, behavioural studies using Tetris games will be used to extend earlier research (e.g. Holmes et al., 2009; Holmes et al., 2010) and further inform the design of a potential treatment intervention to reduce flashbacks. Research on this area is still in the early stages; thus, a laboratory-based approach, using the trauma film paradigm, will be the chosen method for investigating the effects of Tetris on flashback reduction. In order to inform the studies within this thesis, a review of recent literature which uses the trauma film paradigm was undertaken. This was in order to inform experimental design, as well as isolating areas for development and extension within the trauma film paradigm.

The Trauma Film Paradigm: A Literature Review Since 2008

A current review of the published literature using the trauma film paradigm was conducted in order to inform study design within the thesis. The paradigm has been reviewed previously in a published article from 2008; '*Inducing and Modulating Intrusive Emotional Memories: A Review of the Trauma Film Paradigm*' (Holmes & Bourne, 2008) therefore the current literature search only included studies which had used the trauma film paradigm design since the earlier review.

Literature search strategy

Scopus, PubMed and Web of Knowledge data bases were searched from 2007 through to January 2013 using the search terms, "trauma* film" OR "stress* film" and

"trauma* video" OR "stress* video". Results were further refined by excluding the subject areas of physics, material science and engineering. Titles and Abstracts were used to screen suitable articles for inclusion. References dated between 2007 and 2008 were checked against the previous literature review by Holmes and Bourne (2008) and were excluded if they had previously been included. Forty articles were identified as suitable for inclusion.

In addition, the literature search included 'Citation Alerts' (received since 2010) from Scopus and Web of Knowledge for the Holmes and Bourne (2008) review article. A further 3 articles were identified for inclusion using this method.

Literature search results (2008-2013)

A total of 43 journal articles were included in the review, yielding a total of 50 experiments. For clarity within the thesis, these have been separated into three broad categories. First, those which have used 'low intensity' approaches such as simple competing tasks to modify response to the trauma film (see Table 1.2 for 'at a glance' summary and Table 1.5 for full experimental details; eighteen experiments); Second, experiments which have used higher intensity approaches (e.g. those which necessitate more face-to-face time between experimenter and participant to complete and require more guided experimental procedures) such as Cognitive Bias Modification (CBM) to modify responses to trauma (see Table 1.3 for 'at a glance' summary and Table 1.6 for full experimental details; fifteen experiments). The final broad category reviewed prospective designs using the trauma film paradigm (see table 1.4 for 'at a glance' summary and Table 1.7 for full experimental details; seventeen experiments).

Tables 1.2 through to 1.4 provide a brief overview of the three broad categories of experiments in relation to intrusion methodology (Table 1.2 relates to low intensity approaches to modify response to trauma; Table 1.3 higher intensity approaches, and Table 1.4 prospective designs). Tables 1.2, 1.3 and 1.4 correspond to Tables 1.5, 1.6 and 1.7, respectively; however, rather than providing experimental details, they give 'at a glance' information on the following: whether intrusions were an outcome and, if so, the method of measurement (e.g. via a Diary, the Impact of Event Scale, within laboratory-based monitoring techniques or others), as well as the duration between film viewing and 'intervention' (e.g. the method used to investigate modulating intrusions). Studies are provided in reverse chronological order identical to that in Tables 1.5 through 1.7.

Tables 1.5 through to 1.7 also correspond to the broad categories outlined previously and provide detailed information on each of the 50 experiments. Experiments in these tables are listed in reverse chronological order by publication date. Abbreviations are defined in the notes at the end of each corresponding table. For clarity, main independent variables (IV) and dependent variables (DV) are formatted in bold font. Tables 1.5 and 1.7 contain six columns with the following information from left to right: 1) 'Research group'; 2) 'Design'- this includes the number of participants (per group where available), the experimental design and the duration of the trauma film; 3) 'independent variable' - this column includes IV name as provided by the original study (typically in an abbreviated form) and its composition; 4) 'IV details' - provides information of when during the experimental procedure the IV was administered and its duration; 5) 'dependent variable'- provides details of the DV (listed in bold font). Where intrusions are listed, additional information on how they were quantified is provided underneath in underlined text (e.g. frequency or distress). The time-frame over which the DV is measured is provided in italics (e.g. *Days 1 to 7)* followed by the method of measurement (e.g. diary method). Finally, column 6) 'Result(s)' provides a summary of the main findings for each experiment. Table 1.7 details prospective designs using the trauma film paradigm and follows an identical format to Tables 1.6 and 1.5 minus the fourth column, 'IV details', as there is no manipulation as such to be expanded upon. Only results pertaining to the main hypotheses are reported (i.e. subsequent supplementary or exploratory analyses are not included). Reported differences are significant unless stated otherwise e.g. where there are no significant group differences.

Studies which use the trauma film paradigm to study intrusions: An overview

Notably, 42 out of the 50 experiments reviewed had intrusions as their main outcome measure. The term 'intrusion' was defined within the articles as being 'involuntary' (spontaneously occurring) and of content from the analogue trauma film. Intrusions took several forms (specific, detailed information is provided for each experiment in Tables 1.5 through 1.7). Image-based intrusions, (that which the thesis terms 'flashbacks'), were investigated in 19 of the 42 experiments (45%) and were characterised as being sensory-based. Experiments which investigated purely verbal, thought-based intrusions were less common (5 out of 42, or 12 %). Experiments captured in the review have also explored the occurrence of intrusive images and thoughts in combined analysis (9 out of 42, or 21%) as well as being analysed separately (2 out of 42, or 4.8%). Seven out

of the 42 experiments (16.7%) did not explicitly define what form intrusions in their study took. For clarity, within this review only, the term image-based intrusions will be used rather than 'flashbacks' in keeping with the terminology used predominately within the reviewed literature.

Intrusions have largely been studied in terms of their frequency (41 out of the 42 experiments, see Tables 1.2 to 1.4) – that is, how often they are experienced across a discrete duration of time. In the current review 33 experiments achieved this by using a diary methodology. The diary method for capturing intrusions requires participants to note down every time they experience an involuntary intrusion of the analogue trauma in a simple, paper tabular diary which can be taken away from the laboratory. Intrusions can thus be documented over longer periods of time, e.g. within the review durations spanned from between 2 to 7 days. Diaries are typically of the pen and paper variety; however one study within the review used an electronic diary format, via the internet, to capture intrusions (Bisby et al., 2009). Nineteen experiments exclusively used diaries to capture intrusion frequency; with the remaining using the diary method in combination with an alternative and convergent method of measuring intrusion frequency. One such technique was laboratory-based intrusion 'monitoring' – a method that was originally pioneered in the 1960's (e.g. Horowitz, 1969). Intrusion monitoring in the current body of work typically lasted for brief periods of time, between 2 min and 5 min, during which time participants indicated every time they experienced an intrusion, i.e. by pressing a button or lifting a finger. Intrusion frequency monitoring occurred shortly after trauma film viewing, or following a brief reminder of the film at a laboratory based follow up in most cases.

Intrusion frequency rates were also assessed using various self-report questionnaire methods, e.g. the Impact of Event scale (Horowitz, Wilner, & Alvarez, 1979; Weiss & Marmer, 1997), Intrusion Questionnaire (Michael, Ehlers, Halligan, & Clark, 2005) or Trauma Memory Questionnaire (Halligan, Michael, Clark, & Ehlers, 2003) etc. Over half the studies (23 out of 42) which had intrusion frequency as an outcome variable favoured a combined approach of using multiple methods to capture intrusion frequency and their characteristics allowing for the testing of convergent results.

Table 1.2. *Summary of Experimental Methods Relating to the Study of Intrusions in Experiments Using Competing Cognitive Tasks to Modify Response to Trauma*

		Method of Intrusion Measurement							
	Reference [reverse chronological order]	Intrusions	Frequency	Diary	IES (R)	Lab-induced monitoring	Other measures	Details of other measures	Duration between film and 'intervention'
1	Krans, Janecko & Bos, 2013	✔	✔		✔		✔	IQ	12 min post
2	Marks et al, 2012	✔	✔	✔		✔	✔	TMQ	Concurrent
3	Logan & O'Kearney, 2012	✔	✔	✔	✔			-	Concurrent
4	Deeprose et al, 2012; Expt 1	✔	✔	✔				-	Immediately post
5	Deeprose et al, 2012; Expt 2	✔	✔	✔				-	30 min post
6	Bourne et al, 2010; Expt 1	✔	✔	✔				-	Concurrent
7	Bourne et al, 2010; Expt 2	✔	✔	✔				-	Concurrent
8	Krans, Naring, Holmes & Becker, 2010	✔	✔	✔				-	Concurrent
9	Hagenaars et al, 2010; Expt 1	✔	✔	✔				-	Concurrent
10	Holmes et al, 2010; Expt 1	✔	✔	✔		✔		-	30 min post
11	Holmes et al, 2010; Expt 2	✔	✔	✔				-	4 hours post
12	Krans, Naring & Becker, 2009	✔	✔	✔				-	Concurrent
13	Holmes et al, 2009	✔	✔	✔	✔			-	30 min post
14	Krans, Naring, Holmes & Becker, 2009	✔	✔	✔				-	Immediately post
15	Nixon et al, 2009 b	✔	✔	✔		✔		-	Immediately post
16	Nixon et al, 2009 a	✔	✔	✔		✔		-	Immediately post
17	Bisby et al, 2009	✔	✔	✔				-	40 min prior
18	Nixon et al, 2007	✔	✔		✔	✔		-	Concurrent
	Total	18/18	18/18	16/18	4/18	5/18	2/18		

Note. IES – (R) = Impact of Event Scale - (Revised); IQ = Intrusion Questionnaire (Hackmann et al., 2004; Michael et al., 2005); TMQ = Trauma Memory Questionnaire (Halligan et al., 2003)

Table 1.3. *Summary of Experimental Methods Relating to the Study of Intrusions in Experiments Targeting Cognitions and Processing Styles to Modify Response to Trauma*

		Method of Intrusion Measurement							
	Reference [reverse chronological order]	Intrusion	Frequency	Diary	IES (R)	Lab-induced monitoring	Other measures of intrusion measurement	Details of other measures	Duration between film and 'intervention'
1	Woud et al, in press	✔	✔	✔				-	Immediately prior
2	Woud et al, 2012	✔	✔	✔	✔	✔		-	Immediately post
3	Hagenaars & Artnz, 2012	✔	✔	✔				-	30 min post
4	Verwoerd et al, 2012	✔	✔	✔			✔	-	Immediately post
5	Pearson et al, 2012	✔	✔	✔				-	Concurrent
6	Varker & Devilly, 2012							-	1 week prior
7	Brown et al, 2012	✔	✔			✔		R-SR	Immediately prior
8	Lester et al, 2011								10 min prior
9	Buck, Kindt & van den Hout, 2009	✔	✔				✔	VAS	45 min prior
10	Shartau, Dalgleish & Dunn, 2009 Expt. 1							-	Concurrent
11	Shartau, Dalgleish & Dunn, 2009 Expt. 2							-	Immediately post
12	Shartau, Dalgleish & Dunn, 2009 Expt. 3							-	Immediately post
13	Zetsche et al, 2009	✔	✔			✔	✔	IMQ	2 min post
14	Ehring et al, 2009	✔	✔				✔	IQ	Immediately post
15	Devilly & Annab, 2008							-	Immediately post
	Total	9/15	9/15	5/15	1/15	3/15	4/15	-	

Note. IMQ = Intrusive Memory Questionnaire (Michael & Ehlers, 2007); IQ = Intrusion Questionnaire (Hackmann et al., 2004; Michael et al., 2005); R-SR = Retrospective Self-Report; VAS = Visual Analogue Scale

Table 1.4. *Summary of Experimental Methods Relating to the Study of Intrusions in Prospective Experimental Designs*

		Method of Intrusion Measurement							
	Reference [reverse chronological order]	Intrusion	Frequency	Diary	IES (R)	Lab-induced monitoring	Other methods of intrusion measurement	Details of other measures	Duration between film and 'intervention'
1	Bourne et al, 2013	✔		✔					--
2	Laposa & Rector, 2012	✔	✔	✔	✔				--
3	Meyer et al, 2012	✔	✔	✔	✔		✔	PSS-SR	--
4	Bomyea & Amir, 2011	✔	✔			✔			--
5	Hagenaars & Putman, 2011	✔	✔	✔					--
6	Hagenaars & Krans, 2011	✔	✔	✔	✔				--
7	Krans, Naring, Speckens & Becker, 2011	✔	✔	✔					--
8	Verwoerd et al, 2011	✔	✔	✔			✔	IMS	--
9	Renner & Beversdorf, 2010								--
10	Wiksch & Nixon, 2010	✔	✔	✔		✔			--
11	Wessel et al, 2010	✔	✔			✔			--
12	Hagenaars et al, 2010; Expt 2	✔	✔	✔					--
13	Faree & Carhill, 2009	✔	✔				✔	Retrospective SR	--
14	Laposa & Alden, 2008	✔	✔	✔	✔				--
15	Geratcioti Jr. et al, 2008								--
16	Wessel et al, 2008	✔	✔	✔					
17	Wessel et al, 2008	✔	✔	✔					
	Total	15/17	14/17	12/17	4/17	3/17	4/15		

Note. PSS-SR = PTSD Symptom Scale-Self Report; IMS = Impact of Movie Scale (an adapted version of the Impact of Event Scale); SR = Self report

Studies which have used competing tasks to modulate intrusive memories (2008-2013)

The following section reviews experiments which have used relatively simple, 'low-intensity' methods, such as competing cognitive tasks, to modify intrusion development (See Table 1.5 for full experimental details), rather than the more elaborate 'high intensity' methods covered in in Table 1.6. All 18 of the studies in this section had intrusions as their DV, unlike the other two broad categories. This section includes a series of studies in which I have previously been involved[1], and upon which the work presented within this thesis is developed, as described earlier in the thesis (Holmes et al., 2009;. Holmes, James, et al., 2010).

Experiments that have used cognitive tasks to test the modulation of intrusion frequency provide evidence of the differential effects of various types of competing task. Furthermore, it is possible to observe a distinction between tasks which are largely visuospatial-based versus those which are largely verbal-based (see Table 1.5, column 2 for precise descriptions of tasks which fit these distinctions) both of which are summarised below in relation to tasks performed concurrently (memory encoding) or following trauma film viewing.

Memory-encoding: Tasks during a trauma film

Eight experiments which used competing tasks to modulate intrusions investigated their effect whilst undertaken simultaneously with traumatic film viewing. Findings demonstrated a consistent effect of visuospatial type tasks on reducing intrusions. Tasks included clay modelling (following which intrusions were reduced the subsequent 24 hr. period post film viewing compared to a verbal-based and no-task condition; Logan & O'Kearney, 2012) and complex pattern sequence tapping (Expt. 1; Bourne et al., 2010; Expt. 1; Deeprose, Zhang, Dejong, Dalgleish, & Holmes, 2012; Krans, Naring, Holmes, & Becker, 2010). There was only one instance, contrary to predictions, where a complex pattern sequence tapping task was comparable to a no-task control group on intrusions frequency, with the authors suggesting that the use of a prohibitively difficult visuospatial tapping task may have accounted for findings (Marks, Steel, & Peters, 2012).

In contrast, verbal-based tasks undertaken concurrently with film viewing were much less likely to result in a reduction in intrusion frequency, with only one study finding this (Krans, Naring, & Becker, 2009). Indeed, several studies demonstrated that not only

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did practicing a verbal-based task whilst viewing aversive film material result in comparable numbers of intrusions compared to a no-task control, in some instances it could even exacerbate flashback frequency. For example, concurrent verbal tasks such as counting backwards in 3's (Logan & O'Kearney, 2012; Expt. 1; Bourne et al., 2010; Expt. 1; Deeprose et al. 2012) was comparable to a no-task control, whereas counting backwards in 7's had a deleterious effect and increased intrusions across the week (Expt. 2; Bourne et al., 2010). This effect was also demonstrated in research whereupon participants were asked to hold a predetermined 9 digit number in mind (termed a Verbal Cognitive Load (VCL) task by the authors; Nixon, Nehmy, & Seymour, 2007), resulting in a greater number of intrusions in a post-film intrusion monitoring task as well as higher scores at one week on the hyperarousal component of Impact of Event Scale-Revised (Weiss & Marmer, 1997).

Alternative explanations for a cognitive tasks' ability to modulate intrusion frequency was investigated in one study which sought to test whether the slight physical movement associated with completing a task is a causal factor behind findings. Most tasks involve slight physical movements (for example, clay modelling involves spatial hand movements as does tapping sequences), thus an experiment by Krans and colleagues (2010) sought to test the impact of a configural movement task (CMT; chewing gum in a specific way thought to employ spatial orientation resources) on intrusion frequency. Participants in the CMT group experienced more intrusions than a visuospatial tapping group, which was interpreted as spatial movement not being a reasonable account for why certain types of tasks lead to a reduction in intrusions (Krans et al., 2010). In contrast, the effect of full-body deliberate non-movement (where participants are told that they must not move) and experimenter-induced dissociation on intrusion frequency was also investigated, to assess the impact of movement (or not) on intrusion development (Expt.1; Hagenaars, Brewin, van Minnen, Holmes, & Hoogduin, 2010). Results indicated that non-movement during traumatic film viewing, either self-imposed by the participant (DEL-NM) or induced as a dissociative state by the experimenter (DISS-NM) had a negative impact on subsequent reactions and resulted in an increase in intrusive thoughts and images, compared to being able to watch the film normally (Hagenaars et al., 2010).

Memory consolidation: Tasks soon after a trauma film

Of the studies that explored the effect of simple tasks following film viewing on intrusion development three were administered the task immediately post-film. One such

study involved giving a simple recognition memory test for the trauma film post-film. The effect resulted in those participants given a memory test (compared to a no-memory test control) experiencing less intrusions in the subsequent week (Krans, Naring, et al., 2009b). This appears to parallel research which found that a lower score on a recognition memory test for a trauma film was associated with a *greater* number of intrusions across the week (Expt.2; Bourne et al., 2010). The finding by Bourne et al., (2010) suggests that diminishing or 'erasing' the episodic memory of trauma in its entirety, i.e. memory for facts and events about the trauma that can be intentionally retrieved, may not be a useful technique in the pursuit of reducing intrusive memories of the trauma that pop to mind unintentionally. In essence the removal of an episodic memory for a traumatic event in its entirety could be potentially damaging for a number of reasons (by increasing levels of emotional distress, making proceedings in a court of law problematic etc. Holmes, Sandberg, & Iyadurai, 2010). Rather we would seek to remove the emotional elements associated with a trauma memory. Studies may find it useful to measure intentionally retrievable episodic memory for analogue trauma in assessing the impact of simple tasks on flashback development to ensure that tasks do not impact on this and unintentionally provoke intrusive symptoms.

Nixon and colleagues (Nixon, Cain, Nehmy, & Seymour, 2009a, 2009b) investigated the effect of verbal and visual cognitive load on suppression and its impact on intrusion development post trauma. This was an extension of previous research which had used the tasks concurrently with film viewing. In one experiment the authors compared Verbal Cognitive Load (VCL), e.g. holding a list of 9 digits in mind, VCL with suppression and suppression only, and found that VCL with suppression resulted in more intrusions in the subsequent week relative to the other conditions. This finding was taken to suggest that cognitive load was able to eliminate any short-term beneficial effects that suppression may confer on reducing subsequent intrusions following a trauma (Nixon et al., 2009b). However, a second experiment failed to replicate these findings (Nixon et al., 2009a).

Poor integration and organisation of trauma into autobiographical memory is believed to impact on intrusive memory symptoms (Ehlers & Clark, 2000; Ehlers, Hackmann, & Michael, 2004; Halligan et al., 2003). Unconscious thought (UT) has been hypothesised to facilitate memory organisation, thus leading to fewer intrusions. This prediction was tested by Krans et al., (2013) in an experiment where UT was operationalized by completion of a 2-back task (a task in which participants are presented

with a series of stimuli and they have to indicate when there is a match with the current stimulus and that 2 previously). In addition to the UT task, participants in this condition were instructed that there would be a memory test for the trauma film afterward. This was in contrast to conditions where participants were asked to deliberately think about the film (CT; conscious thought) and mere distraction (MD; 2-back task with *no* mention of a memory test). Those in the UT had reduced intrusions on the Impact of Event Scale (Horowitz et al., 1979) compared with the other conditions (Krans, Janecko, & Bos, 2013). Both UT and CT conditions used the same task, with the only difference being the omission of informing participants there was going to be a memory test in the CT condition. It is inferred that the UT condition facilitated memory integration resulting in fewer intrusions, however it might also be inferred that those in the UT condition kept the film in mind to a greater extent than the CT condition, resulting in the 2-back task being able to successfully compete for resources necessary for intrusion of the film to develop.

A small number of studies have focused on extending the time frame between film viewing and administering a task to modulate flashbacks. Such studies have demonstrated the impact of visuospatial tasks on reducing image intrusions (i.e. specifically flashbacks) when played at 30 minutes post film, both with a laboratory visuospatial task such as concealed complex visuospatial pattern tapping (Deeprose et al., 2012) as well as widely-available 'ecological tasks' such as playing the computer game Tetris (Expt. 1; Holmes et al., 2009; Holmes, James, et al., 2010). Research went further to demonstrate effects of Tetris on reducing image-based intrusions from 30 minutes up to 4 hours post film (Expt. 2; Holmes, James, et al., 2010). Thus, 4 hours marks the greatest length of time that has been tested between film viewing and using a cognitive task *after* film viewing.

One study also tested the application of a 'task' *before* film viewing. In particular the study explored the impact of alcohol on intrusion development following traumatic film viewing (Bisby et al., 2009). A high-dose versus low-dose of alcohol was compared to a placebo control. Over the course of a week, electronic diaries demonstrated that those who had the low dose of alcohol had more intrusions of the film than the high dose and placebo control, whereas those who were given the high dose had fewer intrusions than those given a placebo. Memory tests at follow up indicated that findings were likely due to the high-dose group having significantly poorer scores on a recognition memory test for the film at one week. Thus in this instance recognition memory for the film appeared congruent with intrusive memory frequency (e.g. poorer scores on the recognition memory tests were associated with fewer intrusions, as opposed to Bourne et.al., 2010 discussed

previously who found that poorer recognition memory scores were associated with a greater number of intrusions). Findings from Bisby et al., (2009) are congruent with a loss of immediate and short term memory as a consequence of alcohol consumption (Ryback, 1971).

Table 1.5. *Experimental Details of Studies that use Competing Tasks to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
(Krans et al., 2013)	*N*=78 3 condition, between-groups; Film duration: 8.45min	**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 12min post-film for a 4min duration	**Intrusive images:-** Frequency *Day 1*: IES Intrusions subscale score Characteristics *Day 1*: IQ: vividness, arousal & 'nowness' scores **Memory for analogue trauma:-** *Day 1*: Sequential memory recall test score	**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:* Memory test score UT = CT and MD
(Marks et al., 2012)	*N*=49 Mixed design; 2 condition (LS vs. AE) within group (VST vs. NT Control) LS: *n*=26 AE: *n*=23	**VST =** complex sequence tapping on keypad held out of sight **NT** Trait measures: High vs. low schizotypal traits **LS** **AE**	Manipulation administered concurrently with film (2 different films at 5 ½ min each)	**Intrusive thoughts and images:-** 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 thoughts and images** Frequency *Day 1:* 4 min monitoring AE > LS *Day 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

Table 1.5. *Experimental Details of Studies that use Competing Tasks to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
(Logan & O'Kearney, 2012)	*N*=105 3 condition between groups; Film duration: 9min	**VIT =** counting backwards in 3's **SIT =** clay modelling geometric shapes **NT**	Manipulation administered concurrently with film for 9min duration	**Intrusive images:-** Frequency *Day 1 over 24hr*: Diary method *Days 1 to 7*: Diary method *Day 7:* IES Intrusions subscale score	**Intrusive images** Frequency *Day 1 over 24hr:* Diary VIT = NT / SIT< NT *Day 1-7:* Diary VIT = NT / SIT=NT *Day 7:* IES-I score VIT = NT/ SIT = NT
(Deeprose et al., 2012)	**Expt. 1.** *N*=60 3 condition between groups; *n*=20 per group Film duration: 12min **Expt. 2.** *N*=75 3 condition between groups; Film duration: 22min	**Expt. 1.** **VIT** = counting backwards in 3's; **VST =** complex sequence tapping on keypad held out of sight **NT** **Expt. 2.** **VIT** = counting backwards in 7's; **VST =** complex sequence tapping on keypad held out of sight **NT**	**Expt. 1.** Manipulation administered immediately post-film for 10min duration **Expt. 2.** Manipulation administered 30min post- film	**Expt. 1.** **Intrusive images:-** Frequency *Days 1 to 7*: Diary method **Expt. 2.** **Intrusive images:-** Frequency *Days 1 to 7*: Diary method **Memory for analogue trauma:-** *Day 7*: Recognition memory test score	**Expt. 1.** **Intrusive images** Frequency *Days 1 to 7*: Diary VST < NT and VIT VIT=NT **Expt. 2.** **Intrusive images** Frequency *Days 1 to 7*: Diary VST < NT and VIT VIT=NT **Memory for analogue trauma:-** *Day 7*: memory score No group differences
(Bourne et al., 2010)	**Expt. 1.** **Intrusive images** Frequency	**Expt. 1.** **VIT** = counting backwards in 3's; **VST =** complex sequence	**Expt. 1.** Manipulation administered concurrently	**Expt. 1.** **Intrusive images:-** Frequency *Days 1 to 7*:	**Expt. 1.** **Intrusive images** Frequency *Days 1 to 7*: Diary

Table 1.5. *Experimental Details of Studies that use Competing Tasks to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
	Days 1 to 7: Diary VST < NT and VIT; VIT = NT	tapping on keypad held out of sight	with film for 13min duration	Diary method	VST < NT and VIT; VIT = NT
	Expt. 2. **Intrusive images** Frequency *Days 1 to 7*: Diary VIT > NT **Memory for analogue trauma:-** *Day 7*: memory score VIT < NT	**Expt. 2.** **VIT**= counting backwards in 7's **NT**	**Expt. 2.** Manipulation administered concurrently with film for 21 min duration	**Expt. 2.** **Intrusive images:-** Frequency *Days 1 to 7*: Diary method **Memory for analogue trauma:-** *Day 7*: Recognition memory test score	**Expt. 2.** **Intrusive images** Frequency *Days 1 to 7*: Diary VIT > NT **Memory for analogue trauma:-** *Day 7*: memory score VIT < NT
(Krans et al., 2010)	**Intrusive thoughts and images** Frequency *Days 1 to 7*: Diary VST < NT and CMT CMT = NT	**VST =** complex sequence tapping on keypad held out of sight **CMT**= chewing gum in specific configurations **NT**	Manipulation administered concurrently with film	**Intrusive images and thoughts:-** Frequency *Days 1 to 7*: Diary method	**Intrusive thoughts and images** Frequency *Days 1 to 7*: Diary VST < NT and CMT CMT = NT

Table 1.5. *Experimental Details of Studies that use Competing Tasks to Modify Response(s) to Analogue Trauma*

Research Group	**Design**	**Independent Variable(s)**	**IV Details**	**Dependent Variable(s)**	**Result(s)**
(Hagenaars et al., 2010) Expt. 1 of 2: (See Table 4 for Expt.2)	*N*=79 3 condition between groups; DEL-NM: *n*=25 DISS-NM: *n*=27 FM: *n*= 27 Film duration: 10min	**DEL-NM**= Deliberate non-movement **DISS-NM**= Dissociative non-movement **FM**=Free Movement	Manipulation administered concurrently with film for 10min duration	**Intrusive images and thoughts:-** Frequency *Days 1 to 7*: Diary method	**Intrusive images** frequency *Days 1 to 7*: Diary DEL-NM > FM DISS-NM > FM DEL-NM = DISS-NM **Intrusive thoughts** Frequency *Days 1 to 7*: Diary DEL-NM and DISS-NM: Images > thoughts FM: images = thoughts
				Peri-traumatic emotion:- *Day 1:* Self-report Anxiety, Horror, Anger & Sadness	**Peri-traumatic emotion** *Day 1:* No between group differences. Greater levels of Anxiety, Horror, Anger correlate with greater numbers of image intrusions
(Holmes, James, et al., 2010)	**Expt. 1.** *N*=60 3 condition between groups; *n*=20 per group Film duration: 21min **Expt. 2.** *N*=72 3 condition between groups *n*=24 per group;	**Expt. 1 and Expt. 2** **VST**= Tetris computer game **VIT**=Pub Quiz computer game **NT**	**Expt. 1.** Manipulation administered 30min post-film for 10min duration. **Expt. 2.** Manipulation administered 4	**Expt. 1.** **Intrusive images:-** Frequency *Days 1 to 7*: Diary method **Expt. 2.** **Intrusive images:-** Frequency	**Expt. 1.** **Intrusive images** Frequency *Days 1 to 7*: Diary VST< NT and VIT VIT>NT **Expt. 2.** **Intrusive images** Frequency

Table 1.5. *Experimental Details of Studies that use Competing Tasks to Modify Response(s) to Analogue Trauma*

Research Group	**Design**	**Independent Variable(s)**	**IV Details**	**Dependent Variable(s)**	**Result(s)**
	Film duration: 12min		hr. post-film for 10 min duration.	*Days 1 to 7*: Diary method	*Days 1 to 7*: Diary VST< NT and VIT VIT = NT
(Krans, Naring, & Becker, 2009)	*N*=57; Within-groups	**RMT** = Memory test performance for sections of film **No-RMT** = Sections of the film for which there was no RMT	Manipulation administered immediately post-film	**Intrusive images:-** Frequency *Days 1 to 7*: Diary method	**Intrusive images** Frequency *Days 1 to 7*: Diary RMT < no-RMT
(Holmes et al., 2009)	*N*=40 2 condition, between groups; *n*=20 per group Film duration: 12min	**VST** = Tetris computer game **NT**	Manipulation administered 30min post-film for 10min duration	**Intrusive images:-** Frequency *Days 1 to 7*: Diary method *Day 7:* IES Intrusions subscale score	**Intrusive images** Frequency *Days 1 to 7*: Diary VST< NT *Day 7:* IES score VST< NT
(Krans, Naring, & Becker, 2009)	*N*=76; Within-groups Film duration: 6min 48sec	**VIT** = counting backwards in 3's **VET**=verbalise emotion and sensory experience of film **NT**	Manipulation administered concurrently with film	**Intrusive memories:-** Frequency *Days 1 to 7*: Diary method **Memory for analogue trauma:-** *Day 7*: Cued recall memory test score Recognition memory score	**Intrusive memories:-** Frequency *Days 1 to 7*: Diary VET = NT VIT < NT (trend level) VET = VIT **Memory for analogue trauma:-** *Day 7*: Memory test score Cued recall memory test score VIT<VET and NT Recognition memory score No group differences

Table 1.5. *Experimental Details of Studies that use Competing Tasks to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
(Nixon et al., 2009b)	*N*=80 4 condition, between groups; *n*=20 per group Film duration: 5min	**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	Manipulation administered immediately post-film for 5min duration (concurrently with intrusion monitoring on Day 1)	**Intrusive thoughts:-** Frequency *Day 1:* 5min monitoring *Days 1 to 7*: Diary method *Day 7*: 5min monitoring	**Intrusive thoughts** Frequency *Days 1:* 5min monitoring No group difference *Days 1 to 7*: Diary VCL&S > VCL, S and NT *Day 7:* 5min monitoring No group difference *Day1 compared to Day7* Day1 > Day 7
				Implicit memory for analogue trauma:- *Day 1:* DPT performance WST performance	**Implicit memory for analogue trauma** *Day 1:* DPT performance No group difference WST performance VCL&S > VCL, S and NT
(Nixon et al., 2009a)	*N*=210 5 condition, between groups; *n*=20 per group Film duration: 5min	**VCL&S** = Nixon et al 2009a **HVPT&S** = break every 2sec (HPT) & suppress film (S) **BRT&S** = pattern sequence tapping on keypad (BRT) & suppress (S) **S**= Nixon et al 2009a **NT**	Manipulation administered immediately post-film for a 5min duration (concurrently with intrusion monitoring on Day 1)	**Intrusive thoughts:-** Frequency *Day 1:* 5min monitoring *Days 1 to 7*: Diary method *Day 7*: 5min monitoring	**Intrusive thoughts** Frequency *Day 1*: 5min monitoring No group difference *Days 1 to 7*: Diary No group difference *Day 7:* 5min monitoring No group difference

Table 1.5. *Experimental Details of Studies that use Competing Tasks to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
(Bisby et al., 2009)	*N*=48 3 condition, between groups; *n*=16 per group Film duration: 12.5min	**Low Dose** 0.04 g/kg alcohol **High Dose** 0.08 g/kg alcohol **Placebo control**	Manipulation administered 40 min prior to film; 30min alcohol consumption followed by 10min break	**Intrusive images:-** Frequency *Days 1 to 7*: Electronic diary method **Physiological response:-** *Day 1:* SCR **Memory for analogue trauma:-** *Day 7:* Cued recall memory test score	**Intrusive images** Frequency *Days 1 to 7*: Diary 0.04 g/kg > 0.08 g/kg 0.04 g/kg > placebo 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 test score Placebo > 0.08 g/kg 0.04g/kg > 0.08 g/kg Placebo = 0.04g/kg
(Nixon et al., 2007)	*N*=65 3 condition, between groups; VCL: *n*=22 HVPT: *n*=22 NT: *n*=21 Film duration: 5min	**VCL** Hold 9-digit number in mind **HVPT =** Instruction to break every 2sec **NT**	Manipulation administered concurrent with film viewing	**Intrusive memories:-** Frequency *Day 1:* 5min monitoring *Day 7*: IES-R score **Working memory capacity** OSPAN performance	**Intrusive memories** Frequency *Day 1*: 5min 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; 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 & Marmer, 1997); IQ = Intrusion Questionnaire (Hackmann et al., 2004; Michael et al., 2005); LS = Low Schizoptype; MD = Mere Distraction; NT = No Task (No manipulation for the equivalent duration as the other experimental conditions, unless stated otherwise); NF = Neutral Film; OSPAN = Operation Word Span Task (a measure of working memory capacity; M. L. Turner & Engle, 1989); RMT = Recognition Memory Test; S = Suppression; 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); 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; VST = Visuospatial Task; WST = Word-Stem Task (intended to assesses implicit priming effects)

Studies which use complex tasks to modify cognitions and information processing styles to modulate intrusive memories (2008-2013)

Nine studies used more complex tasks to modify cognitions and processing styles in order to assess how this can influence intrusions frequency (Table 1.4). Compared to the previous section which identified relatively simple competing tasks, the current experiments used more complex tasks which typically involved more elaborate procedures (e.g. greater direct contact between the experimenter and participant) such as training inductions or Cognitive Bias Modification (CBM) a (typically) computerised technique which modifies biases.

Memory-encoding: Complex tasks before and during a trauma film

Computerised Cognitive Bias Modification (CBM) was employed by Woud and colleagues (2012) to train appraisals of negative events. Negative appraisals are implicated in PTSD development and maintenance (Ehlers & Clark, 2000) suggesting being able to reduce negative or increase positive appraisals may impact trauma response. Participants were either trained to appraise events with high self-efficacy (the perceived ability to cope well) or low self-efficacy, prior to trauma film viewing with those trained positively experiencing less intrusions over the subsequent week in addition to lower scores on the IES intrusion subscale (Weiss & Marmer, 1997). Further to this, positively trained individuals experienced a reduction in cognitions typically associated with PTSD as demonstrated by lower scores on the Post Traumatic Cognitions Inventory (PTCI; Foa, Ehlers, Clark, Tolin, & Orsillo, 1999). The same training procedure when induced immediately post-film however did not result in fewer intrusions across the week or lower scores on the PTCI (Woud, Postma, Holmes, & Mackintosh, in press) but a reduction in distress resulting from intrusions. This suggests this particular form of bias training may be preferable as an inoculate measure rather than preventative one. Self-efficacy was further explored by Brown and colleagues (2012) who found that merely providing verbal feedback (participants' believed feedback derived from a personality questionnaire administered earlier in the experiment) that a person was or was not able to cope well could influence intrusion frequency, with those who were told they were less able to cope having more intrusions over the course of 48 hours post film (Brown, Joscelyne, Dorfman, Marmar, & Bryant, 2012).

Models of PTSD (Ehlers & Clark, 2000) posit that intrusions may be the result of a deficit of elaboration for the trauma (e.g. lack of context in time and place as well as previous and subsequent information associated alongside the trauma; Ehlers & Clark, 2000), thus the

addition of contextualisation should result in fewer intrusions. In a study testing this theory, audio commentary - provided concurrently with film viewing - was used as a method of providing additional context to the trauma film. Contrary to predictions, however, those provided with additional audio information had more intrusions than those participants who received no 'contextualising' audio commentary (Pearson, 2012). The result could perhaps be explained in terms of research which has demonstrated that intrusions could be induced from merely listening to a traumatic report (see Table 1.7; Krans, Naring, Holmes, & Becker, 2009a). Thus, the provision of additional information in this instance, even via verbal report, instead of providing context may have provided more stimuli from which intrusions could derive. This might also have implications in terms of face-to-face treatment for suffers of trauma and PTSD where the therapist listens to traumatic reports of the patient.

Memory consolidation: Complex tasks soon after a trauma film

Zetche and colleagues (2009) tested whether training particular thinking styles immediately post film impacted on intrusions. In their work they promoted either memory integration (e.g. by facilitating chronological thoughts about the film) or rumination (e.g. dwelling on 'why' and 'what if' statements). Ruminative thinking is a maladaptive coping strategy and can prolong symptomatology (Nolen-Hoeksema & Morrow, 1991). Participants who were asked to engage in rumination immediately post trauma film compared to those who had been allocated to the memory integration condition had lower score on an Intrusive Memory Questionnaire (IMQ) however, this effect did not hold at one week (Zetsche, Ehring, & Ehlers, 2009).

A study by Verwoerd et al., (2012) found that participants trained to avoid negative reminders (via an exogenic cueing task) had fewer intrusions during a monitoring task, as well as over the course of 3 days. Trained participants also reported lower scores on an adapted version of the Impact of Event Scale (IES) called the Impact of Movie Scale (Verwoerd, Wessel, & de Jong, 2012). Findings were interpreted to be due to trained participants being less likely to attend to negative perceptual stimuli, resulting in less associated cues for the trauma film and fewer intrusions.

Engaging in imagery techniques to treat a range of psychological disorders is becoming increasingly widely used (Hackmann, Bennett-Levy, & Holmes, 2011). Post-trauma imagery techniques were explored in an experimental design where in imagery 'rescripting' (IRS; retrieving the trauma memory then 'Rescripting' – altering the outcome) was compared to imagery re-exposure (IRE; repeated retrieval of the trauma memory

promoting habituation or fear extinction, where repeated exposure results in a decreased fear response) or merely imagining an unrelated positive memory (PI; Hagenaars & Arntz, 2012). This procedure was given 30 min following film viewing. Imagery rescripting led to fewer intrusions over the week than either the PI or IRE condition. Further, both IRS and PI had lower scores on the Post Traumatic Cognition Inventory (indiciative of a better outcome; Foa et al., 1999) (Hagenaars & Arntz, 2012) compared to IRE suggesting mere imagery exposure may not be the most effective method of post-trauma imagery-based treatment. This finding is of interest given recent research which has successfully used repeated imagery exposure as an early treatment technique in the aftermath of trauma (Rothbaum et al., 2012), and hints at the potential for procedures to be optimised and refined further.

Table 1.6. *Experimental Details of Studies that use Complex Tasks Targeting Cognitions and Processing Styles to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
(Woud et al., in press)	*N*=76 2 condition between groups; *n*=37 per group Film duration: 20min	Computerized 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, post film* *Day 7:* PTCI score change (lower scores = improvement)	**Intrusive images and thoughts** Frequency *Days 1 to 7*: Diary Positive = Negative Distress *Days 1 to 7*: Diary Positive < Negative **Trauma cognitions** *Baseline to post-film:* PTCI score No group differences *Baseline to Day 7:* PTCI score Positive = decrease in score Negative = no change in score
(Woud et al., 2012)	*N*=76 2 condition between groups; *n*=37 per group Film duration: 20min	Computerized 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 & Arntz, 2012)	*N*=76 3 condition between groups; IRS: *n* = 24 IRE: *n* =25 PI: *n* =27	Imagery technique training facilitated by experimenter: Picture in the first person and in as much sensory detail as possible; **IRS** = the film (for 3min)	Manipulation administered 30min post film, for 9min duration	**Intrusive images:-** Frequency *Days 1 to 7*: Diary method	**Intrusive images** Frequency *Days 1 to 7*: Diary IRS < IRE and PI IRE = PI

Table 1.6. *Experimental Details of Studies that use Complex Tasks Targeting Cognitions and Processing Styles to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
	Film duration: 10min	then create and imagine a positive resolve **IRE** = the film **PI** = A recent positive event		**Trauma Cognition:-** *Day 7:* PTCI total score **Memory for analogue trauma:-** *Day 7:* Cued recall memory test score	**Trauma cognition** *Day 7:* PTCI score IRS < IRE PI < IRE IRS = PI **Memory for analogue trauma** *Day 7:* Recall test score IRS and IRE > PI
(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 :-** *Day 1:* RSVP performance (error frequency and RT for analogue trauma footage)	**Intrusive memories** Frequency *Day 1:* 3 min monitoring Training < Control *Days 1 to 3*: Diary Training < Control *Day 3:* IMS Training < Control **Attention bias** *Day 1:* RSVP error performance Training < Control RT (for previously seen film scenes): Training > Control
(Pearson, 2012)	*N*=40 2 condition between groups; *n*=20 per group Film duration: 13min 40sec	Influence of contextual information: **Contextual =** audio commentary provided with film **Context Free =** no audio commentary provided with	Manipulation administered concurrently with film	**Intrusions:-** Frequency *Days 1 to 7*: Diary method **Memory for analogue trauma:-** *Day 7:*	**Intrusions** Frequency *Days 1 to 7*: Diary Contextual > Context Free **Memory for analogue trauma** *Day 7:*

Table 1.6. *Experimental Details of Studies that use Complex Tasks Targeting Cognitions and Processing Styles to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
		film		Cued recall memory test score Recognition memory test score	For both tests Contextual = Context Free
(Varker & Devilly, 2012)	*N =80* 2 condition, between groups. Tested groups of between 2 to 9 Inoculation: *n=41* Control: *n=39*	**Inoculation** = Resilience training; education on physical response to trauma, fainting and negative thoughts reduction technique, RTA desensitization (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	Manipulation administered 1 week prior to film. 40min duration	**Depression & anxiety:-** *Day 1 and 1mth:* DASS 21 score **PTSD symptomatology:-** *Day 1 and 1mth:* PSS-SR score **Memory for analogue trauma:-** *Day 1 and 1mth* Cued recall memory test score and self-report confidence ratings: -Peripheral film details -Central film details	**Depression & anxiety** *Day 1 and 1mth:* No group differences **PTSD symptomatology** *Day 1 and 1mth:* No group differences **Memory for analogue trauma** *Day 1 to 1mth: Comparison over time* Both groups: - better recall at Day 1 - Greater confidence of (in) correct responses at Day 1 Control: - Decline in peripheral memory confidence and incorrect recalled memories
(Brown et al., 2012)	*N*=33 2 condition between groups; HSE: *n*=17 LSE: *n*=16 Film duration: 10min	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:-** <u>Frequency and Distress</u> *Day 1:* 3min monitoring *Day 1 to 2 (24hr.):* Retrospective estimates on Day 2 **Memory for analogue trauma:-** *Day 2:* Cued recall memory test score:	**Intrusive images** <u>Frequency</u> *Day 1 AND Day 1 to 2:* LSE > HSE <u>Distress</u> *Day 1 & Day 2:* LSE > HSE **Memory for analogue trauma** *Day 2:* Peripheral

Table 1.6. *Experimental Details of Studies that use Complex Tasks Targeting Cognitions and Processing Styles to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
				-Peripheral film details -Central film details	LSE = HSE Central LSE > HSE
(Lester, Mathews, Davison, Burgess, & Yiend, 2011)	*N*= 60 Film duration: 6 min19sec	CBM training designed to manipulate cognitive errors. **CBM Error modification** **CBM Non-error modification**	Manipulation administered 10min prior to film	**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
(Buck, Kindt, & van den Hout, 2009)	*N*= 90 3 condition between groups; CPC: *n*=31 SC: *n*=29 NT: *n*=30 Film duration: 19min	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 45min post-film	**Intrusive images and thoughts:-** *Day 1: Over 4 hr.* Characteristics -Frequency -Duration -Vividness -Distress -Memory fragmentation All assessed using VAS	**Intrusive images and thoughts:-** *Day 1: Over 4 hr.* Characteristics - Duration (thoughts) CPC > SC NT = CPC and SC No difference for other measures
(Schartau, Dalgleish, & Dunn, 2009)	**Expt. 1.** *N*=41 3 condition between groups Appraisal: *n*=21 Watch: *n*=20	**Expt. 1,** **Appraisal:** Training **Watch:** No emotional regulation	**Expt. 1.** Manipulation administered concurrently with film	**Expt. 1** **Affect response to film:-** *Day 1***:** *Pre to post training* Distress and Horror score change	**Expt. 1.** **Affect response to film** *Day 1: Pre to post training* Distress and Horror score change Appraisal < Watch Watch = no score change

Table 1.6. *Experimental Details of Studies that use Complex Tasks Targeting Cognitions and Processing Styles to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
				Physiological response:- *Day 1***:** *Pre- to post-training change* HR and GSR	**Physiological response** *Day 1***:** *Pre to 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** Manipulation administered post-film	**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	**Expt. 3.** **Appraisal:** As Expt. 1 & 2 **Watch:** As Expt. 1 & 2 **Detachment:** Think about technicalities of making the film	**Expt. 3** Manipulation administered post-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
(Zetsche et al., 2009)	*N*=101 3 condition between groups; Rumination: *n*=31 Memory Integration: *n*=35 DC: *n*=34 Film duration: 17min 30sec	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	Manipulation administered 2min post-film for 12min duration	**Intrusions:-** Frequency *Day 1: 2min post-film* IMQ score *Day 1: 4min post-film/ TT* IMQ score *Days 1 to 7*: IMQ score taken each day	**Intrusions** Frequency *Day 1: 2min post-film* IMQ score No group difference *Day 1:* 4min post-film / TT IMQ Score Rumination > Memory Integration and Distraction *Days 1 to 7*: Daily IMQ No main effects

Table 1.6. *Experimental Details of Studies that use Complex Tasks Targeting Cognitions and Processing Styles to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
		DC = Non film related quiz questions. For all groups a series of questions were displayed on the VDU. Questions vary to promote guided thinking styles		**Mood:-** *Day 1:* PANAS score	**Mood** *Day 1: Post-film/expt. manipulation* PANAS sad score Rumination > Distraction
(Ehring et al., 2009)	*N*=83 3 condition between groups; ART: *n*=28 CT: *n*=28 DC: *n*=27 Film duration: 17min	Thinking style modification: **ARC** = 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 10min duration	**Intrusive thoughts and images:-** Frequency *Day 1: Pre-film, post-film and post-TT* IQ score *Day 3:* IQ **Physiological response:-** HR	**Intrusive thoughts and images** Frequency *Day 1: Post-TT* IQ score CT < DC ART = CT *Day 3:* No differences on IQ score **Physiological response** HR decrease pre to post manipulation CT & DC
(Devilly & Annab, 2008)	*N*=61 2 condition between groups PD: *n*=27 No-PD: *n*=31 Film duration:	Group intervention: **PD** = facilitated CISD **No-PD =** refreshments and non-facilitated interaction	Manipulation administered post film for 40-50 min duration	**Perceived social support:-** *Day 1 and 1mth:* ISEL-12 score **Depression & anxiety:-** *Day 1 and 1mth:* DASS 21 score	**Perceived social support** ISEL-12 scores No group difference **Depression & anxiety** DASS 21 scores No group difference

Table 1.6. *Experimental Details of Studies that use Complex Tasks Targeting Cognitions and Processing Styles to Modify Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	IV Details	Dependent Variable(s)	Result(s)
	10min			**PTSD symptomatology:-** *Day 1 and 1mth:* PDS score	**PTSD symptomatology** PDS scores No group difference
				Behavioural and emotional indicators:- *Day 1 and 1mth:* 16 item questionnaire score	**Behavioural and emotional indicators** No group differences *Day 1 to 1mth:* Reduced scores for both PD and No PD

Note. APT = Affective Picture Task; ART= Abstract Ruminative Thinking; BDI-II Becks Depression Inventory (Beck & Steer, 1987); 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; 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); ES = Emotion Suppression; DASS -21 = Depression Anxiety Stress Scale–21(Lovibond & Lovibond, 1995); 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 (P. J. Lang, Greenwald, Bradley, & Hamm, 1993); IES-R = Impact of Event Scale - Revised (contains 3 subscales, intrusions, avoidance and hyperarousal; Weiss & Marmer, 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; ISEL-12 = Interpersonal Support Evaluation List short form (Cohen, Marmelstein, Kamarck, & Hoberman, 1985)**;** 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); PD = Psychological Debriefing, using the Critical Incident Stress Debriefing method; 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; RSVP= Rapid Serial Visual Presentation task (intended as a measure of attentional bias for (negative) stimuli); RT = Reaction Time; RTA = Road Traffic Accident; SC = Suppression Condition; 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); VAS = Visual Analogue Scale (Zealley & Aitken, 1969); VDU = Video Display Unit

Prospective designs investigating intrusive memories (2008-2013)

The trauma film paradigm has been used successfully in prospective study designs, which aim to discern relationships between dispositional trait factors and trauma response in order to identify vulnerability factors which may influence trauma response (Table 1.7; 17 experiments). Within the review, research has shown that an increase in intrusions may be related to a propensity to feel disgust (Bomyea & Amir, 2012) as well as increased self-report measures of anxiety and depression (Laposa & Alden, 2008), dissociation (Hagenaars & Krans, 2011) and propensity to use a data-driven and self-referent processing style (Laposa & Rector, 2012).

The impact of traumatic film material versus neutral film material on trauma response was measured in several experiments within the review. One study demonstrated the ability of traumatic films, compared to neutral films, to produce the occurrence of both thought and image intrusions (Hagenaars et al., 2010). Trauma film exposure was also associated with a reduction of thought 'flexibility' (e.g. measured by performance levels on associate problem tasks and lexical-semantic tasks), compared to neutral film exposure (Renner & Beversdorf, 2010). Moreover, by comparing *f*MRI encoding for neutral and traumatic film material in a novel use of the trauma film paradigm, it was demonstrated that parts of the trauma film that later intruded into mind could be characterised by difference in brain activation at the encoding stage, compared to those parts of the film that were traumatic and did not subsequently intrude as well as for neutral film, suggesting intrusions may be the result, at least in part, of differential brain activation during the encoding stage (Bourne et al., 2013).

Several prospective experimental designs also investigated working memory capacity, inferring that greater working memory capacity results in an enhanced ability to resist proactive interference (P-I) as well as suppress and inhibit intrusions. Various tasks have been used as a proxy for working memory capacity such as the California Verbal Learning Task (CVLT) which can be used to measure P-I resistance. Findings demonstrated that individuals who performed better on the CVLT had fewer intrusions than those who did not perform so well (Verwoerd, Wessel, de Jong, Nieuwenhuis, & Huntjens, 2011). Similar associations were also seen in another task of cognitive control which assessed the ability to update and inhibit information using a Random Generator task, as well as an AB-AC proactive interference task (Wessel, Overwijk, Verwoerd, & de Vrieze, 2008). Cognitive control was additionally thought to be linked to time of day, with individuals experiencing various 'optimal' and 'non-optimal' times of day. As such, optimal times are associated with

greater levels of cognitive control and therefore fewer intrusions from a trauma film viewed during this time of day (Wessel, Huntjens, & Verwoerd, 2010). Findings indicated no difference between optimal and non-optimal times of day on intrusion development. Thus, findings largely infer that individuals with lower working memory capacity are more vulnerable to intrusions following trauma. However, the various tasks by which working memory capacity is measured are varied and require greater clarification as to which aspects of working memory they are actually measuring, in order to decipher the role of working memory and cognitive control on intrusion development.

Table 1.7. *Experimental Details of Prospective Designs that Investigate Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	Dependent Variable(s)	Result(s)
(Bourne et al., 2013)	*N*=22 Within groups fMRI design. Film duration: 21min	**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
(Laposa & Rector, 2012)	*N*=91 Within groups Film duration: 9min	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
(Meyer et al., 2012)	*N*=82 Within groups; Film duration: 14min	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	**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

Table 1.7. *Experimental Details of Prospective Designs that Investigate Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	Dependent Variable(s)	Result(s)
			Physiological response:- Eye blink startle response *Day 1: 30min post film* Response speed to trauma-film related, negative and positive visual images	**Physiological response** Eye blink startle response *Day 1: 30min post film* No association between SCCT performance and startle potentiation scores
(Bomyea & Amir, 2012)	*N*=38 Within groups	Self-report questionnaire **DS-R** = state score	**Intrusive thoughts:-** Frequency *Day 1*: 5min monitoring post-film	**Intrusive thoughts** Frequency *Day 1:* 5min monitoring Higher DS-R score > Lower DS-R score
(Hagenaars & Putman, 2011)	*N*= 43 Within groups	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 & Krans, 2011)	*N*= 43 Within groups Film duration: 10min	Self-report questionnaires **DES-C**- trait **DSS** - state **Horror** - during film, Likert scale	**Intrusive images:-** Frequency *Days 1 to 7*: Diary method	**Intrusive images** Frequency *Days 1 to 7*: Diary Greater DES-C > Lower DES-C DSS and Horror score = not relationship with image frequency
(Krans, Naring, Speckens, &	*N*= 59 2 condition between groups;	Stimuli modality **Film group** = Seeing trauma film as normal	**Intrusive images:-** Frequency *Days 1 to 7*:	**Intrusive images** Frequency *Days 1 to 7*: Diary

Table 1.7. *Experimental Details of Prospective Designs that Investigate Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	Dependent Variable(s)	Result(s)
Becker, 2011)	Film duration: 11min 42sec	**Imagery group** = Hearing a verbal report (with emotion and original film audio) about events in film	Diary method *Day 7:* IES-R score	Film group = Imagery group *Day 7*: *IES-R* Film group = Imagery group
(Verwoerd et al., 2011)	*N*=85 Within groups Film duration: 9min	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
(Renner & Beversdorf, 2010)	*N*=20 Within groups Film durations: 30min	Film type **TF** **NF**	**Creative thinking:-** *Day 1: 30 min post-film* (C)RAT performance **Memory for analogue trauma:-** *Day 1:* Series recall memory test score	**Creative thinking** *Day 1:* (C)RAT performance TF < NF **Memory for analogue trauma** *Day 1:* TF = NF
(Wilksch & Nixon, 2010)	*N*=49 2 condition between groups; HR: *n*=21 LR: *n*=28 Film duration: 8min	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:* 5min monitoring post-film *Day 1-7:* Diary method *Day 7:* 5min monitoring post-film	**Intrusive thoughts** Frequency *Day 1:* 5min monitoring HR>LR *Day 1-7:* Diary HR>LR *Day 7:* 5min monitoring HR>LR Distress

Table 1.7. *Experimental Details of Prospective Designs that Investigate Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	Dependent Variable(s)	Result(s)
				Day 1: 5min monitoring HR>LR HR reported higher levels of suppression than LR
(Wessel et al., 2010)	*N*=80 2 condition between groups; *n*=40 per group Film duration: 112sec	Times of day **Non-Optimal =** index of low self-control **Optimal** = index high self-control	**Intrusions:-** Frequency *Day 1:* 5min monitoring during suppression	**Intrusions** Frequency *Day 1:* Non-Optimal = Optimal
(Hagenaars et al., 2010) Expt 2 of 2 (see Table 2 for Expt. 1)	*N*=52 2 condition between groups; TF: *n*=29 NF: *n*=23 Film duration: 10min	Film type **TF** **NF**	**Intrusive images and thoughts:-** Frequency *Days 1 to 7*: Diary method	**Intrusive images** frequency *Days 1 to 7*: TF> NF **Intrusive thoughts** frequency *Days 1 to 7*: TF: Images > Thoughts NF: Images = Thoughts
			Peri-traumatic emotion:- *Day 1:* Self-report Anxiety, Horror, Anger & Sadness	**Peri-traumatic emotion** *Day 1:* Higher scores on Anxiety, Horror and Sadness = more image intrusions
(Ferree & Cahill, 2009)	*N*=48 Within groups; TF and NF consisted of 6 separate clips each	Film type **TF** **NF**	**Intrusions** (SIR)**:-** Frequency *Day 1-3 (48hr.):* Retrospective self-report **Memory for analogue trauma:-** Subjective memory strength	**Intrusions** (SIR) Frequency *Day 1-3 (48hr.):* TF > NF **Memory for analogue trauma** Subjective memory strength

Table 1.7. *Experimental Details of Prospective Designs that Investigate Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	Dependent Variable(s)	Result(s)
			Self-report rating per clip Film details remembered Free recall memory test score	TF > NF Film details remembered Higher memory test score = more intrusions (for TF and NF)
(Laposa & Alden, 2008)	*N*=68 Within groups; Impact depression, anxiety and dissociation on intrusive thought and image frequency Film duration: 9min	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
(Geracioti Jr et al., 2008)	*N*=8 Within groups; Clinical population. Film durations: 1hr.	Film type **TF** **NF**	**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:* Anxiety VAS	**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 of CSF-CRH

Table 1.7. *Experimental Details of Prospective Designs that Investigate Response(s) to Analogue Trauma*

Research Group	Design	Independent Variable(s)	Dependent Variable(s)	Result(s)
(Wessel et al., 2008)	**Expt. 1.** *N*=58 Within groups Film duration: 1min 52sec	**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 (48hr):* Diary method	**Expt. 1.** **Cognitive control and P-I resistance** *Day 1:* CNI performance negatively correlated to RNG performance **Intrusive Thoughts** Frequency *Day 1 to 2 (48hr):* Diary Higher scores on RNG task = more intrusive thoughts
	Expt. 2 *N*=104 Within groups Film duration: 1min 52sec	**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 (48hr):* 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 (48hr):* 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); ARQ = Anxious Rumination Questionnaire (Rector, Martin, Laposa, Kocovski, & Swinson, 2008); BDI-II = Beck's Depression Inventory (Beck & Steer, 1987); BP = Blood Pressure; 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 togther 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 (E. M. 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); 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); NE = norepinephrine; NF = Neutral Film; 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); RIQ = Response to Intrusions Questionnaire (Clohessy & Ehlers, 1999); RNG* = Random number Generator task (designed to assess updating and interference resources in working memory capacity); 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; STAI-T State Trait Anxiety Inventory - Trait (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983); 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); VAS = Visual Analogue Scale (Zealley & Aitken, 1969).

Studies which have used the trauma film paradigm to investigate trauma response other than intrusive memories.

Of the fifty experiments which had used the trauma film method to explore response to a stressor, only 8 were not concerned with intrusions as a main outcome of interest. Three experiments were within the same article (see Table 1.6; Schartau et al., 2009) which investigated the impact of using computerised Cognitive Bias Modification (CBM) on physiological and mood disturbances following an analogue trauma. The series of studies showed that training individuals to develop a 'bigger picture' approach to thinking about negative events, either before or after viewing traumatic material led to less negative affect for that material. Another study used the trauma film paradigm to look at the impact of a CBM package designed to manipulate cognitive errors following a stressor and showed error bias modification resulted in less negative affect experience for the film (Table 1.6; Lester et al., 2011). A fifth experiment by Renner and Beversdorf (2010; Table 1.7) looked at the impact of stress on cognitive flexibility (defined as involving lexical and semantic systems and operationalized by performance on a Remote Associate Task (RAT). As predicted, cognitive 'flexibility' declined following a stressor (the trauma film) compared to a non-stress condition (a neutral film). A sixth study (Geracioti Jr et al., 2008) explored physiological responses (norepinephrine and corticotrophin releasing hormones which play a part in bringing about secretion of the stress hormone cortisol) to stress (the trauma film) in individuals who already suffer from PTSD. This was the only study within the current review that did not use a non-clinical, 'healthy' population. Intriguingly, findings showed that norepinephrine increased during and following the trauma; however, corticotrophin releasing hormones actually decreased, contrary to what was predicted.

The trauma film paradigm has also been employed as a method through which to safely explore effects of psychological trauma treatment which have been met with concern (Rose et al., 2002) - critical instance stress debriefing (Devilly & Annab, 2008). Research assessed perceived social support, depression, anxiety, PTSD symptoms and emotional indicators in response to receiving debriefing. Findings indicated it did not offer any benefits compared to a non-facilitated interaction, corroborating Cochrane Reviews which suggest that it is not an effective treatment in the early aftermath of experiencing a trauma (e.g. Rose et. al., 2003). An additional experiment exploring treatment for use following the early aftermath of trauma found no effects at one-month follow up on levels of depression, anxiety and PTSD symptoms for what was termed 'pragmatic' training

(consisting of information on what to do in a road traffic accident) compared to 'resilience' training administered prior to experiencing an analogue trauma (Varker & Devilly, 2012).

The above studies suggest the utility of using traumatic film materials as an analogue to real life trauma and its sequela. They demonstrate that viewing traumatic film material provokes a physiological reaction of the kind experienced following real stress and trauma, and that it can be used as a safe, ethically sound way of assessing treatment effectiveness.

Conclusion

Intrusive re-experiencing symptoms are a hallmark symptom of PTSD and typically take the form of flashbacks (defined within the thesis as image-based memories of trauma). Currently treatments for PTSD can only be administered one month post trauma, following a diagnosis (National Institute for Health and Clinical Excellence, 2005). There are few successful evidence-based treatments in practice that are available to ameliorate symptoms experienced in the early aftermath of trauma. Early re-experiencing symptoms experienced soon after trauma may be predictive of the PTSD severity later on (O'Donnell et al., 2007; Shalev, 1996) and present a target for treatment intervention.

An approach to studying flashbacks is using the analogue design, trauma film paradigm. This allows for prospective investigation of traumatic responses not possible in those who already present with the full blown disorder. In addition the paradigm allows for experimental manipulation in order to explore potential ways in which symptom such as flashbacks can be modulated. A review of the trauma film paradigm was conducted in order to inform the experiments within the thesis which seek to develop the use of the visuospatial task Tetris to reduce flashbacks to an analogue trauma.

The majority of experiments which have used the trauma film paradigm have looked at intrusions (a term which encompasses flashbacks). Since the last review in 2008, the use of the trauma film paradigm as an analogue model for studying psychological trauma and its consequences has expanded. Experiments could be assigned into one of three broad categories; *(1)* those that used low intensity interference tasks to modulate response to trauma (Tables 1.2 and 1.5); *(2)* those that had more high intensity approaches, requiring more elaborated methods to modulate response to trauma (Tables 1.3 and 1.6) and *(3)* studies which used prospective designs to assess individual differences and vulnerability factors which modulate trauma response (Tables 1.4 and 1.7). Re-experiencing symptoms in the form of intrusions were the primary response of interest for the majority of research using the analogue trauma film paradigm, typically in terms of

their frequency. However, intrusions have not been studied exclusively; there is accumulating evidence that using the trauma film paradigm can produce responses (both in terms of mood affect and physiological arousal) analogous to those experienced following real-life trauma. The volume of experiments which have used the trauma film paradigm since 2008, support its utility as a potential experimental medicine tool with which to study intrusive memories.

Of the methods used to measure rates of intrusions, some were more common than others. The widely-used pen-and-paper diary method is advantageous in that it can be kept over longer periods of time than, say, measuring intrusions using a laboratory-based intrusion monitoring task, with participants able to record intrusions as and when they occur over the course of their daily lives. As such, this may offer a more ecologically valid insight into intrusion development, compared to laboratory based methods of 'capturing' intrusion frequency or retrospective self-report questionnaires. It was recognised that diary compliance and accuracy may be difficult to assess using a measure completed away from the laboratory, particularly using paper formats (although electronic formats can record time-stamped entries and check for daily compliance; Stone, Shiffman, Schwartz, Broderick, & Hufford, 2003). Experiments which used additional measures of intrusion frequency such as a 'monitoring' and questionnaire measures tended to complement findings obtained using a diary method and provided convergent results. This suggests that employing convergent measures of intrusion development is a common and useful approach when investigating intrusions in the laboratory.

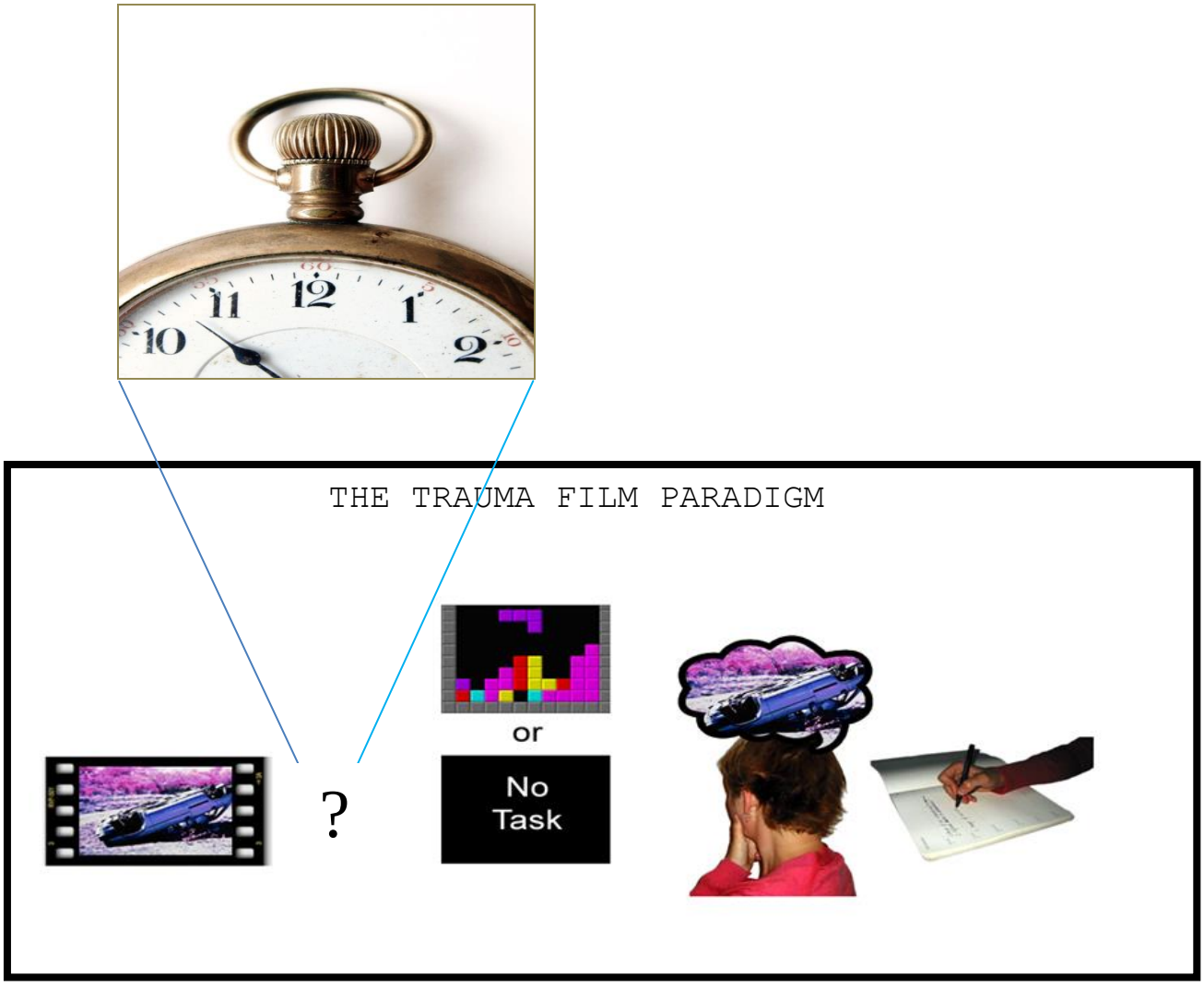
The three broad categories of studies which investigate intrusions offer valuable insight into factors which promote and protect against intrusion development. Tasks which offer a relatively simple competing task may be a possible target for further exploration, if only in terms of simplicity and ease of application. More complex tasks require training and resources, e.g. face-to-face contact with trained personnel etc., and, as such, they may be cumbersome and difficult to administer quickly, particularly to large numbers of people (for example in the aftermath of a natural disaster) or where there are minimal resources available. Visuospatial cognitive tasks consistently reduced intrusions whereas verbal-based task did not and were, in some instances, also potentially harmful for increasing intrusions. Therefore, lines of enquiry within the thesis will focus on the use of the visuospatial computer game Tetris. Tetris confers the added advantage of being widely recognised, available on multiple playing platforms and being language free, potentially enabling it to be provided quickly and efficiently with no limits imposed by language

boundaries (e.g. as might be the case for talking therapies administered to refugees and asylum seekers within English speaking communities).

Finally, results from the review demonstrated that the maximum experimentally-investigated time frame between analogue trauma and task administration of a simple competing task to reduce intrusions was 4 hours (Holmes et. al, 2010). A task that can be administrated over a wider time frame following an index trauma would extend the number of people who can potentially benefit. Thus, a key next step is to explore extending the time frame further during which Tetris game play can be used to successfully reduce the occurrence of flashbacks. As such, the next steps of this thesis will be to review the literature on human *reconsolidation* which indicates that memories may be modifiable under certain conditions, even after they have undergone consolidation (e.g. after 24 hours). This may represent an opportunity to further understand the development of flashback memories and whether or not they can be reduced, 24 hours after an analogue trauma, with a relatively simple cognitive task, Tetris game play.

CHAPTER 2

Contrasting Memory Consolidation with Memory Reconsolidation: Reviewing the Literature in which Memory Reconsolidation has been Experimentally Disrupted in Humans, to Inform Intervention Design



Procedural overview adapted from Holmes et al., 2009

Contrasting Memory Consolidation with Memory Reconsolidation: Reviewing the Literature in which Memory Reconsolidation has been Experimentally Disrupted in Humans, to Inform Intervention Design

Introduction

Following acquisition, memory undergoes a time dependent process of stabilisation (a cascade of molecular processes involving protein synthesis and the development of new synaptic connections) necessary for the memory to persist, referred to as memory 'consolidation' (for a review see; Lee, 2009). What is known of the neurobiological underpinnings of memory suggests there is a limited time window following acquisition in which memory consolidates; during this time the memory is labile and vulnerable to disruption (Myers, Ressler, & Davis, 2006; Nader et al., 2000b; Walker et al., 2003).

Chapter 1 reviewed research that had used the trauma film to investigate analogue post-traumatic stress reactions. Findings indicated that simple visuospatial cognitive tasks may selectively interfere with memory for aversive materials (e.g. trauma film) resulting in a reduction in post-traumatic stress reactions, predominately a reduction in the occurrence of flashback development. The maximum time frame tested between film viewing and simple cognitive task intervention was 4 hours (Holmes, James, et al., 2010) - within the postulated time frame during which memory is consolidating and is thus labile (Walker et al., 2003). A logical next step is to extend the time frame between trauma film viewing and task intervention, since doing so would increase the real-world utility of an intervention (e.g. one that could be delivered a day after a trauma).

Retrieval of a consolidated memory may reactivate the memory rendering it once again transiently vulnerable to modification (Alberini, 2007; Dudai, 2006; Lee, 2009; Nader & Einarsson, 2010; Nader & Hardt, 2009; Sara, 2000). The period during which memory *re*consolidates may present an opportunity to investigate a key question, whether it is possible disrupt memory *re*consolidation and thus modify a previously consolidated memory.

Research has delineated distinctions between consolidation and reconsolidation and has shown that, although the processes are similar, reconsolidation is not an exact replica of consolidation. Thus, in the following chapter the functional and structural properties of memory consolidation and **re**consolidation are discussed in order to review their similarities and distinct differences. The chapter then presents a review of research that has used experimental approaches to investigate reconsolidation in humans (since this is the

focus of the current thesis). This emerging body of research allows investigation into the 'boundary conditions' thought necessary for reconsolidation to occur, and as such will inform experimental design within the thesis.

Memory Consolidation

Memory consolidation is defined as a time-dependent process whereby newly acquired memory traces stabilise to become long term memories. Mueller and Pilzecker coined the term consolidation (McGaugh, 2000; Muller & Pilzecker, 1900) in early empirical research in order to explain findings in which memory for lists of paired syllables showed interference effects from new learning, but only when new learning occurred within a particular time frame. This transient interference effect correlated with the time, e.g. the more time that passed following initial learning the less likely there was to be interference effects from new learning (McGaugh, 2000). The phenomena was one of the first instances where memory processes were explicitly linked with the passing of time, giving rise to the idea that memory traces start out fragile and over time become less vulnerable to change or modification, as opposed to memories occurring instantaneously and remaining fixed in mind.

Functions of Memory Consolidation

The role or function of memory consolidation is not completely understood and as such there are several possible explanations as to why memory undergoes a time dependent process of stabilisation following acquisition (Dudai, 2004; McGaugh, 2000). Explanations include, *i)* allowing for incorporation of information from the environment, an adaptive function; *ii)* the time frame of plasticity allows for some events, if not helpful or necessary to be dropped from mind, a necessary requirement for organisms who have a limited cognitive capacity and *iii)* memory consolidation is merely an epiphenomena of the biological mechanisms needed for memory formation and has no purpose as such.

Two Types of Memory Consolidation: Synaptic versus Systems

Research differentiates between two distinct types of memory consolidation; synaptic and systems consolidation (Dudai, 2004; Haist, Bowden Gore, & Mao, 2001; McIntyre, McGaugh, & Williams, 2012). Both appear to follow temporal gradients; however, research indicates that typically synaptic consolidation occurs in the minutes and

hours following memory acquisition whereas systems consolidation may take days, weeks or even years to complete.

Brain regions involved in the formation of recent (new) memories relating to synaptic consolidation include the hippocampal complex and MTL with older, remote memories relating to systems consolidation, involving the cortical areas.

Synaptic consolidation

Synaptic consolidation is thought to take place from minutes to hours after memory acquisition and involves a cascade of molecular and structural changes within key brain regions (Frankland & Bontempi, 2005). The time window during which synaptic consolidation takes place has largely been explored in studies which attempt to modify memory following acquisition. Modification, either in terms of impairing or enhancing memory not only provides an indication of the time window during which memory is labile and subject to modification, but also of the biological and molecular mechanisms involved in the process.

Time frame during which synaptic consolidation takes place. Walker and colleagues (2003) showed memory for a learned tapping sequence suffered from interference effects (operationalized by the performance of a previously learned sequence) when a second sequence was learned immediately after the first. However if a second motor sequence was learned 6 hours after the first no interference effects were found for either of the learned motor sequences (Walker et al 2003). Further, pharmacological or biological agents that block or enhance protein synthesis and synapse formation also lend support the idea of a transient time frame in which memory becomes gradually more resistant to modification (Dudai, 2004; Schafe & LeDoux, 2000); when such agents become ineffective at modifying memory this is taken to mean that consolidation processes has finalised and that the memory is stable (Myers et al., 2006). Taken together studies on the neurobiology of memory suggests there is up to a 6 hour time frame whilst memory consolidates, during which memory is labile and vulnerable to disruption (Dudai, 2004; Nader et al., 2000b; Walker et al., 2003).

Brain regions involved in synaptic consolidation. The Medial Temporal Lobe (MTL) is involved in early memory formation of declarative memory following acquisition. The MTL is made up of hippocampal region (the CA fields, the subicular complex and the dentate gyrus) and the adjacent parahippocampal gyrus which is comprised of the entorhinal, perirhinal, and parahippocampal cortices. The hippocampal region is

implicated as the principal memory system (for declarative memory) in humans (Phelps, 2004). However it should be noted that other types of learning and memory are relatively independent of the MTL, e.g. procedural memory which is thought to be predominantly formed within in the cerebellum (Gao, van Beugen, & De Zeeuw, 2012).

Systems consolidation

Systems consolidation, in contrast to synaptic consolidation, can take days, weeks, months or even years to occur (Frankland & Bontempi, 2005; Haist et al., 2001). It involves the gradual reorganisation of a memory trace from the MTL to the neocortex (Dudai, 2004; Nader & Hardt, 2009). This is supported by studies involving patients with specific brain lesions in the MTL who have spared remote but not recent memories (indicating remote memories are retrieved independently of the MTL; Squire, Stark, & Clark, 2004) and by fMRI studies in humans, which show temporally-graded use of the hippocampal region during recall over time, taken to imply the reorganisation of memory from the MTL to other brain regions (Haist et al., 2001; Hoffman & McNaughton, 2002; Takashima et al., 2006). Although systems consolidation implies memory traces become independence of the MTL over time, recent research suggests that remote memory traces may still recruit the MTL for retrieval (Nadel & Land, 2000; Nader, 2003).

Consolidation and the Role of Sleep

Sleep has been implicated in the promotion of memory consolidation (Born & Wilhelm, 2012; Walker, 2009). Following sleep, performance on motor learning task is enhanced suggesting that sleep facilitates memory stabilization and may promote learning (Walker et al., 2003). There is evidence of co-ordinated activation during sleep of memory traces between hippocampus and cortical areas (Hoffman & McNaughton, 2002) suggesting that sleep may facilitate the strengthening of a memory trace by repeated neuronal firings/activation and the role of sleep in facilitating the reorganisation of memory from the MTL to cortical regions of the brain (e.g. systems consolidation; Born & Wilhelm, 2012). The role of sleep on memory consolidation is further supported by research in which participants who were sleep-deprived (compared to participants who had been allowed to sleep) in the 24 hours following viewing of aversive material later showed reduced fear responses, e.g. extinguished physiological responding (Kuriyama, Soshi, & Kim, 2010) or fewer flashback memories to the aversive material (Porcheret et al., 2012),

indicating sleep deprivation led to a reduction of memory consolidation for the aversive film materials.

Consolidation of Emotional Events

Emotion has frequently been shown to facilitate the consolidation of memory; emotional memories are typically perceived as being more vivid and persistent (McGaugh, 2004). The consolidation of emotional memory particularly involves the basolateral region of the amygdala (BLA) and the lateral nucleus of the amygdala (LA) (LeDoux, 2000; McIntyre, Power, Roozendaal, & McGaugh, 2003). Experiments using animal models have determined the role of the BLA in facilitating stress-activated memory processes (McIntyre et al., 2012; McIntyre et al., 2003; Pare, 2003). During a stressful event the adrenal glands release stress hormones (for example, cortisol) which in turn facilitate the binding of norepinephrine to beta adrenergic receptors in the BLA.

Prolonged adrenergic activation during or following a traumatic event contributes to an increased risk of developing PTSD. Thus, the use of the drug propranolol, a β-adrenergic blocker, administered within 6 hours post-trauma may reduce later traumatic stress symptoms (Pitman et al., 2002). Findings are hypothesised to be due to the β-adrenergic blocker preventing the 'over consolation' of fear memories via the amygdala (Pitman et al, 2000).

Research on non-clinical populations indicate that emotion is particularly associated with enhanced *perceptual* memories, i.e. memories that are given rise to through the senses - hearing with the mind's ear, seeing with the mind's eye etc. (Arntz, de Groot, & Kindt, 2005). Clinical data in PTSD patients also demonstrate the predominance of sensory perceptual-based memories following a traumatic event (Ehlers et al., 2004; Ehlers et al., 2002; Hackmann et al., 2004).

Memory Consolidation - Clinical Implications

From a clinical psychological perspective, understanding the processes underlying memory formation after acquisition, and the nature and functions of consolidation may aid our understanding of disorders where memory is dysfunctional e. g. PTSD, drug addiction. To that end studies using the trauma film paradigm have taken advantage of the time window during which memory is consolidating following acquisition and viewed it as a window of opportunity to modulate memory for aversive material (for examples see

studies reviewed in Chapter 1 of the thesis; e.g. Holmes et al., 2009; Holmes, James, et al., 2010).

Memory Reconsolidation

Memory reconsolidation is the term given to the process whereby, following successful memory retrieval, a previously-consolidated memory requires another round of protein syntheses in order to persist (Nader & Einarsson, 2010; Nader et al., 2000b; Ricco, Millin, & Bogart, 2006; Sara, 2000; Schiller & Phelps, 2011), rendering that memory transiently plastic and vulnerable to disruption. Nader and colleagues (Nader, Schafe, & LeDoux, 2000a) galvanised interest into memory reconsolidation by demonstrating that, contrary to traditional theories of memory consolidation, remote (e.g. at least 24 hours old) memories could, under particular circumstances, be de-stabilised rendering memory transiently vulnerable to disruption. This appeared to violate standard consolidation theory which thought that memory traces, once consolidated, become permanent and bound within mind (Dudai, 2012). The discovery that there may be a window of opportunity to modify a previously-consolidated memory was significant, particularly in terms of potential treatment applications in disorders where memory is pathological (e.g. in PTSD or drug addiction where persistent memories are thought to contribute to the disorder and relapse; Lee, Milton, & Everitt, 2006). Figure 2.1 provides a simple illustration of memory consolidation and reconsolidation. The top blue arrow represents memory consolidation, whereby memory becomes increasingly resistant to modification and change over time i.e. it goes from being ‘active’ and labile to relatively ‘inactive’ and resistant to change. Retrieval of an ‘inactive’ memory may cause that memory to become ‘reactivated’ (green bottom arrow) rendering the memory active and labile once more. Thus memory reconsolidation (black arrow) may represent a window of opportunity to modify a previously consolidated memory once more (diagram adapted from; Inda, Muravieva, & Alberini, 2011).

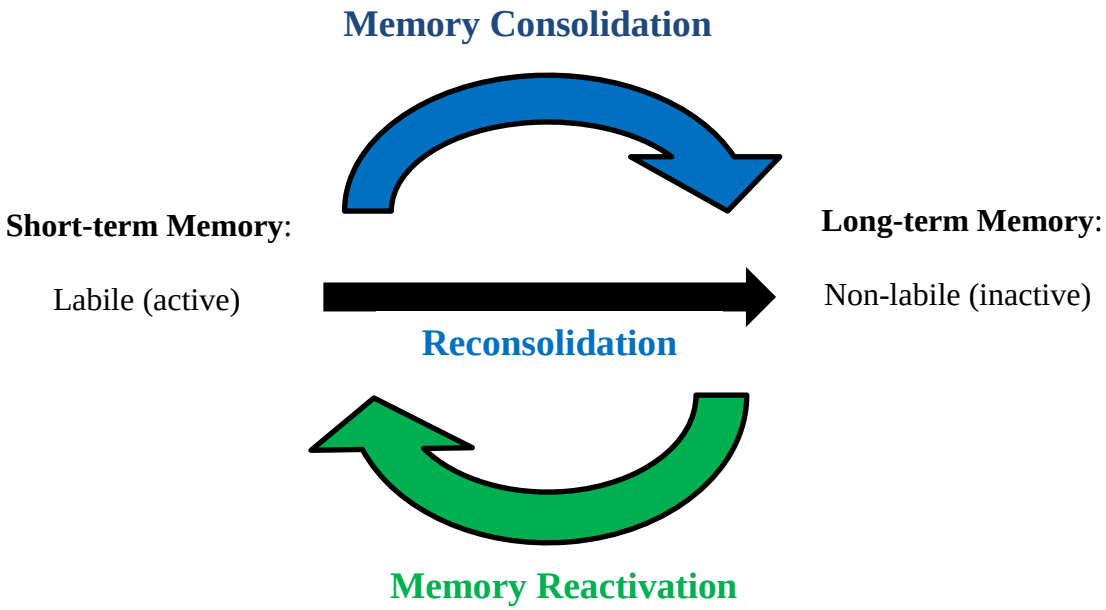


Figure 2.1. Schematic overview depicting the processes behind memory consolidation and *re*consolidation (Adapted from Inda, Muravieva, & Alberini, 2011)

A surge of research using animal models, as well as more recent studies with human participants (e.g. Schiller et al., 2010), have clarified the conditions under which reconsolidation may occur. Studies reveal that despite reconsolidation sharing characteristics with memory consolidation, it is in fact a distinct process. Thus, assumptions which hold for modifying memory whilst it gradually stabilises following acquisition (e.g. during consolidation) may not necessarily be applicable during memory reconsolidation. Further, research on potential boundary conditions affecting memory reconsolidation, i.e. conditions which dictate whether or not reconsolidation will occur, have highlighted that there is no one method or protocol by which reconsolidation is successfully initiated. Indeed, it has been implied that, given the right circumstances, any boundary condition can be overcome. Thus, it is hypothesised that all memories can be potentially subject to modification (Lee, 2009). What is undisputed is that memory only undergoes reconsolidation if the memory is retrieved sufficiently first (e.g. it becomes reactivated as a consequence of retrieval).

Functions of Memory Reconsolidation

It has been postulated that, similar to memory consolidation, reconsolidation has an adaptive purpose, in that it may allow for the incorporation of new or relevant information

into existing memories (Forcato, Rodriguez, Pedreira, & Maldonado, 2010; Hupbach, Gomez, Hardt, & Nadel, 2007; Lee, 2008, 2009).

Further to this, research also indicates that memory reconsolidation may have a role to play in the strengthening of memory (Forcato, Rodriguez, & Pedreira, 2011; Lee, 2008, 2009; St Jaques & Schacter, in press). Forcato and colleagues (2011) experimentally demonstrated that merely retrieving a memory was not necessarily sufficient to lead to memory enhancement, rather memory had to be reactivated proper (i.e. there has to be a mismatch component between the original expected memory and the reactivation procedure) for memory enhancement to occur. Wichert and colleagues (2013) tested whether repeated destabilisation and re-stabilisation resulting from multiple reactivations of a memory would render that memory increasingly resistant to reactivation techniques. Although repeated reactivation of a memory and subsequent reconsolidation has been shown to enhance a memory (Forcato et al., 2011; Wichert, Wolf, & Schwabe, 2011), it was still possible to repeatedly reactivate a memory and subsequently disrupt reconsolidation, resulting in memory modification in the form of interference effects. This suggests that the disruption of memory reconsolidation may not be a 'one time opportunity'. Anecdotally, this may corroborate the functionality of reconsolidation as an adaptive process whereby memory can repeatedly allow for the incorporation of new information *or* enhancement - an indispensable function for survival where new information is encountered on a daily basis.

Time Frame during which Memory Reconsolidation takes place

The period of time during which a memory reconsolidates becoming increasingly resistant to change is similar to consolidation. Studies using behavioural methods in humans as well as pharmacological agents in animal models suggest a time window of between 10 minutes and 6 hours (Schiller & Phelps, 2011) in which a memory is in a protein synthesis-dependent state and thus labile. Outside of this window, memories are protein synthesis-independent and resistant to change or modification (either enhancement or interference effects; Nader et al., 2000a; Schiller et al., 2010; Walker et al., 2003). The use of a 10 minute gap between memory reactivation and methods to disrupt reconsolidation processes has been used in several experiments. It is not clear however whether the 10 minute gap between memory reactivation and the deliverance of subsequent intervention designed to disrupt reconsolidation is required to ensure reconsolidation processes are 'optimal' (e.g. memory has begun to become labile

following reactivation) or whether the 10 minute gap is a necessary consequence related to the types of experimental paradigms in which reconsolidation is being investigated e.g. fear conditioning paradigms (J. E. LeDoux, personal communication, February, 2000). Within fear conditioning paradigms, protein synthesis may facilitate reconsolidation or extinction depending on how the reminder cue is presented (Pedreira & Maldonado, 2003; Suzuki et al., 2004). For example, memory is reactivated using a single presentation of a conditioned stimulus (CS). However, this is the same stimulus as the 'intervention' used to modify memory (e.g. extinction - repeated presentation of the CS so that it is no longer associated with a negative outcome, i.e. the UCS). Thus, if the two are undertaken in too close proximity, the memory reactivation cue may just become part of the extinction training and lose its ability to reactivate memory and induce reconsolidation.

Contrasting Memory Consolidation with Memory Reconsolidation

Newly acquired memories engage the MTL and hippocampus during consolidation. The retrieval of a consolidated, remote memory engages the hippocampus once again, as the memory undergoes reconsolidation (Myers & Davis, 2002). However, animal studies implicate independent cellular processes in memory consolidation and reconsolidation within the hippocampus (Lee, Everitt, & Thomas, 2004). This is corroborated by research which demonstrates that the consolidation of new information in memory requires hippocampal C/EBPβ (a protein that regulates neuron differentiation in the hippocampus) whereas this is not true for the reconsolidation of established memories (Lee, 2009; Taubenfeld, Milekic, Monti, & Alberini, 2001). Thus, despite both consolidation and reconsolidation recruiting the hippocampus, the two processes are not directly comparable. Research has also shown that the β-adrenergic blocker propranolol may disrupt not only the consolidation of fear memories (Pitman et al., 2002) but also the reconsolidation of fear memories (Brunet et al., 2008; Kindt, Soeter, & Vervliet, 2009). However, these findings have been inconclusive (Debiec & Ledoux, 2004; Milton et al., 2012) with one study finding that not all types of fear memory (e.g. inhibitory avoidance compared to auditory fear conditioning) respond to propranolol administration during reconsolidation (Muravieva & Alberini, 2010).

Literature investigating memory reconsolidation has demonstrated opposing effects of stress and emotional arousal on memory consolidation and reconsolidation, demonstrating enhancement and impairment respectively (Maroun & Akirav, 2008; Roozendaal, 2002; Schwabe & Wolf, 2010). However, findings are mixed, with recent

research demonstrating an enhancing effect of stress on memory (e.g. for learning syllable pairs or Swahili-English vocabulary pairs) subsequent to memory reactivation (Coccoz, Maldonado, & Delorenzi, 2011; Finn & Roediger III, 2011). The locations of processes which involve emotion and memory formation during reconsolidation are similar to those involved in consolidation e.g. the basolateral amygdala (Argen et al., 2012; Wang, Zhao, Ghitza, Li, & Lu, 2008).

Sleep, is known to play a role in the consolidation of memories has also been implicated in the stabilisation of reconsolidation of memories (Walker et al., 2003) where task performance (that had consolidated) only showed signs of modification following sleep. Furthermore, evidence of memory modification following the disruption of reconsolidation may not observable in behaviour (e.g. via subsequent memory tests) straight away and can take approximately 24 hours to become apparent, e.g. following sleep (Hupbach et al., 2007; Hupbach, Gomez, & Nadel, 2011) again suggesting the role sleep in the stabilisation of a reconsolidating memory.

Memory Reconsolidation - Clinical Implications

Reconsolidation may offer an opportunity to target dysfunctional memories that cause distress or maladaptive behaviours. Conventional wisdom suggested that once a memory is consolidated it is relatively resistant to modification, thereby limiting the effectiveness of treatment opportunities for pathological memories. However, the emerging reconsolidation literature suggests that there are certain conditions under which a consolidated memory can be made malleable again, requiring reconsolidation in order to persist in memory. By *disrupting* reconsolidation processes it may be possible to interfere with or modify the memory that is undergoing reconsolidation. Clinically disrupting reconsolidation might be used to extinguish a fear response (Brunet et al., 2008; Schiller et al., 2010) or diminish drug-associated memories which can lead to drug taking behaviours (Lee et al., 2006; Milton & Everitt, 2010; Xue et al., 2012).

Memory Reconsolidation in Experimental Designs involving Humans: Reviewing the Literature to Inform Experimental Intervention Design within the Thesis

Chapter 2 has thus far compared and contrasted memory consolidation and reconsolidation to illustrate that the two processes, although similar, are distinct. Next follows a review of the literature regarding human reconsolidation. This was to inform the design of experiments within the thesis which aimed to extend the time-frame between

viewing an analogue trauma and the use of a cognitive task to interfere with memory *reconsolidation* for the analogue trauma, from 4 hours (Holmes et al., 2010) to 24 hours. Research indicates that mere retrieval of a memory is not sufficient to initiate reactivation and subsequent memory reconsolidation, thus reviewing the literature may provide experimental clues as to disrupting memory reconsolidation for a trauma film viewed 24 hours earlier using the cognitive task Tetris.

Search Strategy

PubMed, Web of Knowledge and Scopus databases were searched from 2000 (when seminal animals studies rejuvenated research on reconsolidation; Nader et al., 2000a) through to February 2013 using the search terms, memory* reconsolidation AND human*. Results were refined by excluding the subject areas of physics, material science and engineering within the search and excluding review articles. Titles and Abstracts were used to screen suitable articles for inclusion. Articles were included in the review if they contained experimental research investigating memory reconsolidation in human participants.

The search yielded 29 published articles, containing 39 individual experiments. Table 2.1 provides information on each of these. The table contains 6 columns with the following information from left to right; (1) The reference for the research group in which the research was conducted; (2) the experimental paradigm used to investigate reconsolidation; (3) the interference method used to disrupt reconsolidation and the method used to reactivate memory; (4) the dependent measure used for each experiment; (5) the main finding and results, and (6) the conclusions that were derived from each experiment. Experiments within the table are also divided by memory type, e.g. procedural memory, episodic declarative memory.

Experiments that investigated being able to disrupt memory reconsolidation did so by demonstrating that memory for a consolidated memory (typically 24 hours old) had been modified (see Table 2.1 for specific methods of disruption). Thus, the disruption of the reconsolidation of a memory was said to occur upon demonstration of memory enhancement, removal or interference effects. Experiments within the review most commonly occurred in healthy, non-clinical populations. Exceptions included an experiment which used propranolol following script-driven memory reactivation of a trauma memory in individuals who have experienced a real traumatic event (Brunet et al., 2008) and another which investigated the modification of memory for drug-related words

in recovered heroin addicts (Zhao et al., 2011). An overriding finding was that merely retrieving a memory back into mind does not result in retrieval-induced plasticity, a signature of memory reconsolidation. As such, studies have begun to document several boundary conditions that may potentially impede memory modification occurring during memory reconsolidation as will be reviewed subsequently.

Boundary Conditions

Age of memory. The age of a memory may be a factor behind whether that memory is able to undergo reconsolidation and be subsequently modified. The majority of articles within the review investigated the modification of a 24 hour old memory (n = 24), the time frame being long enough to 'substantiate consolidation' (Soeter & Kindt, 2012a, 2012b). This widely used time-frame had been exceeded in several experiments. Schwabe and colleagues (2009; 2010) demonstrated that neutral episodic memories up to 2 week old may be updated with new information (Schwabe & Wolf, 2009) or impaired following a stressor (Schwabe & Wolf, 2010) following memory reactivation. Research has also specifically compared the effect of propranolol on recent and remote memories and in doing so has shown that it was possible to interfere with memory of pictures that had been learnt 7 days previously (Wichert et al., 2011).

Reconsolidation time-window during which memory is labile. To date, research indicates a time frame of between 10 minutes and 6 hours during which a reactivated memory is in a protein synthesis-dependent state (e.g. reconsolidating) and thus labile (e.g. Argen et al., 2012; Schiller et al., 2010). Outside of this time-window it appears that a memory becomes resistant to interference interpreted as meaning reconsolidation has concluded and the memory has stabilised and is resistant to change. This was demonstrated in a pioneering experiment that used a Pavlovian fear conditioning paradigm in human participants. The study showed that it was possible to modify a fear memory (i.e. conditioned fear response) by disrupting memory reconsolidation, using non-invasive, behavioural methods (in this instance using extinction training). This experiment also helped to identify boundary conditions surrounding reconsolidation processes in terms of the time frame during which memory is labile as it reconsolidates, and how long the effects of modification may persist. Schiller et al (2010) employed a 3-condition, between-group experimental design consisting of 3 consecutive stages, each 24 hours apart. On Day 1 participants underwent fear acquisition. The conditioned stimulus (CS) consisted of

yellow and blue squares and the unconditioned stimulus (UCS) was an electric shock to the wrist. There was partial reinforcement where the CS+ (a yellow square) was followed by a shock on 38% of trials with the CS- (a blue square) was never paired with the shock. Following fear acquisition, on Day 2 all participants underwent extinction training. Two of the 3 conditions had their fear memory reactivated (a single presentation of the CS+) 10 minutes *prior* to extinction training. Condition 1 had their fear memory reactivated then underwent extinction training after a 10 minute break. Condition 2 had their fear memory reactivated then underwent extinction training after a 6 hour break (outside of the time window where memory is thought to be reconsolidating) and Condition 3 did not have their memory reactivated but went immediately onto the 10 minute break followed by extinction training. Results demonstrated that the fear response (determined by changes in skin conductance) was extinguished, but only for those participants for which the CS+ was reactivated, and within 6 hours post-reactivation. Further, fear responses did not return and were not subject to spontaneous recovery (as is typically the case following extinction training in fear conditioning paradigms). Differences between conditions in fear responding lasted for at least one year, indicating that modifying memory during reconsolidation can lead to lasting alterations. This suggests that extinction training relating to memory consolidation and reconsolidation differ. Extinction of the CS during consolidation would seem to form a new memory and as such the original fear memory is susceptible to return (i.e. via reinstatement, spontaneous recover or renewal). However, the absence of a fear response following extinction trained during memory reconsolidation suggests that the original memory may have been modified (Graham et al., 2011)

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Memory reactivation – the importance of the retrieval cue. A consistent and major finding throughout the literature on memory reconsolidation was that a targeted memory may only be modified following memory retrieval or 'reactivation'. Thus, mere memory retrieval is not necessarily sufficient to initiate reconsolidation and retrieval-induced plasticity. Retrieval *must* result in the memory becoming reactivated i.e. the memory destabilises requiring another round of protein synthesis in order to persist. Indeed, it has been asserted that experiments may only infer that they have interfered with memory reconsolidation if they can show that modification effects would **not** occur if memory was not 'reactivated' (Schiller & Phelps, 2011; Schwabe & Wolf, 2010). Thus, retrieval of the memory resulting in memory reactivation is a crucial component, for which research indicates there are also several boundary conditions.

The 'mismatch' component. Memory retrieval and subsequent reactivation is triggered by a reminder of an event that is a similar, but not identical, experience to the original (Lee, 2009; Schiller & Phelps, 2011; Sevenster, Beckers, & Kindt, 2012, 2013; St Jaques & Schacter, in press). It has been suggested that this mismatch component, or 'prediction error' (Sevenster et al., 2013), is crucial and that retrieval without a sufficient mismatch does not result in memory modification. For example, Forcato and colleagues (2011) demonstrated that mere memory retrieval was not sufficient to lead to memory modification (in this instance retrieval did not lead to memory enhancement) rather memory had to be reactivated proper (e.g. there has to be a mismatch component between the original expected memory and the reactivation procedure) in order for memory strengthening to be demonstrated. Findings which have systematically explored levels of 'prediction error' in tasks designed to reactivate memory also corroborate the need for a mismatch component to reactivate memory (Sevenster et al., 2012, 2013).

Context-cues. Within the current review it was demonstrated in several cases that returning to the same contextual environment in which initial memories are formed can act as a reminder, and thus help facilitate the reactivation and subsequent reconsolidation of memories (e.g. Hupbach et al., 2007; Hupbach et al., 2011). This is consistent with theories of general memory which evidence context-dependent memory effects (for example, that memory benefits when the spatio-temporal, mood, physiological or cognitive context at retrieval match that of encoding; Godden & Baddeley, 1980; Smith & Vela, 2001). Experiments have specifically tested and capitalised on contextual-cue effects in order to facilitate a mismatch component between what occurred during initial learning and memory retrieval and initiate memory reactivation (Forcato, Argibay, Pedreira, & Maldonado, 2009; Hupbach et al., 2011; Hupbach, Hardt, Gomez, & Nadel, 2008). Contextual cues serving as a reminder cue to reactivate memory have yet to be explicitly tested in experimental studies relating to emotional or fear-response memories.

When does memory modification following the disruption of reconsolidation become apparent in behaviour? As discussed previously in this chapter, memory modification as a result of memory reconsolidation disruption may not necessarily become immediately observable in behaviour. Literature indicates that there may be a delay of approximately 24 hours between memory reconsolidation disruption and memory modification that can be observed in behaviour (Hupbach et al., 2007; Hupbach et al., 2011; Walker et al., 2003).

Synthesising the Literature to Inform Experimental design within the Thesis

Experimental research detailing the boundary conditions that may impede the successful initiation of memory reconsolidation indicate that, in order for studies within the thesis to capitalise on memory reconsolidation processes several conditions must be met. Experiments 1 and 2 aim to extend previous research using the trauma film paradigm and lengthen the time frame from 4 hours (during consolidation) to 24 hours (during reconsolidation) to test whether a simple cognitive task (Tetris) can disrupt memory reconsolidation for aversive material resulting in a reduction in subsequent flashbacks. A period of 24 hours between the initial learning event and a form of 'intervention' (a method for modifying flashback memory development) has been consistently employed in literature on human reconsolidation and represents a logical next step in extending the time frame between analogue trauma (film viewing) and Tetris game play to interfere with flashback memory frequency. Studies typically use experimental designs that occur across 3 sessions on 3 separate days. For example, Session 1 = fear acquisition, Session 2 (24 hours later) = memory reactivation followed by an intervention to disrupt reconsolidation and finally Session 3 = demonstration of memory modification. Thus, a study investigating the disruption of the reconsolidation of flashbacks using the trauma film paradigm should also seek to employ a similar design layout in terms of experimental session.

Following reactivation, memory becomes increasingly resistant to interference effects as it begins to re-stabilise. Thus, studies within the thesis may find it beneficial to model those within the review which have found that modification was apparent only for those memories that had been disrupted between 10 minutes and 6 hours after reactivation.

A method for reactivating memory of the trauma film, 24 hours after viewing is a crucial consideration, in order to be able to disrupt reconsolidation and modify the memory with the cognitive task Tetris. Literature from within the current review demonstrated that memories that had been modified through the disruption of reconsolidation were reactivation dependent, i.e. approaches used to intervene and modify memory reconsolidation were not successful in the absence of memory reactivation.

A main caveat for memory reactivation was that there has to be a mismatch component or violation of expectation between initial learning and the subsequent retrieval cue. Accordingly, it can be hypothesised that merely asking participants to view the trauma film viewed 24 hours previously would not be sufficient to reactivate memory. Furthermore, it is unclear the extent to which situational context effects may help facilitate

a mismatch component between initial reaction and retrieval cue, e.g. would a familiar context between film viewing on day 1 and participants' return on day 2 increase expectation that they will view the film again, thereby increasing the violation of expectation when a task designed to reactivate memory plays in place of the film.

There was not any one single method that was used to reactivate memory, due in part to the different nature of the types of memories and the experimental paradigms being used. Within the literature it was possible to identify two broad categories of memory reactivation tasks: (1) those which appeared to reactivate the original learning experience as a whole (albeit one that incorporated a mismatch) and, (2) those that target discrete episodes from memories occurring within the original learning experience. An example of the former approach include a series of studies in which paired syllables were learnt on day one in a specific laboratory set-up, and then 24 hours later participants returned to the same laboratory set up with identical instructions that participants were about to learn some paired syllables. The procedure at the start of the experiment was therefore the same as original learning. However, after the first syllable-pair cues an error message appeared, so that learning was interrupted (Coccoz et al., 2011; Forcato et al., 2009; Forcato et al., 2007; Forcato et al., 2011; Forcato et al., 2010). This mismatch from day 1 to day 2 allowed for the subsequent disruption of reconsolidation when participants were required to learn new syllable pairs. Similarly, a series of studies in which participants were asked to memorise a series of objects capitalised on the specificity of the learning experience (e.g. returning to the same laboratory with the same experimenter as the original learning) in addition to getting participants to talk about the events surrounding the learning (but not the list that was learnt *per se*) in order to reactivate memory (Hupbach et al., 2007; Hupbach, Gomez, & Nadel, 2009; Hupbach et al., 2011; Hupbach et al., 2008). Thus, such an approach suggests that although original learning may involve multiple components to be memorised (e.g. different sets of syllable pairs, different objects within a list of items to be learnt) reactivation does not necessarily have to be for each individual item, but can be for the experience as a whole.

Alternatively, the other broad approach to reactivating memories was to target each discrete memory from the original learning experience, e.g. providing individual reminder cues for series of autobiographical memories (Schwabe & Wolf, 2009, 2010). Similarly, within fear conditioning paradigms the provision of the conditioned stimulus without the expected accompanying shock could be viewed as targeting the specific fear memory association rather than the experience of learning as a whole (Argen et al., 2012; Schiller et

al., 2010; Soeter & Kindt, 2010, 2011). To date, no studies have investigated the modification (via interference) of emotional, involuntary flashback memories to (analogue) trauma. Due to the novel use of the trauma film paradigm in memory reconsolidation literature, the study design may benefit from preliminary work in order to ascertain if one particular strategy may work best to 'reactivate' memory for a trauma film.

Finally, tactics used to disrupt reconsolidation were multiple and included behavioural methods such as extinction training within conditioning paradigms (Golker, Bellander, Olsson, & Ohman, 2012; Oyarzún et al., 2012; Schiller et al., 2010). They also included behavioural tasks designed to capitalise on retroactive interference during the reconsolidation time window, e.g. learning new keyboard tapping sequences (Walker et al., 2003), syllable-pair lists (Finn & Roediger III, 2011; Forcato et al., 2007), memorising different sets of still images (Wichert et al., 2013), verbally describing the procedures involved around previous learning (Hupbach et al., 2007; Hupbach et al., 2009), as well as being asked to memorise a fictional story (Schwabe & Wolf, 2009). Experimental work that investigated the modification of fear memories via non-invasive behavioural means (e.g. extinction training during reconsolidation) may be considered the most similar to experimental work within the thesis that aims to modify emotional, involuntary flashback memories to analogue trauma, e.g. both are clinically relevant to PTSD.

Pharmacological approaches have also been used as a method to disrupt reconsolidation in humans with studies investigating the use propranolol to reduce fear response (e.g. Brunet et al., 2008; Soeter & Kindt, 2010; Wichert et al., 2011; Zhao et al., 2011) and clonazepam on the enhancement of memory during reconsolidation (Rodriquez et al., 2013). However, strategies which use non-invasive, behavioural approaches to disrupt reconsolidation and modify existing memories provide support for the proposition that, *if* memory for a traumatic film viewed 24 hour previously can be reactivated, the cognitive task Tetris may be sufficient to interfere with reconsolidation, as it has done with consolidation.

Chapter 3 provides pilot work related to the experimental studies presented within the thesis which seek to test whether, 24 hours after viewing aversive film material, playing the computer game Tetris can interfere with the reconsolidation of flashback memories to the film. It is based on the literature reviews carried out in Chapters 1 and 2 and was carried out to consider, (i) the design of a new visual recognition memory test for the film, as hitherto only a verbal-based recognition memory test had been used; (ii)

investigate the utility of a 3-session laboratory-based design using the trauma film paradigm and (iii) explore how best to 'reactivate' memory for a consolidated (24 hour old) trauma film, so that Tetris may interfere with its reconsolidation, subsequently resulting in fewer flashbacks being experienced of the film.

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
Procedural Memory					
(Walker et al., 2003)	Sequenced Finger tapping	Post reactivation learning of a new finger tapping sequence Reactivation = single practice of previously learned sequence	Speed and accuracy of finger tapping	Reduced performance for reactivated sequence followed by new learned sequence	Performance was only affected following sleep; demonstrating memory updating/modification is not immediate
Episodic – Declarative Memory					
(Hupbach et al., 2007)	Learning object lists	Post reactivation learning of new object list. Reactivation = participants are asked the retrieval question can you verbally describe the general learning procedure (without mentioning specific list items)	Recall of list objects originally learnt	**Expt. 1** Intrusions from second list learnt in original list learnt (but not other way around; known as memory updating effect) **Expt. 2** Effects on memory following reactivation and new learning were time dependant e.g. the effects are not apparent straight away. **Expt. 3** Source monitoring difficulties was not an explanation for findings	Reactivation should not be identical to original learning to reactivate memory Effects of memory updating may not become apparent immediately (approx. 24 hr.)

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
(Hupbach et al., 2008)	Learning object lists	Post reactivation learning of new object list Reactivation: **Expt. 1** a) different experimenter and different room but same retrieval question (describe learning procedure but not list themselves) b) same experiment, different room, no question c) same room, different experimenter and no question **Expt. 2** a) same experimenter and room but no reminder question; b) same experimenter and the reminder questions but in different room; c) Same room, reminder question but different experimenter. **Expt. 3** a)Mentally reinstatement (imagining) of spatial context	Recall of list objects	**Expt. 1** Intrusions from second list into the original list learnt was only observed for the group who had learned both lists in the same room. **Expt. 2** Both groups in the same room/context had memory Intrusions from the second list learnt into the original list, but not more so than experienced in Expt. 1. Spatial context necessary and sufficient to cause memory updating **Expt. 3** Imagining spatial context or a brief exposure was not sufficient to act as a reminder before learning of list 2	Spatial context may be crucial part of memory reactivation allowing for memory updating Spatial context necessary and sufficient to cause memory updating

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
		b) briefly seeing room from original learning before going elsewhere			
(Hupbach et al., 2009)	Learning object lists	Post reactivation learning of new object list. Reactivation: same room, experimenter and question asking to recall procedure of earlier learning. Additional recognition memory test and asked from what session objects from (with foils).	Recall of list objects	The incorporation of list two into the original was not mis-attribution of some details from post-event information into list original event.	Memory following reactivation was updated rather than being a produce of source errors
(Hupbach et al., 2011)	Learning object lists	Post reactivation learning of new object list Reactivation: same room, experimenter and question asking to recall procedure of earlier learning **Expt. 1** Children in day care setting. (5 yrs.) **Expt. 2 a + 2 b** Does a familiar context e.g. home, act as a reminder sufficient to reactivate memory for children	Recall of list objects	**Expt. 1** Intrusions from second list learnt in recall of original list only occurred when both lists learnt in same spatial context. Relationship between target recall and intrusion levels indicating that stronger memories are less likely to be updated. **Expt. 2 a** Familiar context alone does not suffice as a reminder to reactivate memory	Familiarity of the spatial context modulates the role of spatial context as a successful memory reactivation condition; the more familiar it is the less likely it will serve to reactivate a memory Effects of memory updating may not become apparent immediately (approx. 24 hr.)

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
				Expt. 2 b The effects of memory updating are not immediately observable	
(Forcato et al., 2007)	Paired-associate learning	Post reactivation learning of a new paired-associate syllable list. Reactivation = context reminder (same laboratory and introduction to the experiment procedure) with single presentation of one cue syllable	Cued recall of syllables	More recall errors. First list updated with items from second but not vice versa	Reconsolidation window is between 6 -10 hrs. post initial reactivation.
(Forcato et al., 2009)	Paired-associate learning	Post reactivation learning of a new paired-associate syllable list. Reactivation = context reminder (same laboratory and introduction to the experiment procedure) with single presentation of one cue syllable without response syllable	Cued recall of syllables	No updating effect e.g., memory is not labile if there is no cue reminder to reactivate memory	Reactivation task is crucial in order to begin reconsolidation process. There needs to be mismatch (prediction error) between initial learning and reactivation task

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
(Forcato et al., 2010)	Paired-associate learning	Post-reactivation learning of a new paired-associate syllable list. Reactivation = context reminder (same laboratory and introduction to the experiment procedure) with single presentation of one cue syllable without response syllable	Cued recall of syllables	First list explicitly updated with new information	A verbal instruction was necessary following reactivation in order for participants to explicitly update a consolidated memory
(Forcato et al., 2011)	Paired - associate learning	Post-reactivation learning of a new paired-associate syllable list following multiple reactivations: one, two or four reminders for a syllable pair. Reactivation = Context reminder (same laboratory and introduction to the experiment procedure) with single presentation of one cue syllable without response syllable. Multiple reactivations: one, two or four reminders for a	Cued recall of syllables	Memory for paired syllables strengthened where there were two or more memory reactivations. Multiple memory retrievals without mismatch component (e.g. memory was not reactivated) did not strengthen memory Multiple memory reactivations only strengthen memory if they are within 6 hr. of each other	Memory for paired syllables was strengthened where there were two or more memory reactivations Memory enhancement was not due to mere retrieval of the memory, but the repeated destabilisation / re-stabilisation of the memory (e.g. reconsolidation) There is a time window of 6 hrs. where by multiple reactivations of a memory can lead to its enhancement

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
		syllable pair.			
(Rodriquez et al., 2013)	Paired - associate learning	Post-reactivation new learning of paired associate syllables with the administration of clonazepam	Cued recall of syllables	Those who had their memory reactivated followed by clonazepam had improved memory	Clonazepam enhances memory during reconsolidation
(Finn & Roediger III, 2011)	Paired - associate learning Swahili-English pairs	Post-reactivation stressor (negative pictures) following learning Reactivation = Correct retrieval of a Swahili word's English pair. Learning, reactivation and final recall of pairs all took place on the same day	Recall of Swahili-English pairs	**Expt. 1** Enhanced recall for items followed immediately by a negative image **Expt. 2** Enhanced recall for items followed 2 sec by a negative image **Expt. 3** There was not enhanced recall for items that were not successful reactivated but were followed by a negative image	Negative affect following memory reactivation can enhance memory for reactivated memory. Memory reactivation crucial in order to demonstrate enhancing effects
(Coccoz et al., 2011)	Paired - associate learning	Post-reactivation stressor (cold pressor stress) following learning Reactivation = Context period (colour light, image then music in sequence)	Recall of syllables	Improved recall for those who had their memory reactivated then the cold pressor stress. Reactivation task must	A stressor following memory reactivation can enhance memory during reconsolidation. Mismatch component

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
		followed by expected cue – syllable then error notice so participants did not get chance to not the syllable pair		include prediction error. When participants allowed to complete syllable pair effects were not seen	crucial to reactive memory
Emotional Episodic Memories					
(Schwabe & Wolf, 2009)	Recall of neutral or emotional autobiographical memories (at most 2 wks. old)	Post-reactivation memory interference via learning of a story 'war of the Ghosts' Reactivation of autobiographical memory via autobiographical memory cueing test	Number of details remembered of auto-biographical memories	Fewer details recalled for neutral (but not positive or negative) memories only for those whose memory was reactivated first	Neutral autobiographical memories can be modified by interfering with reconsolidation via new learning. Reactivation of target memory crucial prior to interference.
(Schwabe & Wolf, 2010)	Recall of neutral or emotional autobiographical memories (at most 2 wks. old)	Post-reactivation stressor (cold pressor test) Reactivation = autobiographical memory cueing test	Number of details remembered of auto-biographical memories	Fewer details recalled for neutral (but not positive of negative) memories for participants who experienced a cold pressor test after memory reactivation	Stress can impair the reconsolidation of neutral autobiographical memories. Reactivation of target memory crucial prior to stressor test

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
(Wichert et al., 2011)	Learning neutral and negative images (50 x IAPS)	Propranolol administered 60 min prior to memory reactivation for 1, 7 and 28 day old memories. Reactivation = 2 min of recall (in mind only) of original learning	Recognition of previously learned images [mixed with foils]	Reduced memory recall for original learning was only modified following reactivation on Day 7. Reactivation only (with no interference via new learning) resulted in enhanced memory for original learning	Memory reactivation on its own may enhance memory recall
(Wichert et al., 2013)	Learning neutral and emotional images (50 x IAPS)	Post-reactivation memory interference via new learning Reactivation = 2 min of recall (in mind only) of original learning **Expt. 1** One reactivation **Expt. 2** Two reactivations **Expt. 3** Three reactivations	Recognition of previously learned images [mixed with foils]	Reduced memory recall for original learning for all experiments 1 through 3.	Multiple reactivations may still render memory vulnerable to modification via interference during reconsolidation
(Schwabe, Nader, & Pruessner, 2013)	Learning of neutral and negative pictures (50 x IAPS)	Propranolol administered 60 min prior to memory reactivation. Reactivation = 2 min of recall (in mind only) of original learning	Recognition of previously learned images mixed with foils	Reduced memory (fewer 'remember' judgements) for negative images for participants in the propranolol followed by reactivation condition	Propranolol before memory reactivation disrupts reconsolidation of negative memories. Reactivation of target memory crucial

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
Emotional Post-Trauma Memory					
(Brunet et al., 2008)	Script-driven reactivation of traumatic memory in patients with PTSD	Post-reactivation Propranolol administration Reactivation = describing the memory which caused their PTSD	Change in differential conditioned response; HR SCR; & left corrugator electromyogram	Reduction in physiological responses; HR, SCR and left corrugator electromyogram Expectancy rating (awareness of what images is reinforced by a shock e.g. CS+) remained	Beta-adrenergic blockade during reconsolidation reduced the expression of fear
Emotional Associative Learning					
(Kindt et al., 2009)	Fear conditioning UCS = Electric wrist shock CS = spider image	Propranolol administration 90 min prior to memory reactivation Reactivation = single presentation of the CS+ unreinforced (no shock)	Change in differential conditioned response eye blink startle; expectancy rating (awareness of what images is reinforced by a shock e.g. CS+)	Reduction in eye blink startle response Expectancy rating (awareness of what images is reinforced by a shock e.g. CS+) remained	Beta-adrenergic blockade during reconsolidation prevented the expression of fear eye blink startle response
(Soeter & Kindt, 2010)	Fear conditioning UCS = Electric wrist shock CS = spider images	Propranolol administration 90 min prior to memory reactivation Reactivation = single presentation of the CS+	Change in differential conditioned response: Eye blink startle.	Reduction in startle response with intact declarative memory for the fear stimulus (expectancy rating for image associated with shock e.g. CS)	Beta-adrenergic blockade during reconsolidation via Propranolol prevents expression of fear eye blink startle response. Cognitive expectancy rating intact.

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
		unreinforced (no shock)	Expectancy rating	Startle response was not subjec to spontaneous recovery at 1 month Expectancy rating (awareness o what images is reinforced by a shock e.g. CS+) remained	Effect persisted at 1 month. Reactivation of target memory crucial
(Soeter & Kindt, 2012a)	Fear conditioning UCS = Electric wrist shock CS = Gun and spider pictures	**Exp. 1**: Propranolol administration 90 min prior to memory reactivation **Exp. 2**: Post- memory reactivation Propranolol administration Reactivation = single presentation of the CS+ unreinforced (no shock)	Change in differential conditioned response: startle response	**Exp. 1**: Memory strengthened via α 2-adrenergic receptor antagonist prior to acquisition = delayed extinction training. Propranolol prior to reactivation reduce fear response **Exp. 2**: Propranolol administered post reactivation led to a reduction in startle response	Noradrenergic strengthening of a fear memory impairs extinction training but not reconsolidation interference via Propranolol. Propranolol demonstrated effects when administered prior to reactivation *and* after reactivation
(Soeter & Kindt, 2012b)	Subjective fear learning UCS = expected shock with none given CS – spider images	Propranolol administration 90 min prior to memory reactivation Reactivation = single presentation of the CS+ unreinforced (no shock)	Change in differential conditioned response: eye-blink startle Subjective anxiety, SCR and expectancy rating	Behavioural responses such as eye-blink startle response and subjective rating of anxiety were reduced post reactivation/propranolol administration. Physiological SCR and cognitive expectancy ratings were not reduced	There might be differences in the types of memory traces that can be modified following reconsolidation.

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
(Schiller et al., 2010)	Fear conditioning UCS = Electric shock CS = geometric shapes	Post-reactivation interference through extinction training. Reactivation = single presentation of the CS+ unreinforced (no shock) 10 min break in-between reactivation and interference procedure	Change in differential conditioned response; eye-blink startle response	Reduction in startle response with intact declarative memory for the fear stimulus. Effect persisted at 1 year.	Reactivation of target memory crucial prior to interference.
(Argen et al., 2012)	Fear conditioning: UCS = Electric shock. CS= Coloured lamp photo	Post-reactivation interference through extinction training 10 min break in-between reactivation and interference procedure. Reactivation (e.g. presentation of CS) lasted 2 min	Change in differential conditioned response: SCR Activity in the basolateral amygdala	Greater activity bilaterally in the BLA group who had reconsolidation disrupted. Positive correlation between return of fear and BOLD activity No effect of interference when occurs 6 hr. post reactivation	Reactivation of target memory crucial prior to interference. Reconsolidation lasts between 10 min and 6 hr. Extinction training during reconsolidation erases fear memory trace in amygdala
(Oyarzún et al., 2012)	Auditory fear conditioning: UCS = Electric shock CS= Aversive sound	Post-reactivation interference through extinction training 10 min break in-between reactivation and interference procedure	Change in differential conditioned response: SCR	Reduction in SCR. fear response was permanently extinguished – it was not prone to reinstatement	Reactivation of target memory crucial prior to interference.
(Golker et al., 2012)	Fear conditioning UCS = Electric	Post-reactivation interference via extinction training.	Change in differential conditioned	**<u>Expt. 1</u>** Recovery of physiological fear response following	A single reactivation cue was not sufficient i.e. the fear responses were not

Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
	shock **Expt. 1** CS = Fearful faces **Expt. 2** CS = geometric shapes	10 min break in-between reactivation and interference procedure	response; eye-blink startle; SCR	extinction. **Expt. 2** Recovery of physiological fear response following extinction.	erased during extinction for either fear relevant (emotional faces) or irrelevant (geometric shapes) stimuli. Findings are hypothesised to be due to memory strength acquisition (stronger memories more resistant to reconsolidation and updating mechanisms
(Sevenster et al., 2012)	Fear conditioning UCS = Electric shock CS = spider images	Propranolol administration 90 min prior to memory reactivation Reactivation = - single presentation of CS with no shock + no electrodes (prediction error absent) - single presentation of the CS with no shock + electrodes (prediction error present)	Change in differential conditioned response: eye-blink startle and SCR	There was no effect of propranolol on conditioned response in the group where there was no 'prediction error'.	Memory retrieval requires a 'prediction error', e.g. something new needs to be learnt when memory is retrieved in order for reactivation to occur
(Sevenster et al., 2013)	Fear conditioning UCS = Electric shock	Propranolol administration 90 min prior to memory reactivation (either with or without new learning/prediction error)	Change in differential conditioned response SCR; Eye-blink startle	No effect of propranolol prior to reactivation if reactivation cue does not contain new information, e.g. if there is no prediction error	Memory retrieval should contain new information for memory reactivation and subsequent modification Reactivation of target

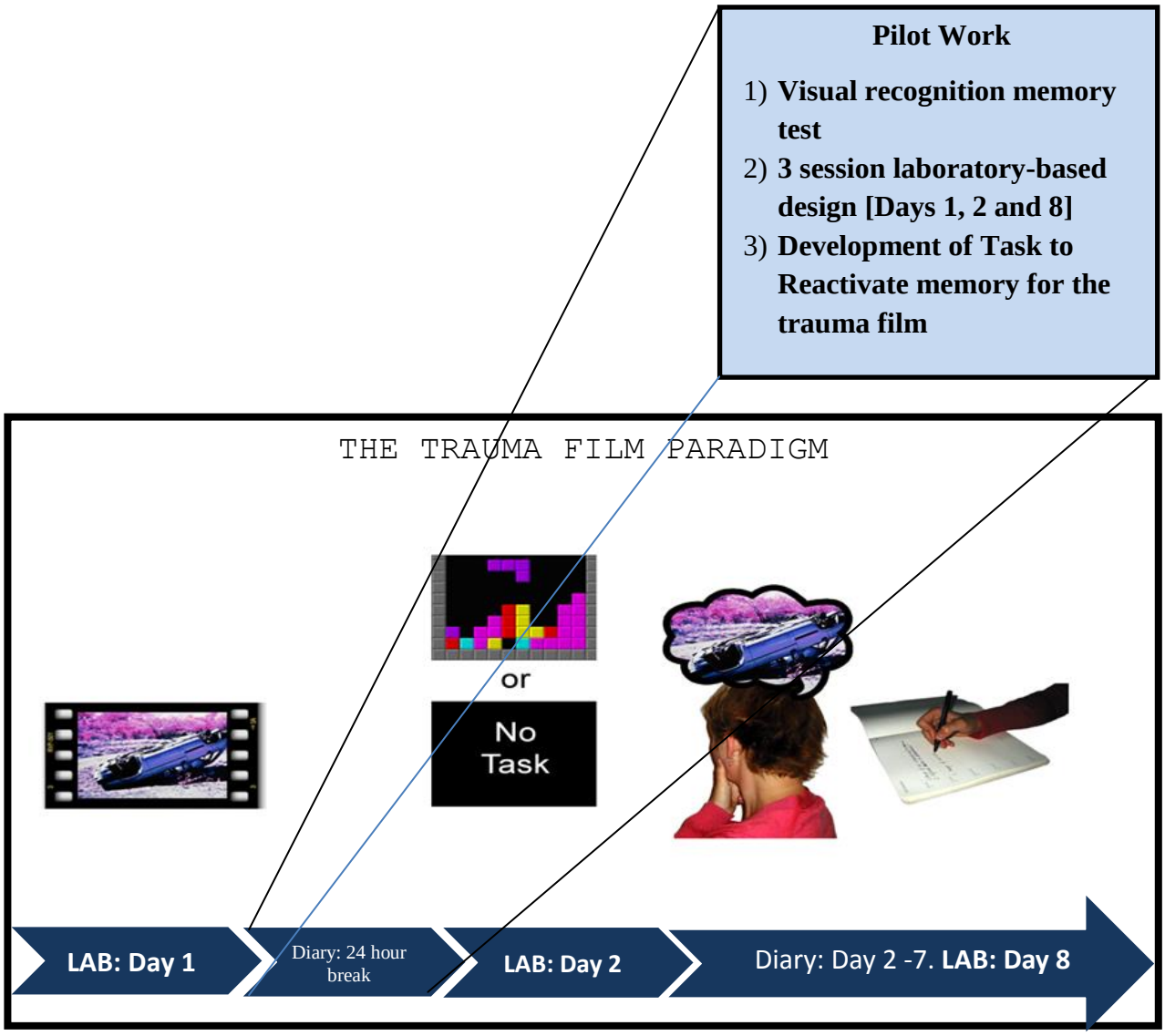
Table 2.1. *Studies in Which Human Memory has been Tested for Modification as a Consequence of the Disruption of Reconsolidation*

Reference	Paradigm	Interference Method & Reactivation Method	Dependent Measure	Main Findings	Conclusions
	CS = spider images		response; expectancy measure		memory crucial
(Zhao et al., 2011)	Recall of drug related words; negative, positive and neutral	β-adrenergic receptor blockade using receptor antagonist Propranolol	Free recall of drug related words	Fewer recalled and negative themed drug related words if given propranolol administered prior to reactivation. No change for neutral related words	Memory modified only for words with emotional association Reactivation of target memory crucial
(Xue et al., 2012)	Cue induced heroin craving in abstinent heroin addicts	Post-reactivation interference through extinction training Reactivation = 5 min duration: heroin-cue exposure 10 min break in-between reactivation and interference procedure	Subjective craving for heroin measured using VAS Change in heart rate and blood pressure	Post reactivation extinction training reduced subjective craving only if it was completed between 10 min and 6 h of memory reactivation. Effect persisted when tested on 1, 30 and 180 days after extinction A trend was found for blood pressure change, but not heart rate	Memory modified only if reactivation followed by extinction between 10min and 6 h Reactivation of target memory crucial Reactivation lasted 5 min, suggests stronger reactivation cues required for stronger memories

Note. BOLD = Blood Oxigen Level Dependent; CS = Conditioned Stimulus' IAPS = International affective picture systems (Lang et al); SCR = Skin Conductance Response; UCS = Unconditioned Stimulus; VAS=Visual Analogue Scale

CHAPTER 3

Pilot Work: Preliminary Considerations of New Measures and Procedures using the Trauma Film Paradigm to Target Reconsolidation



Procedural overview adapted from Holmes et al., 2009

Pilot Work: Preliminary Considerations of New Measures and Procedures using Trauma Film Paradigm

Overview

Chapter 1 reviewed literature in which experiments had used the trauma film paradigm to investigate trauma responses, most commonly flashbacks. Four hours marked the maximum time-frame between analogue trauma film viewing and the use of a cognitive task (Tetris) to reduce flashbacks. Chapter 2 reviewed literature on experimental research on memory reconsolidation in humans. Findings indicated that consolidated memories (24 hour old) may become labile following retrieval and subsequent 'reactivation.' Based upon these findings small scale, pilot work was conducted with the aim of considering new methods that aimed to investigate whether; using the trauma film paradigm a consolidated (24 hour old) memory for a trauma film would be modifiable, via interference by Tetris game play.

The pilot work had three aims; (1) to develop a visual recognition memory test for the trauma film (as hitherto only a written test had been used); (2) to investigate the practical feasibility a implementing a novel 3-session experimental design using the trauma film paradigm as previously only 2-session designs had been used and, (3) to consider approaches for 'reactivating' memory for a trauma film that had been viewed 24 hours earlier.

Is a *Verbal* Recognition Memory Test Sufficient to Assess Memory for the Trauma Film?

Previous studies which have used interference tasks to disrupt memory consolidation of traumatic film materials with the aim of modulating flashback development have looked at voluntary (i.e. intentionally recalled) recognition memory for the film at one week post-film viewing (e.g. Deeprose et al., 2012; Holmes et al., 2009; E. A. Holmes, E. L. James, et al., 2010). This was accomplished using a verbal-based recognition memory test, comprised of several true/false items per film clip, such as '*The little girl has blood coming from one of her nostrils*' and '*an old man wearing a hat looks towards the accident in shock*.' Studies demonstrated that recognition memory scores between the visuospatial and no-task control conditions did not statistically differ despite the visuospatial condition experiencing fewer flashbacks for the film in the subsequent week. This has been interpreted as the visuospatial task targeting involuntary retrieval of image-based representations of the film rather than voluntary retrieved recognition

memory of the film. However, the written-verbal recognition memory test may arguably only test verbal-based recognition memory, leaving visual recognition memory for the film insufficiently explored. Thus, the development of a *visual* recognition memory test would complement a written test to examine visual memory for the film.

A visual memory test was developed to assess deliberately recalled recognition memory for visual aspects of the trauma film by adapting procedures which had been used in previous experimental research (e.g. Kindt & van den Hout, 2003; Kindt, Van den Hout, & Buck, 2005; Wegner, Quillian, & Houston, 1996).

The visual recognition memory test consisted of 22 static images, some of which were taken from the trauma film viewed by participants. There were 2 static images linked to each of the 11 scenes from the film. Of the 22 static images 11 were 'filler' images not from the film. These 'filler' images were either part of the film clips that participants had not seen because they had been edited out of the final film or, if this was not possible, they were of similar theme (Wegner et al 1996). A maximum score of 22 correct responses could be obtained. The visual memory test was administered on the third and final laboratory session, 8 days following film viewing. Participants watched the 22 images, shown one at a time on a PowerPoint presentation (set on a 5 second rotation) and were asked to circle '*yes*' or '*no*' on an answer sheet provided as to whether they recognised the image as being from the film they watched 8 days earlier (see Appendix 3.1 for the still images used in the test).

Performance was assessed in the current preliminary study in order to test whether the new visual memory test was not prohibitively difficult or too easy (i.e. that there were no apparent floor or ceiling effects, respectively, that could render the test scores meaningless).

Will Participants Attend 3 Separate Laboratory Sessions?

Previous studies upon which the experiments within this thesis have been developed have used 2 session design framework within the trauma film paradigm, whereby participants are required to attend the laboratory twice in order to complete the experiment. As described previously in Chapter 1, participants view the trauma film on session 1 (day 1). Afterwards participants are required to leave the laboratory and keep an intrusion diary for flashbacks to the film. Participants then return to the laboratory a second time with their completed intrusions diaries (see Table 3.1).

Table 3.1. *Overview of a Simple 2-Session Design commonly used within the Trauma Film Paradigm*

Laboratory Session 1 (Day 1)	**1-week Intrusion Diary**	**Laboratory Session 2 (Day 7)**
Trauma film viewing		Return of diary Convergent intrusion measures

In order to be able to investigate whether, 24 hours after trauma film viewing flashbacks can be modified using Tetris to intervene with memory reconsolidation, the typical 2-session design had to be adapted to allow for a 24 hour break between film viewing and the Tetris game play intervention. Thus, participants would be required to attend three laboratory-based sessions in total (Table 3.2). Participants would view the trauma film on session 1 (day 1) after which they would leave the laboratory and keep an intrusion diary until their return 24 hours later for session 2 (day 2). During session 2 (day 2) participants would be randomly assigned to experimental condition and, upon completion, sent away from the laboratory for a further 7 days to continue filling out the intrusion diary. Participants return for the third and final session on day 8 and undertake convergent measures of flashback frequency and recognition memory tests for the film. Sessions 1 and 2 would be 24 hours apart (to within 2 hours), with session 3 being exactly 7 days after session 2 (also within two hours). The strict time frame was to ensure participants received comparable amounts of time to record flashbacks in the diary. Further, the insertion of the intrusion diary 24 hours after film viewing and prior to participants' return the laboratory meant it was possible to compare numbers of flashbacks prior to assignment to experimental condition.

Table 3.2. *Overview of a Novel 3-Session Design using the Trauma Film Paradigm*

Laboratory Session 1 (Day 1)	**24 hours Intrusion Diary**	**Laboratory Session 2 (Day 2)**	**1-week Intrusion Diary**	**Laboratory Session 3 (Day 8)**
Trauma film viewing	→	Assignment to condition		Return of diary; Convergent intrusions measures; Recognition memory tests
Break during which memory consolidates (24 hours)				

Three session designs are widely employed for experimental design in the reconsolidation literature (e.g. Schiller & Phelps, 2011; see Chapter 2) however to my

knowledge this has yet to be employed using the trauma film paradigm. As such, pilot work hoped to evaluate whether the design was feasible. For example, would participants be willing and able to attend 3 separate laboratory sessions within the time restrictions required by the experiment?

Memory Retrieval: What Approach Might Reactivate Memory for a Trauma Film?

Previous research using Tetris game play shortly after film viewing during the memory consolidation phase (e.g. following a 30 min break in Holmes et al., 2009; or a 4 hour break in Holmes, James, et al., 2010) had given participants a brief 'reminder' task for the film immediately prior to playing Tetris in order to bring the film back to mind after the break which occurred after film viewing. The reminder task consisted of 11 neutral, still images (one for each scene within the film) of the moment immediately prior to the 'worst' moment. The still images were played on power point presentation, on a 3 sec automatic rotation in a fixed order (that of the clips within the film).

Literature on memory reconsolidation in human participants, reviewed in Chapter 2, identified two broad approaches that were used to retrieve and subsequently reactivate memory in order to disrupt reconsolidation. Those which provided a reminder for discrete incidents within the memory and those which targeted memory for the learning experience as a whole. The brief 'reminder' task from previous studies (Holmes et al., 2009; Holmes et al., 2010) seemingly matches the former approach by giving a reminder for each of the film clip incidences, without being a direct replay of the film viewed previously, thus providing a 'prediction error' (Sevenster et al., 2013) thought necessary for reconsolidation initiation. However, the current pilot work sought to consider alternative approaches, e.g. those targeting memory for the learning experience per se, to explore whether such an approach would work to reactivate memory for the trauma film viewed 24 hours earlier (i.e. Forcato et al., 2009; Forcato et al., 2007; Forcato et al., 2010).

Forcato and colleagues (2009; 2007; 2010) showed that following memory reactivation it was possible to update a memory with new information for cue-syllable associations. The specific experimental procedure involved participants learning pairs of syllables on session 1. They then returned 24 hours later, for which the procedure of session 2 matched the earlier learning procedure for session 1. However, just before participants were about to receive the second half of a cue syllable, an error message appeared on the computer screen. The error message, designed by the Forcato research group, had the express purpose of installing a mismatch component so there was a

violation of expectation between initial learning in session 1 and what occurred on session 2. Only one cue syllable was presented prior to the error message, yet memory for the entire syllable-pair associations was updated with new information when tested on the third session, suggesting the approach seemingly targeted memory for the learning experience as a whole and that this was sufficient to reactivate memory and initiate reconsolidation processes.

Pilot work explored the use of an adapted version of the Forcato memory retrieval task, since this was reported to work successfully across numerous experiments (e.g. Forcato et al., 2009; Forcato et al., 2007; Forcato et al., 2011; Forcato et al., 2010; Rodriquez et al., 2013). Participants viewed the trauma film on sessions one. Then upon their return on session 2 (day 2), participants were taken back to the laboratory and told they were about to watch the film they viewed 24 hours earlier. Following the 'start' of the film, just prior to the voice over from the first clip of the trauma film, an error message was displayed on the computer screen and the film, seemingly, stops abruptly. The memory retrieval task adapted from Forcato et al (2007; 2011; 2010; 2013) was administered in the same laboratory as session one and verbal instructions were as matched as far as possible to that of viewing the film 24 hours previously. The procedure for starting the film was the same as that in session 1, except the experimenter left the room following to return 3 min later, following display of the imitation error message.

Method

Preliminary work was conducted under approval from the University of Oxford Central University Research Ethic Committee (MSD/IDREC/C1/2010/104; Appendix 4.1).

Design and Participants

A between-subjects design was used, where participants were randomly assigned to one of two conditions, Memory retrieval task + Tetris (n = 5) or no-task Control (n = 4).

Trauma Film

The 12 min stressful film contained 11 scenes designed to relate to PTSD diagnostic criteria (DSM-V; Muravieva & Alberini, 2010) and was the same as that used for all experiments within the thesis. It is described in more detail in Chapter 4, Experiment 1.

Baseline Measures

Baseline measures included the Beck Depression Inventory-II (BDI-II; Beck, 1993); The State Trait Anxiety Inventory - Trait (STAI-T; Spielberger et al., 1983); the Traumatic Experience Questionnaire (TEQ; Adapted from Foa et al., 1999); The Eysenck Personality Questionnaire - Neuroticism scale (EPQ-N; H. J. Eysenck & Eysenck, 1975); The Spontaneous use of imagery scale (SUIS; Reisberg, Pearson, & Kosslyn, 2003), Proneness to intrusive cognitions rating (PICS; M. Davies & Clark, 1998). See Chapter 4 for further details of the baseline measures.

Film attention. An 11-point VAS scale ranging from 0 '*not at all*' to 10 '*extremely*' was used to assess how much attention participants had paid to the film.

Recognition Memory

Recognition memory tests were administered on Session 3, Day 8.

Visual recognition memory. The visual recognition memory test was that described earlier in the current chapter.

Verbal recognition memory. The written, verbal recognition memory test comprised 32 written statements regarding the film, with approximately 3 statements per film clip (as used in Holmes et al., 2009; Holmes et al., 2010). Participants were asked to write true or false next to each statement as they remembered.

Reactivating Memory for the Trauma Film

Tasks. Participants, upon their return to the laboratory for Session 2 (Day 2) were assigned to 1 of 2 conditions. Condition 1: Participants underwent the Memory retrieval task followed immediately by Tetris game-play for a further 12 min. Condition 2: Participants underwent a no-task break (sitting quietly) for 12 min.

Intrusion diary. Participants kept a simple, pen and paper tabular diary (based on Holmes & Bourne, 2008; Holmes et al., 2004; Holmes et al., 2009; Holmes, James, et al., 2010) of any involuntary flashbacks pertaining to the trauma film they experienced in the 8 days after watching the film. See Chapter 4 for a more detailed description.

Procedural Overview

Participants were booked for all three sessions in advance, with session one and two were timed to be 24 hours apart (to within 2 hours) with the final session 3 being

exactly 7 days after session 2 (again within 2 hours). All participants viewed the traumatic film in session one. Participants were asked to keep an intrusion diary for 24 hours before returning to the laboratory for session 2. Upon return to the laboratory for session 2 participants were randomly allocated those to one of two conditions; (1) Participants in the Tetris condition were given the memory retrieval task immediately before playing the computer game Tetris for further 12 min or (2) Participants in the no-task control condition sat quietly for 12 min. Participants then left the laboratory and kept the intrusion diary for an additional 7 days before returning their diaries in Session 3, 8 days after film viewing.

Pilot Findings

Visual inspection of the data was undertaken between conditions (statistical analysis was not carried out due to small sample sizes). Baseline variables taken at the start of the experiment appeared matched between conditions suggesting such factors would be unlikely to account for group differences.

Recognition Memory for the Trauma Film

Visual recognition memory. Individual scores per item were inspected for invariant items to check that there was not any one question that yielded 100% correct or incorrect recognition from every participant (adapted from procedure used by Kindt & van den Hout, 2003; Kindt et al., 2005). None of the 22 still images used within the test were reported as such for any participants; thus, the images and visual recognition memory test were deemed suitable for inclusion in future experiments.

Verbal recognition memory. Inspection of participants' scores on the written, verbal recognition memory suggested that the scores between conditions were not dissimilar. In addition, scores were comparable to earlier research which had used the same test with participants who played Tetris 4 hours after viewing a traumatic film (the maximum time frame, thus far, between film viewing and the use of Tetris. Expt. 2; Holmes et al., 2010). Visual inspection suggested that test scores between the two experiments were not markedly different.[2]

[2] Pilot work yielded the following mean scores; Tetris condition, *M* = 20.33; *SD* = 2.66; no task Control condition, *M* = 18.50, *SD* = 1.73. Previous research that had used the maximum time frame between film viewing and Tetris game play thus far (4 hours) showed the following; Tetris condition, *M* = 19.25, no-task Control condition, *M* = 20.48 (Expt. 2; Holmes et al., 2010).

Three Separate Laboratory Based Sessions using the Trauma Film Paradigm

No participants dropped out of the study before completion of all 3 experimental sessions. In addition all participants were able to attend the time slots allocated to them so as to ensure that participants all had a comparable time frame in which to record flashbacks in the diary. Recruitment materials were developed that provided very clear instructions about the time requirements of the study (see Appendix 3.2 for the template email sent to participants at contact), and this was given after individuals had made first contact to find out more about what the study involved. It was then confirmed by email when dates had been decided. Reimbursement was provided that aimed to be sufficient to cover expenses incurred through taking part in the study (£30 for 3 sessions: £10 per laboratory visit).

Utility of a 'Memory Retrieval Task' to Reactivate Memory for the Trauma Film

Inspection of the number of flashbacks recorded in the intrusion diary was used to consider the utility of the 'memory retrieval task' (adapted from Forcato et al., 2007, etc.) to induce memory reconsolidation of the trauma film.

Intrusion diary flashback frequency: Day 1: Inspection of the mean number of flashbacks for the film recorded by participants in the 24 hours following the film (but prior to assignment to experimental manipulation on day 2) appeared comparable between conditions; Tetris condition, $M = 2.67$; $SD = 1.97$; No-task control condition, $M = 2.50$; $SD = 2.65$.

Intrusion diary flashback frequency: Days 2 – 8: A visual inspection of flashbacks recorded in participants diaries for the 7 days following assignment to experimental condition indicated that frequency was higher in the Memory retrieval task + Tetris condition, contrary to what would have been expected if memory for the film had been reactivated and reconsolidation had subsequently been disrupted by Tetris game play. Although sample sizes were small, the means and standard deviations for each condition were calculated to help understand observations obtained from the intrusion diary: Tetris condition; $M = 7.00$; $SD = 7.46$; No-task Control condition, $M = 1.75$; $SD = 2.36$. High standard deviation in the Tetris condition appeared to be due one 1 participant who reported very high levels of flashbacks across the week (i.e. 21 flashbacks). Thus, to explore findings further still, the means were again determined with the participant who reported unusually high flashback levels omitted. Inspection of the means again indicated

that participants in Tetris condition experienced more flashbacks of the film in the remaining 7 days, *M* = 4.20; *SD* = 3.27.

Discussion

The aims of the current pilot work were to, (1) develop a visual recognition memory test to complement existing verbal recognition memory test; (2) explore the feasibility of using a 3 session design using the trauma film paradigm framework, and (3) obtain clarification whether a task that serves as a retrieval cue for the trauma film as a whole, opposed to each individual clip would be a useful task to reactivate memory. The pilot data within the current chapter is discussed with the caveat that findings are derived from a small sample, thus data is merely illustrative for the development of the experimental designs to be carried out within the thesis but was not suitable for statistical analysis.

Visual Recognition Memory Test

The development of a visual memory test to accompany the verbal memory test administered on 7 days after film viewing allows for a convergent evaluation of recognition memory for the film. The memory test was piloted within the present work and checked for invariant items, in order to control for potential ceiling and floor effects, none of which were found. Scores on the verbal-based recognition memory test was comparable to earlier studies.

Three Session Design within the Trauma Film Paradigm

The implementation of a 3 session design using the trauma film paradigm was demonstrated by the completion of measures by participants and their successful attendance to all three experimental sessions within the designated time-frames. Care was taken to maximise compliance by ensuring participants were made aware of the full extent of the study and the need to adhere to appointment times. Information on this was provided at both the recruitment stage and before experimental testing. Appointments for all three sessions (both date and time) were worked out ahead of experimental testing with the participant, with a clear accompanying email sent as a reminder and confirmation of appointment times. In summary, the use of a 3-session design within the framework of the trauma film paradigm appeared not to be prohibitive to participants.

'Reactivating' Memory for the Trauma Film

The memory retrieval task (adapted from a design used on successful by Forcato et al., to modify memory 2009; 2007; 2010) administered 24 hours after film viewing (and immediately prior to Tetris game play) did not result in any apparent reduction of flashbacks in the subsequent week relative to a no-task control condition, contrary to what was predicted had the reminder task been successful as a method for retrieving memory for the film. As a consequence it may be inferred that the task may be insufficient to elicit retrieval-induced memory plasticity for the trauma film (e.g. the task did not serve as a method of retrieving memory for the film in a way that facilitated the initiation of reconsolidation processes). A limitation of the memory retrieval task adapted from the design used by Forcato and colleagues (2009; 2007; 2010) may be that it only served to act a retrieval cue for the overall, general experimental procedure, e.g. coming into the laboratory and watching a film. The film contains several contiguous but very different scenes which, in previous studies, have *all* been shown to induce flashbacks. Thus, we might postulate that not all the potential flashback scenes were targeted and subsequently 'reactivated' by the reminder used in the current pilot work. As such the memory retrieval task from pilot work was not used or pursued in further experiments.

Instead, based on the findings from the current pilot work, a new memory reactivation task was designed with the aim of targeting each individual clip from the film. The task was adapted from the brief 'reminder' task used in earlier studies (Holmes et al., 2009). The required 'mismatch' was supplied between day 1 (viewing a continuous film) and the presentation style on day 2 (seeing a series of different still images of the moment immediately prior to the 'worst moment' e.g. the moment just prior to when an accident or scene of death occurs of the film). This was capitalised upon by developing the protocol so that the procedures and materials relating to the film and instructions for the film on day 1 matched as far as possible the stimulus presentation on day 2.

Furthermore, a 10 minute structured break was introduced in between the delivery of the newly developed memory reactivation task and Tetris game play. Several studies on both humans and animals had implemented a 10 minute break separating the task designed to retrieve/reactivate memory and the subsequent deployment of 'intervention' designed to modify memory (Monfils, Cowansage, Klann, & LeDoux, 2009; Oyarzún et al., 2012; Schiller et al., 2010; see Chapter 2.). It was proposed that this might provide time enough for reconsolidation processes to be optimal (e.g. for memory to become labile and as a result modifiable). Information on the memory reactivation task is provided in Chapter 4,

Experiment 1. (Appendix 3.3 gives the full experimental protocol).

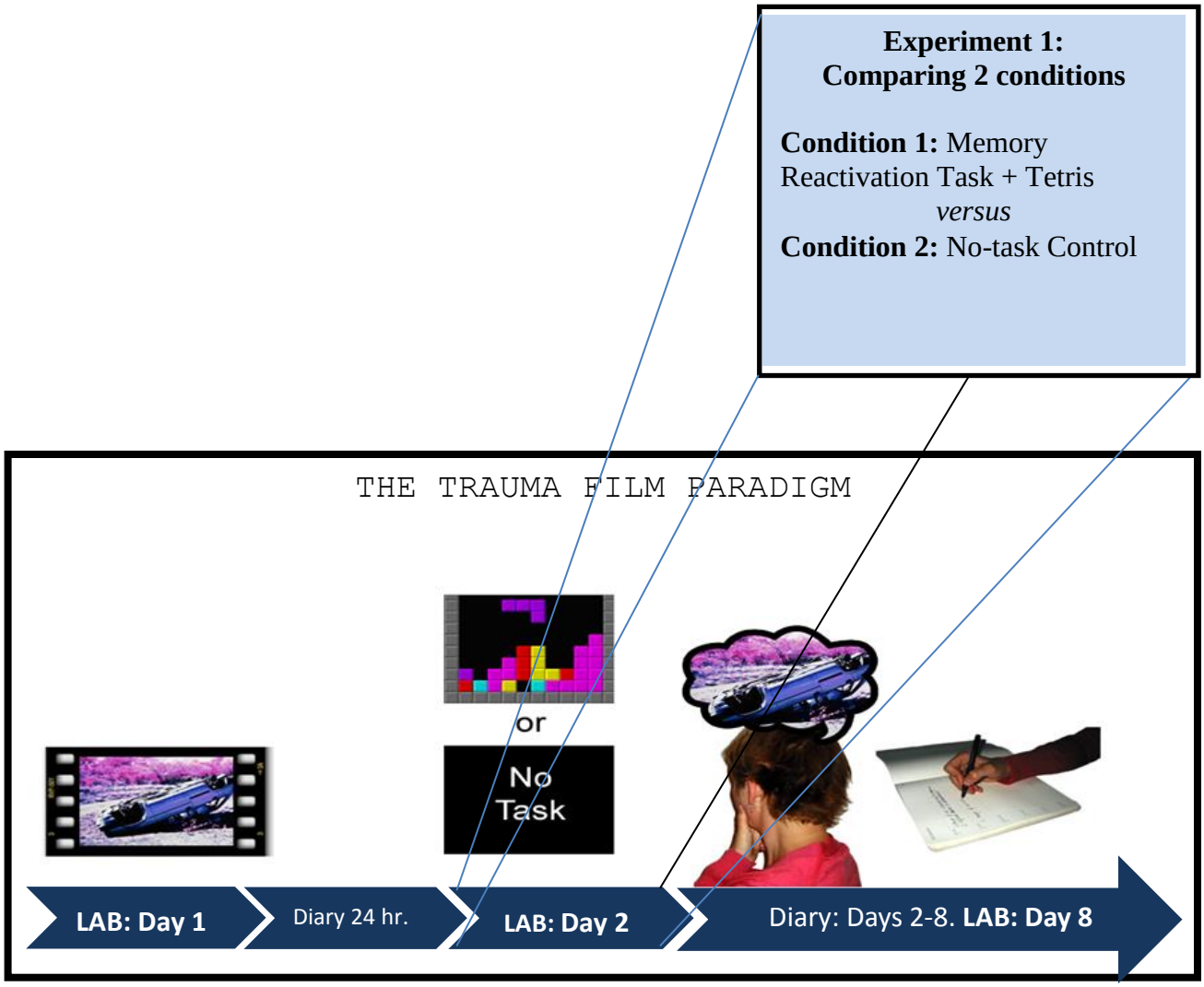
To conclude, pilot work sought to trial a newly designed visual memory test for the trauma film given one week post-film viewing, and the feasibility of conducting a more complex, three session design using the trauma film paradigm. Preliminary findings suggested that both the visual recognition memory test and 3 session design were appropriate to use in the current thesis experiments.

The work also explored the use of a memory retrieval task which, in conjunction with Tetris game play, aimed to reduce flashback memories to a traumatic film viewed 24 hour earlier. Observations indicated that the task was not successful. It was proposed that this was due to the task acting as a reminder cue for the trauma film as a whole experience. A new memory reactivation task was therefore developed to address this by providing reminder for each clip within the trauma film. Its design sought to capitalise on context effects (same laboratory, experimenter and protocol as much as possible between original trauma film and reactivation task) in order to maximise the occurrence of a mismatch between film viewing 24 hours earlier and the current experience of seeing still images for each clip. It was thought this mismatch would increase the chance of retrieval-induced memory plasticity, thereby allowing Tetris to interfere with flashback memory reconsolidation.

The next Chapter in the thesis draws from the findings from the pilot work and literature reviews in Chapters 1 and 2 to provide the first test of a cognitive task, Tetris, 24 hours after trauma film viewing in order to disrupt memory reconsolidation and reduce subsequent flashback frequency.

CHAPTER 4

EXPERIMENT 1: Can We Prevent Flashbacks after Memory has Consolidated? The First Test of a Cognitive Task 24 Hours Post Trauma Film Viewing (Memory Reconsolidation)



Procedural overview adapted from Holmes et al., 2009

Can We Prevent Flashbacks after Memories have Consolidated? The First Test of a Cognitive Task 24 Hours Post Trauma Film Viewing (Memory Reconsolidation)

Overview

A two-condition, between-subjects design was used to test whether flashbacks after a trauma film would be reduced by a cognitive task given 24 hours post film (e.g. during memory reconsolidation). The two conditions comprised a memory reactivation task followed by Tetris game play versus a no-task Control condition. Flashback memories for the film were recorded in an intrusion diary over the subsequent week (following assignment to experimental condition). Convergent measures of flashback development were taken at one week.

Introduction

Re-experiencing trauma in the form of intrusive imagery is common in the early aftermath of psychological trauma (Ehlers & Steil, 1995; Shalev, 1996) and is a hallmark characteristic of PTSD (American Psychiatric Association, 2000; Muravieva & Alberini, 2010). Intrusive images (hereafter referred to as flashbacks) are typically sensory-based, (predominately visual) memories of trauma that intrude into mind spontaneously, without deliberate recall (Hackmann et al., 2004).

As reviewed in Chapter 1, one approach to investigating the development and amelioration of flashbacks is the laboratory-based trauma film paradigm. Healthy participants are exposed to an analogue trauma (e.g. film footage depicting actual or threatened death or serious injury; see Chapter 1, Table 1.1 for a summary of diagnostic criteria). Afterwards, flashbacks (that is, involuntary image based memories for the film) are recorded in a simple diary. Sometimes participants report that verbal thoughts of the film intrude (for example, Hagenaars et al., 2010). However, while both were collected for the experiments within this thesis, the principle area of interest is flashbacks as these are analogous to clinical sensory-based re-experiencing symptoms (Grey & Holmes, 2008; Holmes et al., 2005).

As described earlier, following acquisition, memory undergoes a time-dependent process of stabilization, during which it becomes increasingly resistant to modification, a process termed memory consolidation (McGaugh, 2000). Previous experimental research found that simple cognitive tasks undertaken whilst memory is consolidating, i.e., up to 6 hours post memory acquisition (Walker et al., 2003), reduced subsequent flashback

development (Holmes et al., 2009; Holmes, James, et al., 2010). We have previously demonstrated that the visuospatial task Tetris reduces flashbacks for traumatic film material when it is played up to 4 hours after film viewing (Expt. 2; Holmes et. al., 2010). However, longer time frames have not been tested, in particular once the memory has consolidated, e.g. a day later. Widening the time frame between an analogue trauma and the implementation of Tetris game play in order to interfere with the formation of flashbacks represents an extension of earlier research and is a logical next step in the development of a simple cognitive task that can be administered on a very practical level to a greater number of individuals following trauma.

Research, described in detail in Chapter 2, has shown that the retrieval of a memory that is 24 hours old may render it transiently labile, allowing for it to be modified (Forcato et al., 2010; Hupbach et al., 2007; Schiller et al., 2010). Retrieval-induced memory plasticity may therefore represent a window of opportunity with which to modify consolidated memories of a traumatic event e.g. at 24 hours. Thus, the current experiment sought to test whether, 24 hours after film viewing, administering a task designed to reactivate memory for the trauma film followed by Tetris game play can reduce subsequent flashback frequency.

In the current experiment, an intrusion diary was used to monitor participants' flashback frequency for 8 days following trauma film viewing (as used in Holmes et al., 2004; Holmes et al., 2009; Holmes, James, et al., 2010). In addition, convergent measures of flashback memory were taken at the final follow up session (8 days after the initial session during which the trauma filmed is viewed, and 7 days after assignment to experimental condition). Clinical data and related research indicate that flashbacks may be provoked or 'triggered' by stimuli from the moment just prior to a perceived 'worst moment' (Ehlers et al., 2004; Ehlers et al., 2002; Verwoerd et al., 2011). The 'Intrusion Provocation Task' (IPT; Lang, Moulds, & Holmes, 2009) is an experimental method of inducing flashbacks to an analogue trauma in the laboratory. The task involves showing blurred still images of moments immediately prior to 'worst moments' of the trauma film, i.e. those moments known to become flashbacks. Immediately afterwards, participants signal if they experience a flashback of the film, typically over the course of 2 minutes. Other studies that use this approach to capture the occurrence of flashbacks shortly after viewing traumatic film materials are reviewed earlier (see Chapter 1; e.g. Verwoerd et al., 2012; Wessel et al., 2010). In addition, the Impact of Event Scale-Revised (IES-R; Weiss & Marmer, 1997), a clinical measure of trauma symptomatology, was used to assess post-

traumatic stress symptoms relating to the trauma film, as used in previous studies (see Chapter 1; e.g. Holmes et al., 2009; Krans et al., 2013).

The present study also sought to account for known sources of variation in flashback frequency by collecting data at baseline that would assess whether participants were matched for several known vulnerability factors. Trait neuroticism, the tendency to experience high level of negative affect - a vulnerability factor associated with post-trauma symptom severity and the development of PTSD (Lauterbach & Vrana, 2005; Morgan, Matthews, & Winton, 1995; Parslow, Jorm, & Christensen, 2005) - was assessed using the Eysenck Personality Questionnaire - Neuroticism scale (EPQ-N; Eysenck, Eysenck, & Barrett, 1985). Trait levels of depression and anxiety (using the BDI-II and STAI-T respectively; Beck, 1993; Spielberger et al., 1983); the number of hours of sleep following an index trauma (Kuriyama et al., 2010), blood phobia, and trait tendencies to use mental imagery (Malik, 2012) or experience intrusive cognitions were also assessed.

Experiment 1 aimed to provide the first test of whether 24 hours after an analogue trauma (a traumatic film) the simple cognitive task Tetris played after a memory reactivation task would result in fewer flashbacks to the film compared to a no-task Control condition. Flashbacks were recorded for eight days following trauma film viewing in an intrusion diary. The diary captured participants' flashbacks to the film for the first 24 hours *prior* to allocation to experimental condition, then for the remaining 7 days following experimental condition assignment. After the 7 days, participants' levels of flashbacks in response to a standardised laboratory-based trigger task, the Intrusion Provocation Task (IPT) were assessed, as were symptoms on a clinical measure of PTSD symptomatology, the Impact of Event Scale – Revised (IES-R; Weiss & Marmer, 1997).

Hypotheses

Twenty four hours after viewing a traumatic film, participants assigned to a Tetris condition (participants undergo a memory reactivation task then play the computer game Tetris), relative to a no-task Control condition (participants do not undergo memory activation or play Tetris but instead sit quietly for the equivalent period of time), were predicted to experience;

- Significantly fewer flashbacks of the film over the subsequent week (as recorded in an intrusion diary).

  No difference is predicted in flashback frequency between conditions on day 1 in the intrusion diary, e.g. those flashbacks recorded in the 24 hours *prior* to

experimental assignment.

In addition, on convergent measures of flashbacks at one week;

- Significantly fewer flashbacks as a response to the IPT.
- Significantly lower scores on the clinical PTSD symptom measure, the IES-R (Weiss & Marmer, 1997).

Methods

Approval for the study was obtained from the University of Oxford Central University Research Ethic Committee [MSD/IDREC/C1/2010/104; Appendix 4.1]

Design

A between-subjects design was used where participants were randomly allocated to one of two conditions; memory reactivation task followed by Tetris versus a no-task Control condition (n = 26 per condition). Participants attended repeated sessions over 3 time points (day 1, day 2 and day 8; 156 sessions in total across all participants).

Participants

Sample size estimation. Based on a between groups effect size of d = .91 found by Holmes et.al. (2009), the current experiment assumed a more conservative but still large effect size of 0.8; A sample size of n = 26 per condition was required to ensure an 80% power to detect this difference at the 5% significance level.

Fifty two healthy volunteers (32 males) took part and were reimbursed £30 for their participation. Participants were recruited from two university campuses and from the general public via advertisements in an online newspaper and in the community. Participants were eligible to take part if they were; *a)* between the ages of 18 and 65 years of age, *b)* reported no mental health problems, *c)* able to attend 3 separate laboratory sessions, *d)* not familiar with the paradigm and had not taken part in a study of a similar nature[3]. Due to the nature of the paradigm (e.g. watching potentially traumatic film footage) participants were given written and verbal information at both recruitment and on their first visit to the laboratory about the nature of the film participants would be asked to watch, e.g. that they might find it stressful and upsetting, as well as that would be required

[3] n = 4 were not included in the analysis due to sharing study design and predicted outcomes with other participants who had previously taken part (participants were friends sharing a house), thus un-blinding them to the study's purpose. This was discovered at debriefing.

to attend 3 separate experimental sessions (see Appendix 4.2 for a copy of the information sheet).

All participants provided their informed written consent prior to testing (Appendix 4.3) and were informed they could end the study at any point. Debriefing information was provided on the final experimental session on day 8 (Appendix 4.4).

Trauma Film

The 12 min trauma film contained 11 scenes designed to relate to PTSD diagnostic criteria for a traumatic event (DSM; American Psychiatric Association, 2000; Muravieva & Alberini, 2010). A traumatic event is defined as one involving actual or threatened death, or a threat to the physical integrity either to self or others. The film footage has previously been shown to induce image-based flashbacks of the kind analogous to re-experiencing symptoms following trauma (Holmes et al., 2009; Exp 2 from Holmes, James, et al., 2010). The 11 clips were all available from the public domain and included 5 government road-traffic safety adverts showing graphic injury and death; 2 scenes of graphic surgical procedures, 1 featuring laser eye surgery and the other deep leg surgery; 1 documentary clip showing the genocide in Rwanda; 1 government health and safety advert warning against the dangers of drinking and swimming and finally, 1 clip of an elephant going on a rampage at a circus seriously injuring and killing several people. A projector (NEC model LT25) was used to project the trauma film onto a white wall, with screen dimensions of 100-.x 133- cm. Participants were sat at a distance of approximately 173 cm from the viewing screen. The film was played using Microsoft Windows Media Player version 11. Appendix 4.5 provides complete list with a description of each of the film clips.

Tasks

See Table 4. 1 for simplified overview of the tasks within each experimental condition.

Condition 1: Memory Reactivation Task + Tetris

The following tasks were undertaken by those participants assigned to the Memory reactivation task plus Tetris game play condition. (Appendix 3.3 provides the experimental protocol for each experimental condition).

***Memory reactivation task*.** Participants viewed eleven neutral (i.e. taken from the moment immediately preceding the worst moment) static pictures, one from each of the 11 film clips. Still images were presented on a 3 sec automatic rotation using Microsoft

PowerPoint. Stills were presented in fixed order, the same as that of the film. The task was played on the same projector with identical projection dimensions as the trauma film viewed 24 hours earlier. Care was taken to ensure that the still images shown in the memory reactivation task corresponded closely to the film (e.g. the background colour and dimensions of the stills were made to match the film, as were participants' seating position when they viewed the film). Immediately prior to the task ending, participants in the memory reactivation task + Tetris went on to do the 10 min music filler task (see Appendix 4.6 for the still images of the film from the memory reactivation task).

Music filler task (10 min). Participants were asked to listen to a selection of 15 classical music excerpts from the 1800's and rate them for pleasantness on a scale of 1 '*not at all pleasant*' to 9 '*extremely pleasant'*. Each clip was between 30-40 sec in length, with music clips played in a fixed order (as used in Holmes et al., 2009; Holmes, James, et al., 2010; Pictet, Coughtrey, Mathews, & Holmes, 2011). The music for the filler task was played over computer speakers in the laboratory using Windows Media Player 9.0. Immediately following the music filler task participants in the memory reactivation task + Tetris condition were asked to play the computer game Tetris.

Tetris (12 min). Tetris is a computer game originating in the 1980's ("Tetris Zone," 2007). The game involves manipulating a series of seven different coloured and shaped 2-D geometric blocks, referred to as 'tetrominoes', by using the keyboard cursor keys. Blocks fall at a steady pace one at a time from the top of the playing screen in a random order. As they fall they can be moved from left to right and rotated 90^{o}. The aim of the game is to place the blocks as they fall in such a way as to form a complete horizontal line at the bottom of the playing screen. When a complete line is made it is removed from the playing screen and awards the player points (see Figure 4.1 for a screen shot of the computer game). Clearing one line at a time awards 100 points; simultaneous line clearing awards increasingly more points depending on difficulty, for example 2 lines = 300 points, 3 lines = 500 points and 4 lines = 800 points. After clearing the required number of lines designated for a particular level a new level automatically begins. Over the course of the game the more horizontal lines and levels are completed the faster the blocks descend. Participants were instructed to play Tetris using their dominant hand. The experimenter was present during game play and recorded the final Tetris score. If the game ended before 12 min it was immediately restarted by the experimenter. Thus, all participants had a comparable duration of game play. (Appendix 3.3 provides the experimental protocol with instructions given to participants for how to play the game Tetris).

Tetris performance. A score sheet was used to record details of whether participants had played Tetris before and their final score after 12 min and the highest level reached.

Figure 4.1. Screen shot of the computer game Tetris on the Marathon game setting (Tetris Zone, 2008)

Condition 2: No-Task Control

The following tasks were completed by participants allocated to the no-task Control condition;

Music filler task (10 min). Participants in the no-task Control did not undertake the memory reactivation task, but instead completed the music filler task. Instructions and task were identical to those given to the memory reactivation task + Tetris group. After the task participants went straight on to the 'no-task' break.

No-task break (12 min). Participants in the no-task Control condition were instructed that they were going to have a break during which time they should sit quietly and not talk to the experimenter. Use of mobile phones or other electronic devices was not permitted. Participants were informed that they could think about anything they liked during this time and that they would be told when the break was finished. The break lasted for 12 min (the same duration as Tetris game play) with the experimenter present throughout.

Table 4.1. *Simple Overview of Tasks in each Experimental Condition*

Condition 1	**Condition 2**
Memory Reactivation Task plus Tetris	No-task Control
Memory Reactivation Task	-
Music Filler task [10 min]	Music Filler task [10 min]
Tetris [12 min]	No-task break [12 min]

Baseline Measures

Beck depression inventory-II (BDI-II). The BDI-II (Beck, 1993) is a 21-item self-report measure. Each item is measured on a scale of 0 – 3, with total scores ranging from 0 to 63, where higher scores indicate greater levels of depression. The BDI-II shows high internal validity, $\alpha = .81$ (Beck, Steer, & Garbin, 1988).

State trait anxiety inventory – trait (STAI-T). The STAI-T (Spielberger et al., 1983). has 20 items and contains several anxiety-absent items (e.g. *I am content*) that are reverse scored. Scores range from a minimum of 20 and maximum of 80 with higher scores representing greater levels of trait anxiety. The STAI-T demonstrates good internal validity; $\alpha = .90$ (Speilberger, Reheiser, Owen, & Sydeman, 2004).

Eysenck personality questionnaire - neuroticism scale (EPQ-N). The EPQ-N (Eysenck et al., 1985) contains 12 items designed to measures neuroticism. Each item requires a '*yes'* or '*no'* response. Positive scores are summed and range from zero indicating low neuroticism to 12 indicating high neuroticism. The EPQ-N has good internal validity: $\alpha = .84$ (Eysenck et al., 1985).

Traumatic experience questionnaire (TEQ). (Adapted from Foa et al., 1999). Participants reported their prior trauma history using a 12-item checklist adapted from the criterion A of the Posttraumatic Diagnostic Scale (American Psychiatric Association, 2000). Participants indicated whether they had experienced or witnessed each of a series of traumatic events. '*Yes*' scores were summed and could range from 0 (no traumatic event) to 12 (each and every type of traumatic event experienced or witnessed). Appendix 4.7

Spontaneous use of imagery scale (SUIS). The SUIS (Reisberg et al., 2003) is a trait measure of an individuals' tendency to engage in spontaneous mental imagery in their day-to-day lives. Participants rate on a scale of 1 (*never*) to 5 (*always*) on 12 different items

such as; '*When I hear a radio announcer or DJ I've never actually seen, I usually find myself picturing what they might look like'*. Scores range from a minimum of 12 indicating '*no use*' to 60 '*high use*'. The SUIS has been shown to have excellent internal consistency (α = .98; Reisberg et al., 2003).

Proneness to Intrusive Cognitions Scale (PICS). The PICS (Davies & Clark, 1998) comprised of a single item on which participants rated how prone they were to experiencing intrusive cognitions from 0 (*not at all*) to 10 (*extremely*).

Blood phobia. A single Visual Analogue Scale (VAS) required participants to '*indicate if you consider yourself particularly fearful of blood, injury, injections, or the like'*. The scale was anchored from 0 (*not at all*) to 10 *(extremely).*

Mood and Distress Ratings

Mood pre- to post-film. Participants rated their levels of sadness, hopelessness and depression on three VAS given both pre and post film. The VAS instructed participants to rate how they felt '*right at this very moment*' and scales were anchored at one end with '*not at all*' and the other '*extremely*'. A composite mood score was calculated by summing the three scales (based upon Holmes et al., 2009; Holmes, James, et al., 2010).

Film distress. Participants rated their distress in relation to the film after viewing had ended. An 11-point scale was used anchored from 0 (*not at all*) to 10 (*extremely*).

Main Outcome Measures: Memory for the Trauma Film

Intrusion diary. Participants were asked to keep a pen and paper, simple tabular diary of any intrusions of the trauma film they experienced in the 8 days after film viewing (based upon Holmes et al., 2004; Holmes et al., 2009; Holmes, James, et al., 2010). Participants rated whether their intrusion was an image (I), thought (T) or a combination (I/T). Clear verbal and written instructions on the definition of intrusions and how to keep the diary were provided (see Table 4.2).

Table 4.2. *Instructions given to Participants about the Different Forms of Intrusions and how to Record them in the Diary*.

"It may be that over the next few days images or thoughts about the film you have just seen will ***spontaneously*** *pop into your mind when you are not deliberately thinking about the film. This is called an intrusion. What goes through our minds can either take the form of words and phrases ("verbal thoughts"), or it can be like mental images…*

… On page 3 and page 4 [of the diary], fill in one of the little boxes every single time you have an intrusion ***[demonstrate what to do on the diary]****;* ***I*** *for image,* ***T*** *for thought or* ***I/T*** *if it was both. So if you have 3 intrusions in the afternoon, then 3 of the little boxes should be filled. If you have had none during that time period then write zero or cross that section of the day out. Make sure that you have completed each of the three time periods (Morning, Afternoon and Evening/Night) as they occur".*

Similar to flashback re-experiencing symptoms, image intrusions were defined as being spontaneous memories of the film that occur without deliberate recall with participants being provided with the following description; "*Although mental images often take the form of pictures in your mind's eye they can actually include any of the five senses, so you can imagine sounds too. Mental images can be fuzzy or fragmented as well as clear; they can also be brief and very fleeting – like a quick flashback of the film*".

Participants were asked to briefly note the content of each intrusion (in order for it to be later matched to the film) and what triggered it. Ambiguous diary entries were later clarified by the experimenter at the final follow up session (session 3, day 8) by asking participants to elaborate on the content of the ambiguous entry. Careful consideration was taken to ensure leading questions were not asked. An example of a flashback recorded in the diary was - 'I saw the bloody man looking at himself in the mirror' from the film clip 'Big Shave' and intrusive thought - 'I need to be careful crossing the road and texting' from 'Don't Text and Walk'. (Appendix 4.8 provides examples of flashbacks reported by participants in the intrusion diary for each of the film clips. See also, Appendix 4.9 for an example of the intrusion diary).

A total score of flashbacks (those labelled I and I/T in the diary) was calculated by the experimenter. Although both flashbacks as well as intrusive verbal thoughts (those labelled T only in the diary) were captured, the former was of primary concern within the thesis as these are the types of intrusions analogous those sensory-based flashbacks

typically experienced by individuals after trauma (Ehlers et al., 2002). However, verbal thoughts were reported on in brief.

Inter-rater reliability was assessed on *n* = 15 (30%) randomly selected participant diaries to ensure good levels of consensus over image-based flashback entries within the diary. A percentage of intrusions not matched to the film were calculated.

Diary accuracy. A single VAS requested participants to '*indicate how accurate you think your diary is'* on a scale from 1 (*not at all accurate)* to 10 (*extremely accurate*).

Intrusion provocation task (IPT). Eleven still pictures were selected from the trauma film (one for every scene; Appendix 4.10). The stills were blurred using Gimp software, Gaussian 2.0 (version 2.1.1; GNU, 2010). The pictures were shown in a fixed, randomised order (different to the order of the film) set on an automatic 3 sec rotation using PowerPoint and displayed on a VDU. After participants have been showed the IPT they have a 2 min break during which they are asked to press a specific key on a computer keyboard whenever they have an intrusive flashback (e.g. image-based intrusion) from the film. The IPT used the same still images as the memory reactivation task; however there are several differences between the two tasks. The images used in the IPT were blurred and played in a fixed-randomised order different to that of the trauma film clips (this was not the case for the memory reactivation task). Furthermore the IPT was not formatted to match the film closely, unlike the reactivation task, e.g. the stills were played on a VDU rather than projected and the slide surrounds were not formatted to match the film.

Impact of event scale – revised (IES-R). The IES-R (Weiss & Marmer, 1997) is 22-item self-report measure in which participants rate their subjective distress as a result of a specific stressful event. The IES-R was anchored '*to the last seven days with respect to the trauma film you watched*'. Each item is rated on a 5-point Likert scale from 0 (*not at all*) to 4 (*extremely*). The IES-R has three subscales corresponding to the three symptom clusters of PTSD, Intrusions (8 items on the IES-R), Avoidance (8 items) and Hyperarousal (6 items). Examples items include; Intrusions '*Pictures about it popped into my mind*'; Avoidance '*I avoided letting myself get upset when I thought about the film or was reminded of the film*' and Hyperarousal '*After the film I was jumpy and easily startled'*. An average of IES-R scores (total and subscales) are calculated with scores ranging from 0 to 4. The IES-R shows high internal validity, $\alpha = .86$ (Sundin & Horowitz, 2002). The total score and subscale were analysed. Appendix 4.11 gives an example of the adapted IES-R.

Recognition Memory

Verbal recognition memory. The written, verbal recognition memory test comprised 32 written statements regarding the film. There were approximately three statements per film clip (Holmes et al., 2009; Exp 2; Holmes, James, et al., 2010). Participants were asked to write true or false next to each statement as they remembered. Example statements include; '*the bones in the girls legs are seen to fall back into place'* (True/False) or '*four small circles are made on the surface of the eye'* (True/False). Appendix 4.12

Visual recognition memory. The visual recognition memory test was developed specifically for this experiment as a complement to the written memory test. The test consisted of 22 static images, 11 of which were taken from the traumatic film viewed by participants. The remaining stills were 'filler' images not from the film and were either part of the film clips that participants had not seen because they had been edited out of the final film or, if this was not possible, they were of similar theme (Wegner et al., 1996). Images were presented in a fixed, randomised order on an automatic 5 sec rotation using PowerPoint and displayed on a VDU. The still images used in the visual recognition memory test were not the same still images that were used in the Intrusion Provocation Task. Participants watched the 22 images whilst simultaneously indicating whether or not they recognised the image as being from the film they watched one week earlier by circling either '*yes*' or '*no*' on an answer sheet provided (Appendix 3.1).

Manipulation Checks

Film attention. Participants were asked to rate '*how much attention did you pay to the film you just watched*' on an 11-point scale ranging from 0 (*not at all*) to 10 (*extremely*).

Sleep duration (24 hr. following film). Participants were asked to write down an estimate of the number of hours they had slept, to the nearest hour, in the 24 hours following film viewing upon their return to the laboratory on day 2.

Demand ratings. Participants were asked to respond to the question, '*How much do you predict that playing the game Tetris task after a distressing film (rather than watching it normally) would increase or decrease intrusive images of the film of the type you recorded in your diary?*' on a single VAS ranging from -10 (*extreme decrease*) to 0 (*no impact*) to 10 (e*xtreme increase*) (based upon Holmes et al., 2004; Stuart et al., 2006).

Procedure

Participants were booked for all three sessions in advance. Session one and two were timed to be 24 hours apart (to within 2 hours) with the final session being exactly 7 days after Session 2 (also to within 2 hours). Thus, all participants had a comparable duration in which to fill out their flashback diaries. See Figure 4.2 for a procedural diagram of Experiment 1.

Session 1 (Day 1). Participants completed a battery of baseline measures prior to watching the trauma film. Following this, all participants regardless of condition undertook a 3 min practice of the computer game Tetris. Tetris was set on the 'Marathon' setting with the sound turned off. Participants were permitted to use the downward cursor key to speed up descent but were asked to refrain from using the space bar instant drop function. Following practice, participants watched the trauma film in a darkened room with the experimenter absent. VAS mood evaluations were taken before and immediately after film viewing. Attention to film and film distress ratings were given post film. Participants were provided with a definition of intrusions and detailed instructions on how to use the intrusion diary and were asked to return to the laboratory in 24 hours.

Session 2 (Day 2). Participants were randomly allocated to condition immediately prior to their return to the laboratory. Upon their return, participants in the Tetris condition they were given the memory reactivation task. This was then followed by the 10 min music filler task (the amount of time thought necessary for memory reconsolidation processes to develop). Following this participants were asked to play Tetris for 12 min. If the game ended before 12 min the final score for that game was noted down and the game was re-started by the experimenter so all participants played for a comparable time duration. Participants in the Control condition did not have a memory reactivation task, only the music filler task. They were then asked to sit quietly for 12 min (the equivalent period of time to Tetris game play). Upon completion of their experimental assignment, all participants were asked to estimate the number of hours sleep they had had the previous night. In addition, a photocopy of the diary over the first 24 hours was taken by the experimenter and participants were reminded of the instructions for keeping the intrusion diary and were asked to keep it for a further 7 days.

Session 3 (Day 8). One week later participants returned with their completed intrusion diary. Participants completed diary accuracy and demand characteristics measures, the IES-R as well as two recognition memory tests for the film (verbal and visual).

Participants then underwent the Intrusion Provocation Task and were debriefed at the end of the experiment. See Appendix 3.3 for experimental protocol.

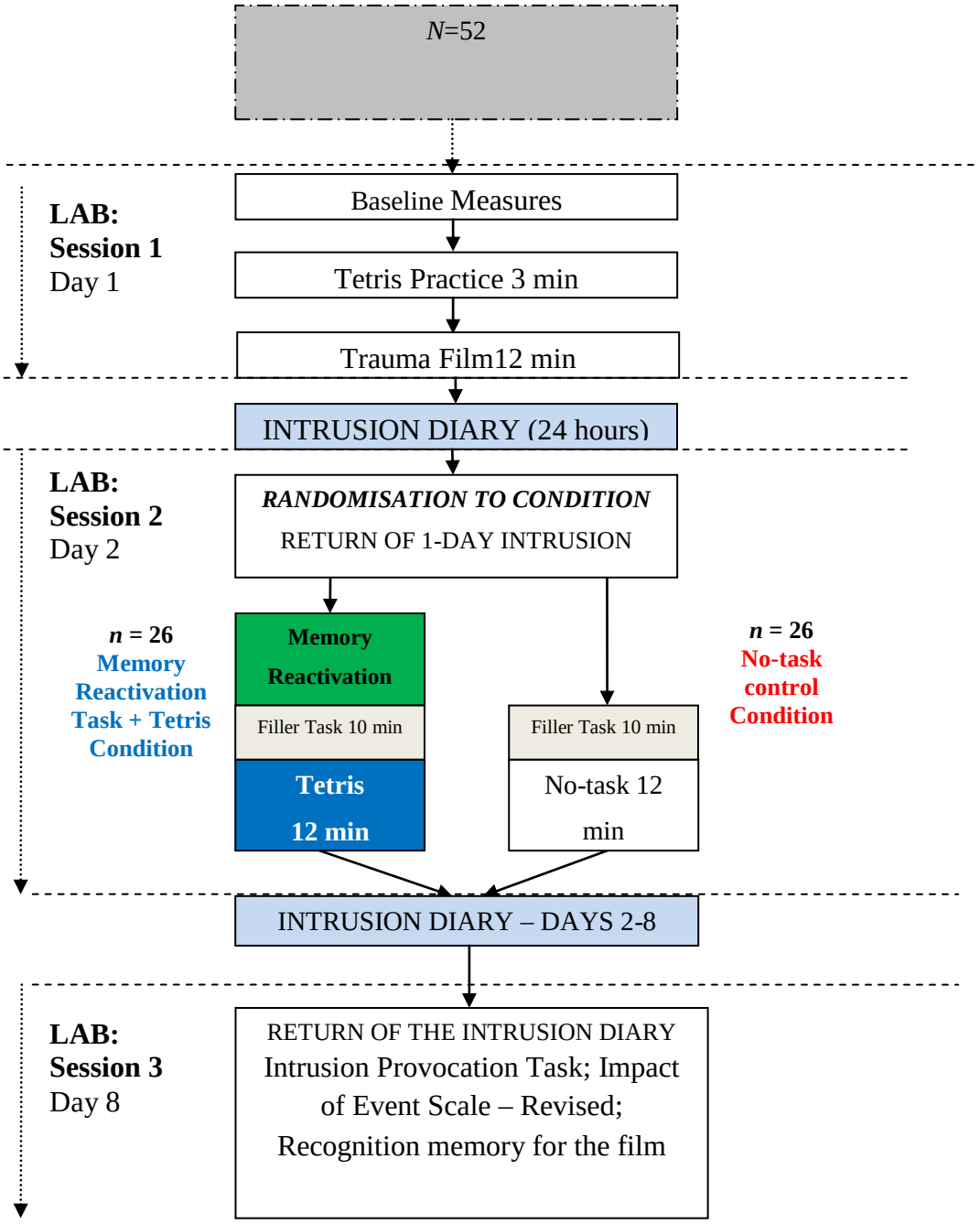


Figure 4.2. Procedural overview of Experiment 1

Results

All data were examined for potential outlying values (greater than 3 standard deviations from the mean in either direction) and none were found. Homogeneity of variance was assessed using Levene's statistic and, where necessary, statistics for which homogeneity of variance is not assumed are reported. Independent samples *t*-tests were used to compare means between conditions; repeated-measures ANOVA was used to compare mood from pre to post film. Nominal data were analysed using the chi-square test with inter-rater reliability assessed using the Kappa statistic. Inferential statistics were analysed using a Pearson's product-moment correlation and partial correlations. An alpha level of .05 was used for all statistical tests. IBM SPSS statistical package version 19.0 was used to analyse results.[4]

Baseline Measures

There were no significant differences between conditions for any baseline measures (Table 4.3).

Table 4.3. *Baseline Characteristics including Mood Measures, Trauma History, Mental Imagery use for each Experimental Condition*

Measure	Tetris (*N* = 26)		Control (*N* = 26)		Analysis		
	n	**%**	***n***	**%**	χ^2	**df**	***p***
Male	13	50	9	35	1.26	1	.26
	M	***SD***	***M***	***SD***	***T***	**df**	***p***
Age (years)	24.08	6.98	24.85	5.07	0.46	50	.65
BDI-II	3.23	2.93	4.50	4.68	1.17	50	.25
STAI-T	33.58	6.92	35.08	7.78	0.74	50	.47
EPQ-N	2.58	2.48	3.23	2.86	0.88	50	.38
TEQ	1.08	1.57	0.92	0.69	0.46	50	.65
SUIS	40.19	8.25	39.23	6.88	0.46	50	.65
PICS	3.68	2.55	3.95	2.49	0.39	50	.70
Blood Phobia	3.11	3.26	2.96	2.96	0.17	50	.87

Note. BDI-II = Becks Depression Inventory – II (Beck, 1993); EPQ-N = Eysenck personality questionnaire - neuroticism scale (Eysenck et al., 1985); PICS = Proneness to intrusive cognitions (Davies & Clark, 1998) STAI = State trait anxiety inventory – trait (Spielberger et al., 1983); SUIS = Spontaneous Use of Imagery Scale (Reisberg, Pearson & Kosslyn, 2001); TEQ = Traumatic Experiences Questionnaire (adapted from Foa, Ehlers, Clark, Tolin & Orsillo, 1999)

[4] Appendix 4.13 provides SPSS outputs for the main outcome variables of Experiment 1.

Mood and Distress Ratings

Mood pre- to post-film. Repeated-measures ANOVA confirmed a main effect of time, indicating that participants' mood significantly deteriorated following the film, but no main effect of group, nor group x time interaction (Table 4.4)

Film distress. There were no significant differences between groups for self-rated distress for film content; Tetris condition, M = 5.81, SD = 2.70; Control condition M = 6.50, SD = 2.08, $t(50) = 1.04$, $p = .31$.

Table 4.4. *Mood Change from Pre- to Post-Film for each Experimental Condition*

Measure	Tetris (N = 26)		Control (N = 26)		ANOVA		
	M	***SD***	***M***	***SD***	**Time**	**Group**	**Group *Time**
VAS Pre film Mood	2.09	2.05	2.32	2.83			
VAS Post film Mood	5.87	4.54	7.38	5.56	$F_{(1,51)}$= 53.13[§]	$F_{(1,51)}$= 1.10	$F_{(1,51)}$= .88

Note. VAS (Visual Analogue Scale) mood composite sum of Sadness, Hopelessness and Depressed (Holmes et al. 2009)

[§] $p < .001$; $\eta\rho^2 = .515$

Main Outcome Measures: Memory for the Trauma Film

Intrusion diary flashback frequency: Day 1. After 24 hours (prior to assignment to experimental condition) participants in the two conditions reported a comparable number of flashbacks (those intrusions labelled I and I/T in the diary), $t(50) = 0.13$, $p = .90$ (Figure 4.3).

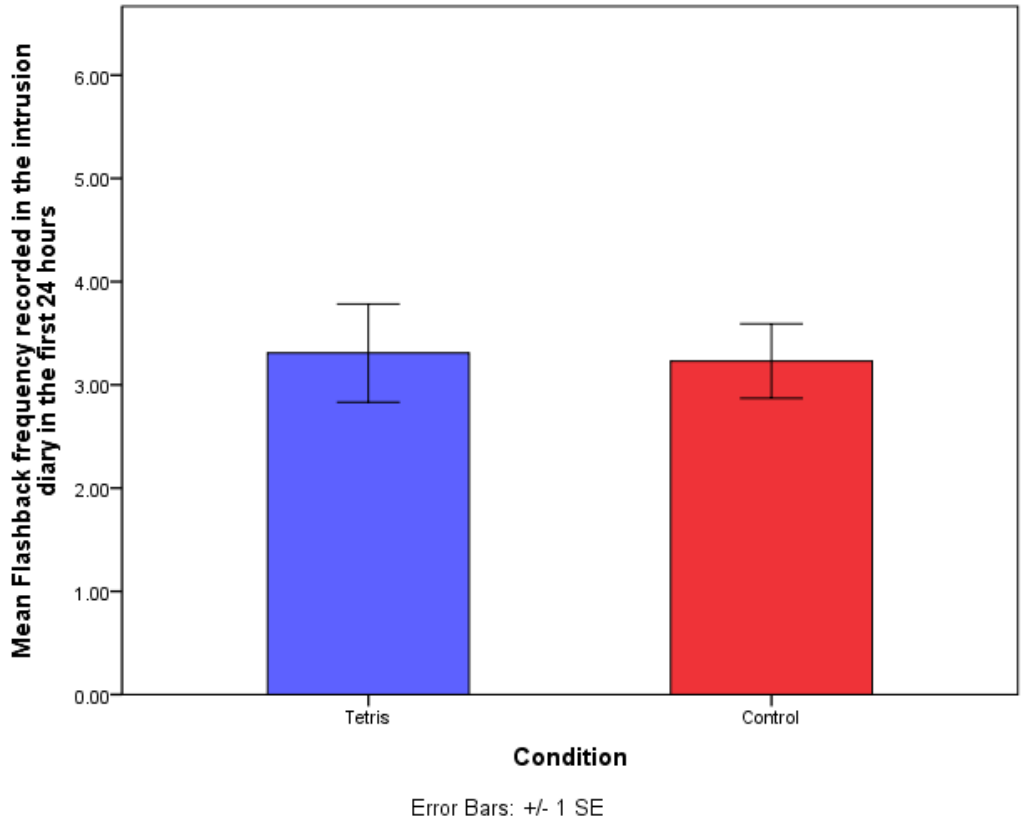


Figure 4.3. Flashback frequency recorded in the intrusion diary for day 1, the first 24 hours following film viewing (and prior to experimental assignment) for each experimental condition (Mean +/- SE of the mean[5]).

There were no significant differences between conditions for intrusive thought frequency (labelled T only in the diary); $t(50) = 0.26$, $p = .80$. Overall intrusion frequency remained non-significant between conditions on Day 1 when intrusive thought frequency was combined with flashback frequency; $t(50) = 0.13$, $p = .89$.

[5] Graphs within the thesis display Standard Error (SE) of the Mean, which indicate mean uncertainty in terms of the estimate of the population mean (Altman & Bland, 2005). Standard deviations (SD) measuring the dispersion of individual data values around the mean can be found in the text.

Intrusion diary flashback frequency: Days 2 - 8. As predicted, participants in the Tetris condition (i.e. those who undertook the memory reactivation task then played the computer game Tetris) had significantly fewer flashbacks over the 7 days following experimental assignment (i.e. 24 hours *after* trauma film viewing) than those in the Control condition, $t(50) = 4.20$, $p = < .001$, $d = 1.17$ (Figure 4.4) [6]

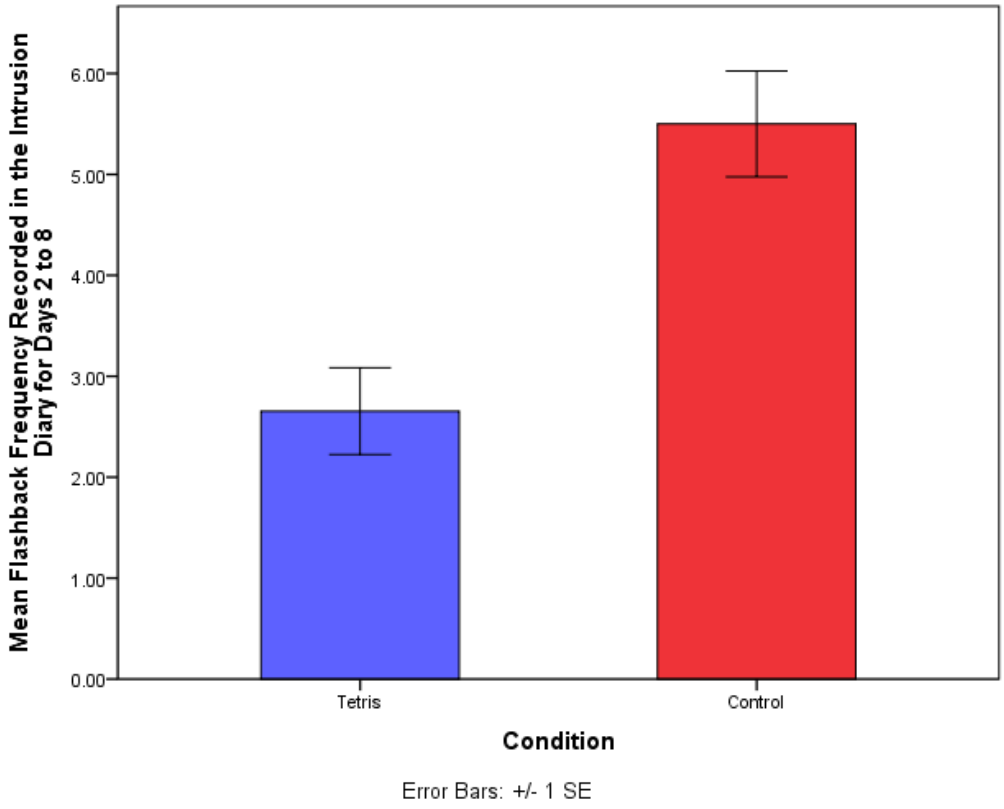


Figure 4.4. Flashback frequency recorded in the intrusion diary for days 2 to 8, for each experimental condition (Mean +/- SE of the mean).

There was no significant difference between conditions in intrusive thought frequency recorded the diary between days 2 to 8; Tetris condition, $M = 0.54$, $SD = 1.17$ and control condition, $M = 0.96$, $SD = 1.40$; $t(50) = 1.18$, $p = .24$. The key prediction relating to flashback frequency from days 2-8 remained significant when intrusive thought frequency was combined with flashback frequency, $t(50) = 4.14$, $p = .0001$, $d = 1.28$

[6] Cohen's *d* is a standardised measure of effect size in which values between .2 to .3 are taken to indicate "small" effect, values around .5 indicate a "medium" effect and values > .8 indicate a "large" effect

Diary accuracy. Participants condition did not differ between conditions for self-rated measures of diary accuracy; Tetris condition, M = 8.31, SD = 1.91 and Control condition, M = 8.23, SD = 1.03; $t(50) = 0.18$, $p = .86$.

Flashback trajectory. Figure 4.5 illustrates the trajectory (mean frequency) of flashbacks reported in the intrusion diary across the 8 days for both experimental conditions. Day 1 represents the first 24 hours following the trauma film (and prior to assignment to experimental condition).

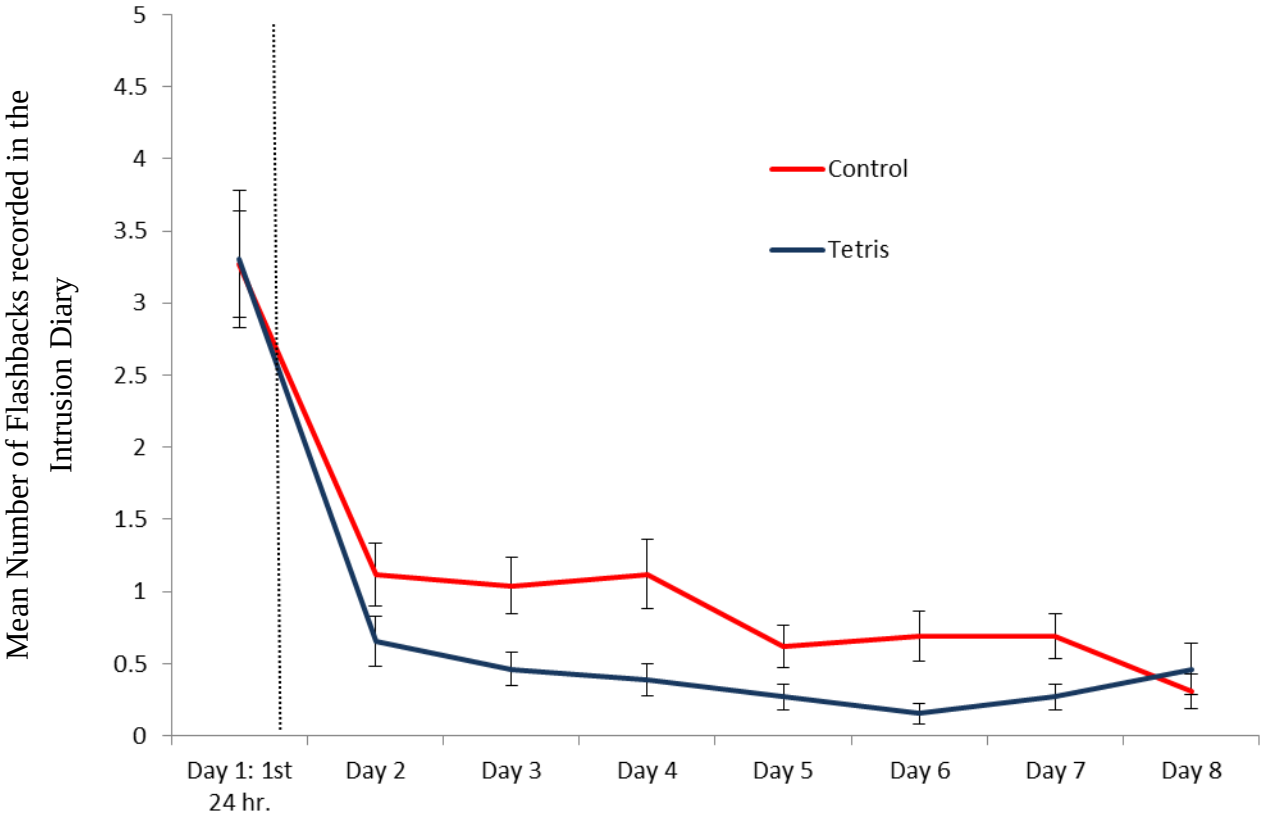


Figure 4.5. Flashbacks frequency recorded in the intrusion diary for each of the days 1 through 8, for each experimental condition (Mean +/- SE of the mean)

Table 4.5 details total and mean frequencies for both conditions across the 8 days post-film. Bonferroni adjustments were implemented to control for multiple pairwise comparisons. There were fewer flashbacks in the Tetris condition, relative to the Control, from day 3 through to 7; however, significance only survived Bonferroni correction on day 4 and day 6.

Table 4.5. *Flashback Frequency in the Intrusion Diary for Days 1 through 8 for each Experimental Condition.*

Day	Tetris (*N* = 26)			Control (*N* = 26)			Analysis		
	Total #	***M***	***SD***	**Total #**	***M***	***SD***	***t***	**df**	***p***
Day 1	86	3.31	2.43	85	3.23	1.83	0.13	50	.989
Day 2	17	0.65	0.89	29	1.12	1.11	1.66	50	.104
Day 3	12	0.46	0.58	27	1.04	1.00	2.54	50	.014
Day 4	10	0.38	0.57	29	1.12	1.21	2.78	50	.008*
Day 5	7	0.27	0.45	16	0.62	0.75	2.01	50	.050
Day 6	4	0.15	0.37	18	0.69	0.88	2.87	50	.006*
Day 7	7	0.27	0.45	18	0.68	0.79	2.37	50	.022
Day 8	12	0.46	0.90	8	0.31	0.62	0.72	50	.477

Note. Day 1 is prior to assignment to experimental condition.
* = significant to Bonferroni adjusted value
p = .008.

The nature of intrusions reported in the diary. An inter-rater reliability analysis conducted on a random sample of participants' flashback diaries (*n* = 15; 30%) using the Kappa statistic (Fleiss, 1981; Landis & Koch, 1977) indicated 'excellent' consensus over flashback diary entries recorded in participant diaries across the 8 days by independent raters; Kappa[7] = .84, $p < .001$.

Day 1: First 24 hrs. following film. Across both conditions, a total of 263 intrusions were reported in the diary in the first 24 hours (prior to experimental assignment to condition). Of these, 229 were flashbacks (e.g. I and I/T; *M* = 3.29, *SD* = 2.15, range: 0 – 10) and 34 were intrusive verbal-thoughts (e.g. T; *M* = 0.65, *SD* = 1.06, range: 0 – 4). Three participants (1.31%) reported zero flashbacks; four (11.76 %) reported having zero verbal thoughts. Of the intrusions recorded by participants 24 hours post film, 11.5 % could not be matched to the film and were therefore not included in subsequent analyses.

Table 4.6 shows the number of different of 'events' (flashbacks to different film clips) recorded in the intrusion diary per experimental condition. Analysis indicated that there was no significant difference between conditions for the number of different events reported in the diary in the first 24 hours prior to assignment to experimental condition, $t(50) = 0.86$, $p = .39$.

[7] Cohen's kappa is a standardised measure of inter-rater reliability in which coefficient values below .40 are taken to indicate "poor" reliability, values between .4 and .6 indicate a "fair" reliability, values between .60 and .74 indicate "good" reliability and values between .75 to 1.00 indicate "excellent" reliability (Fleiss, 1981; Landis and Koch, 1977).

Day 2 - 8: Post experimental assignment to condition. Across both conditions from days 2 – 8, a total of 198 intrusions were recorded in the intrusion diary. Of these 156 were flashbacks (*M* = 4.08, *SD* = 2.81, range: 0 – 12) and 42 were verbal-thoughts (*M* = 0.75, *SD* = 1.30, range: 0 – 5) relating to the trauma film. Three participants reported having zero flashbacks; however they were not the same three participants who reported having zero flashbacks in the first 24 hours; one participant reported zero flashbacks across the whole 8 days. Thirty four participants reported having zero verbal thoughts of the film across days 2-8. Ten intrusions (6%) could not be matched to the film and as such were not included in analyses. There was no significant difference on the number of intrusions not matched to the film between conditions (5 in each).

Table 4.6. *Number of Different Flashback Events Recorded in the Intrusion Diary*

Measure	Tetris (*N* = 26)		Control (*N* = 26)	
	M	***SD***	***M***	***SD***
Day 1	2.08	1.09	2.23	1.16
Days 2 – 8	1.77	1.27	3.27	1.48
All Days	3.85	1.78	5.62	2.33

The number of events recorded in the intrusion diary between days 2 to 8 is provided in Table 4.6. Participants in the Tetris condition reported fewer different flashback events from the film, relative to the no-task Control condition, $t(50) = 3.91$, $p = .000$, $d = 1.10$

Intrusion provocation task (IPT). As predicted, on day 8 (one week after assignment to experimental condition) IPT scores were significantly lower in the Tetris condition than the Control condition, $t(50) = 3.47$, $p < .001$, $d = 0.96$ (Figure 4.6).

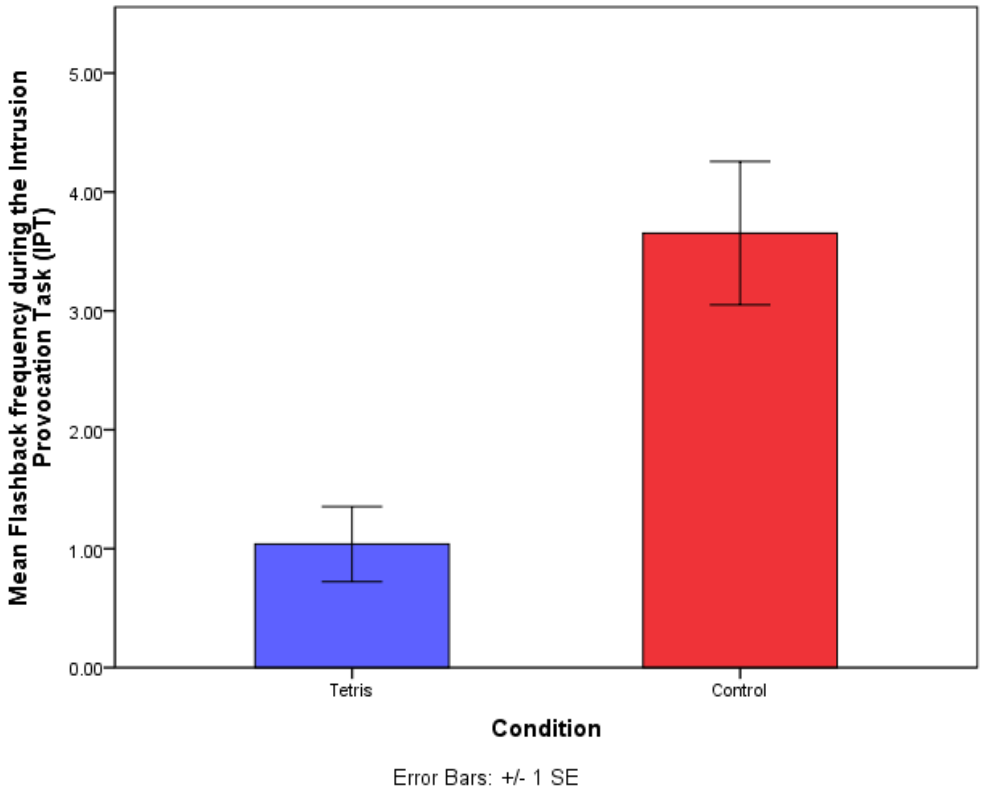


Figure 4.6. Flashback frequency during the 2 min Intrusion Provocation Task (IPT) for each experimental condition (Mean +/- SE of the mean).

Impact of event scale - revised (IES-R). Analysis revealed a significant difference in scores for the Intrusion subscale of the IES-R between the Tetris and Control conditions, $t(50) = 2.53$, $p = .01$, $d = 0.55$ (Figure 4.7). There were no significant differences for the IES-R Total score, Avoidance subscale for Hyperarousal subscales (Table 4.7).

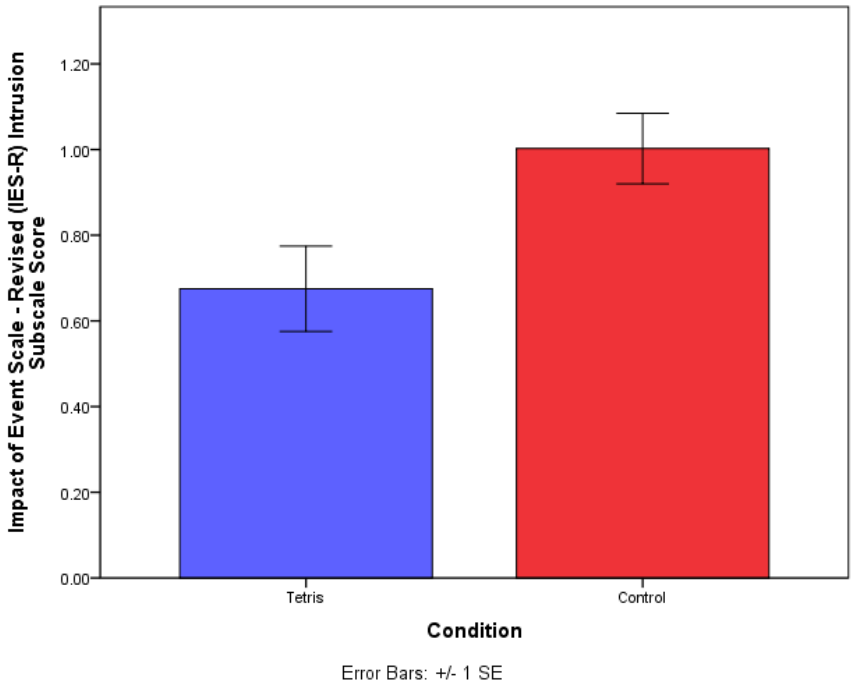


Figure 4.7. Impact of Event Scale - Revised: Intrusion subscale for each experimental condition (Mean +/- SE of the mean)

Table 4.7. *Impact of Event - Revised, Total and Subscale Scores for each Experimental Condition*

Measure	Tetris (N = 26)		Control (N = 26)		Analysis		
	M	***SD***	***M***	***SD***	***t***	**df**	***p***
Impact of Event Scale - Revised							
Total Score	.52	.41	.62	.26	1.07	50	.29
Intrusion Subscale	.68	.51	1.00	.42	2.53	50	.01*
Avoidance Subscale	.61	.62	.68	.62	.42	50	.68
Hyperarousal Subscale	.19	.25	.09	.16	1.67	50	.10

Recognition Memory

Scores did not significantly differ between conditions for the verbal recognition memory test, t (50) = 1.56, p = .13, (Figure 4.8) or the visual memory test, t (50) = 1.56, p = 0.13 (Figure 4.9)

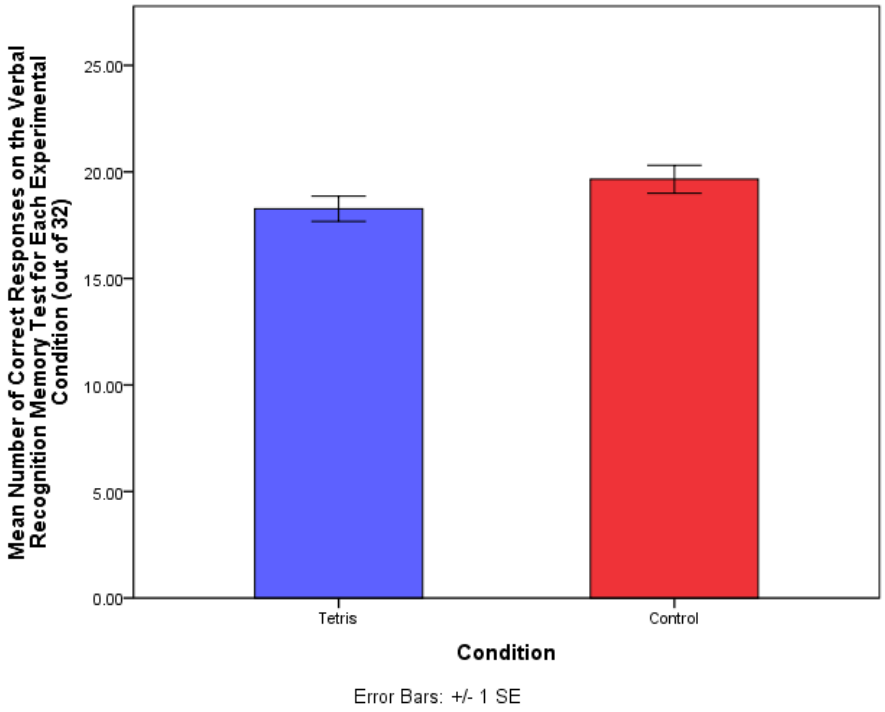


Figure 4.8. Number of correct responses on the verbal recognition memory test for each experimental condition (Mean +/- SE of the mean)

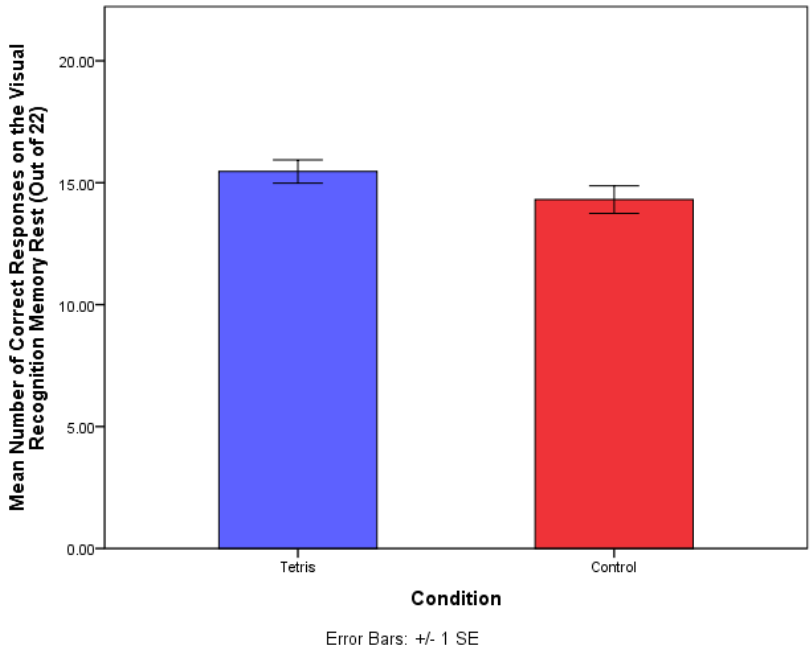


Figure 4.9. Number of correct responses on the visual recognition memory test (Mean +/- SE of the mean)

Manipulation Checks

Film attention. Ratings taken after trauma film viewing confirmed groups did not differ significantly in reported attention paid to the film (Table 4.8).

Sleep duration (24 hr. following film). Participants' self-report of the number of hours slept in-between film viewing on Session 1 and their return to the laboratory on Session 2 did not differ significantly between conditions. A partial correlation, controlling for experimental condition, was not significant for number of hours sleep in the first 24 hours following film viewing and flashback frequency post experimental assignment across the week, $r(49) = -.15$, $p = .28$.

Demand ratings. Participants responded to the question, *How much do you predict that playing the game Tetris task after a distressing film (rather than watching it normally) would increase or decrease intrusive images of the film of the type you recorded in your diary,* with an overall mean close to 0 (*no impact*), $M = -0.56$, $SD = 3.06$. A partial correlation controlling for experimental condition showed no significant correlation between demand ratings and the number of flashbacks reported in the diary from days 2 to 8; $r(49) = -.18$, $p = .21$. Demand ratings did not statistically differ between conditions (Table 4.8).

Tetris performance. Of those participants allocated to the Tetris condition, 3 had not played the game Tetris before. Game playing scores ranged from a minimum of 1168 to maximum of 85160 ($M = 30396$, $SD = 22586$). During game play the minimum level reached by participants was 2 ($n = 4$) and the maximum was 8 ($n = 1$). A Pearson's product moment correlation for Tetris score and flashback frequency over the week following experimental assignment to condition was non-significant, $r = -.33$, $p = .10$.

Table 4.8. *Manipulation Checks for each Experimental Condition*

Measure	Tetris ($N = 26$)		Control ($N = 26$)		Analysis		
	M	***SD***	***M***	***SD***	***t***	**df**	***p***
Attention to Film	9.12	1.03	9.15	1.08	0.13	50	.90
Sleep Duration (hrs.)	7.77	2.08	7.42	2.12	0.59	50	.56
Demand Ratings	-0.88	3.19	- 0.23	2.96	0.77	50	.48

Discussion

Summary of key results

Experiment 1 compared 2 conditions: Twenty four hours after viewing traumatic film material participants either underwent a memory reactivation task (seeing still visual, images of the trauma film) and then played Tetris for 12 minutes or were assigned to a no-task Control condition (where participants did not undertake the memory reactivation task nor Tetris but instead sat quietly for an equivalent period of time).

The major finding from the current experiment was that participants in the Tetris condition reported significantly fewer flashbacks of the film in the intrusion diary over the subsequent week (days 2-8) compared to the no-task Control condition. As expected, flashbacks recorded in the diary for the first 24 hours, following film viewing but prior to experimental manipulation assignment, did not differ significantly between conditions.

A second main and convergent finding was that participants in the Tetris condition reported experiencing fewer flashbacks at 1 week, during the Intrusion Provocation Task (a task designed to induce flashbacks in the laboratory) compared to the no-task Control condition. There was some indication of a reduction in scores on the Impact of Event Scale - Revised (a clinical measure of PTSD symptomatology; Weiss & Marmer, 1997), with participants in the Tetris condition reporting significantly lower scores on the intrusion subscale than the Control condition. However, this finding did not pertain to the whole measure.

Other findings: Controlling for extraneous variables

The inclusion of a visual recognition memory test for the film was novel to the current study, since previous experiments had used only a written, verbal recognition memory test. The visual recognition memory test complements the use of the verbal test and is better matched to the types of flashback memories of interest within the thesis i.e. image-based visual representations of the film. Importantly, recognition memory for the film, both verbal and visual, did not differ between conditions. This suggests that the key finding of a difference in involuntary memory between conditions is unlikely due to participants in the Tetris condition having an impaired voluntary memory for the film. That is, findings suggest the experimental manipulation had impacted on involuntary memory for the film (e.g. flashbacks) but not deliberately recalled voluntary recognition memory.

Baseline measures of depression, anxiety, neuroticism, proneness to intrusive cognitions, blood phobia and number of past traumatic experiences did not differ significantly between conditions, suggesting that groups were well-matched prior to randomisation to condition. As predicted, mood deteriorated significantly from pre to post film and was comparable at both time points for both conditions, indicating the film was able to impact negatively on mood but was not significantly different across conditions. Greater mood deterioration following a trauma film has been shown to be correlated with an increase in the number of flashbacks to that stressor (across 16 seperate studies; Clark et al., 2014); therefore, participants being well matched for mood deterioration from pre to post film is unlikely to account for flashback differences between conditions. Furthermore, participant ratings of distress caused by the film and attention paid to the film were not statistically different, indicating that the effect of a reduction in flashbacks is unlikely to be be confounded by these factors. Ratings of demand suggested participants had not formed an interpretation of the experiment that may account for findings.

The duration of sleep in between film viewing in Session 1 and returning for the Session 2, twenty-four hours later, did not differ between conditions with a partial correlation indicating there was no overall relationship between the number of hours slept and flashback frequency. As memory consolidation is a function of sleep and has been shown to facilitate the strengthening of general memories (Walker, 2009; Walker & Stickgold, 2004), it is worth noting that conditions were matched for sleep duration, suggesting this was unlikely to be a factor which contributed to findings within the current experiment.

Randomisation to condition took place immediately prior to participants returning for the second laboratory session on day 2 (twenty four hours after session 1 had finished). A photocopy of the diary was taken upon participants' return for the second session, in order that flashback frequency in the initial 24 hours (prior to assignment to experimental condition) was clearly identifiable from flashbacks collected in the remaining week. As such, it was unlikely that the experimenter unwittingly affected participants' response to trauma film viewing, or the instructions to record flashbacks in the diary in a manner that might have influenced results, as these were given on day 1 prior to randomisation. Further, demand ratings between conditions suggested participants were matched for their expectancy as to whether Tetris following a trauma film would reduce flashbacks of the kind recorded in the diary.

Limitations

Within the current experiment there was a significant reduction in scores on the Intrusion subscale of the Impact of Event Scale – Revised (IES-R; Weiss & Marmer, 1997) for those participants in the Tetris condition relative to the Control condition. However, such a reduction in scores was not present for the additional subscales of the IES-R, 'avoidance' and 'hyperarousal', nor the measure as a whole. Although this particular finding was not specifically predicted, the current thesis postulated that the visuospatial properties of Tetris serve to compete with the brain's resources necessary for flashback formation, with no prediction made regarding the impact of Tetris on additional symptoms. Accordingly, findings relating to scores on the intrusion subscale may not be viewed as inconsistent. Research by Holmes et al. (2009) had previously demonstrated a reduction in scores for the whole scale on an earlier version of the IES-R (the IES, containing only 2 subscales, Intrusion and Avoidance; Horowitz et al., 1979) for those participants who played Tetris 30 minutes after watching a trauma film. In addition, several other studies have reported differences in scores between groups on the intrusion subscale of the IES (e.g. Krans et al., 2013; Laposa & Rector, 2012; Woud et al., 2012), with the whole scale not reported.

The present experiment was the first test of whether playing the cognitive task Tetris 24 hours after trauma film viewing would reduce the subsequent occurrence of flashbacks to the film. As such, replication of these findings is required in order to be able to interpret the results more reliably. Until the current experiment, 4 hours marked the longest time period between trauma film viewing and Tetris game play for reducing flashback development. Based on reconsolidation literature, this 2-condition design was used which demonstrated that Tetris after a memory reactivation task reduced flashbacks relative to a no-task Control. However, such a comparison does not control for the possibility that flashback development was influenced by Tetris regardless of whether memory for the film was first reactivated. Similarly, the present experiment does not experimentally clarify that the memory reactivation task alone did not influence the subsequent development of flashbacks.

Future Experiments

Future experiments should provide a test of replication for the findings from the current experiment in order to produce cumulative evidence that the results from Experiment 1 are robust. Moreover, further experiments should test whether the memory

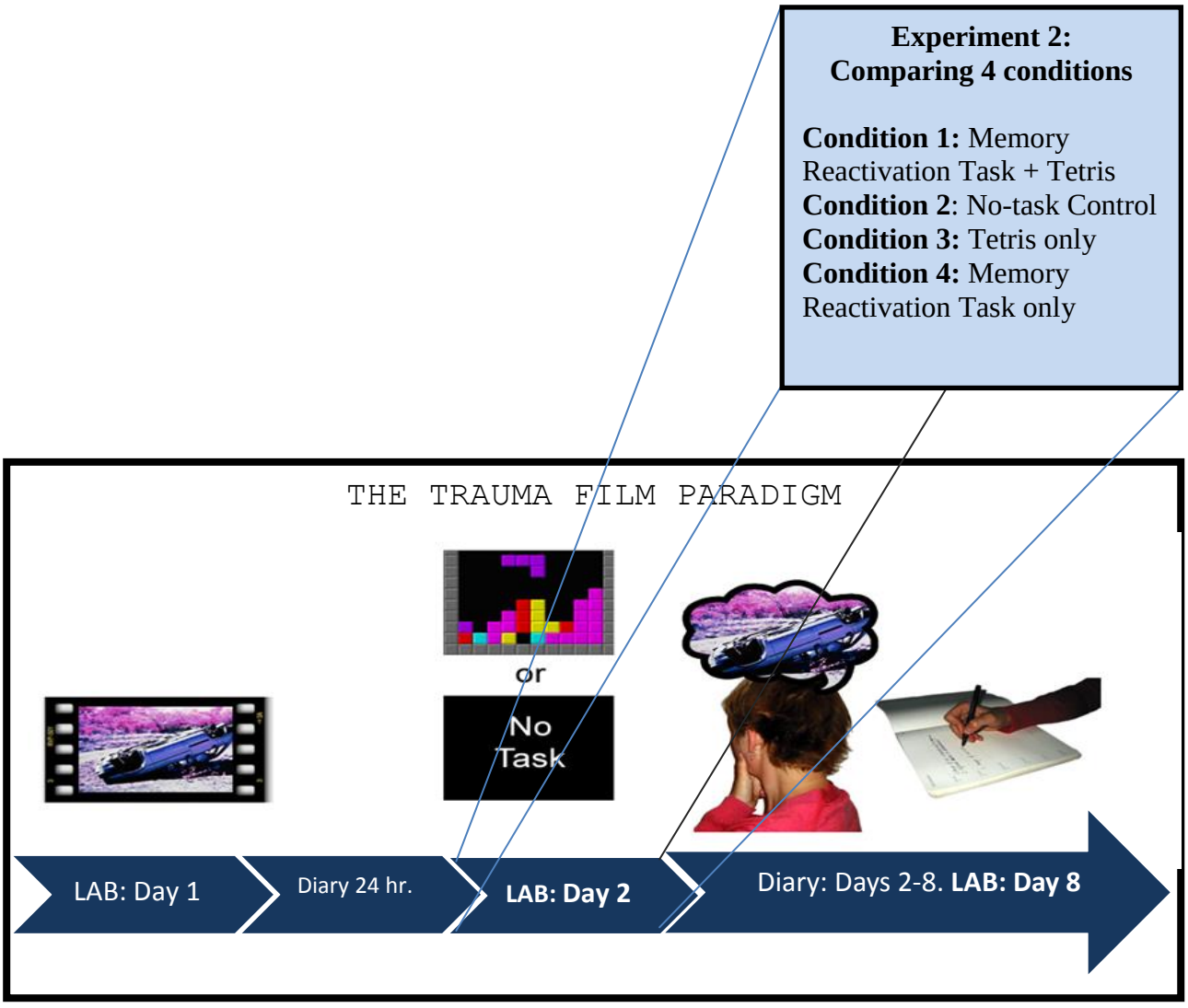
reactivation task *in combination* with Tetris is crucial in order to reduce flashback development, or whether Tetris alone or the memory reactivation alone task would have an effect. Research on memory reconsolidation indicates that memory modification during reconsolidation cannot occur without prior memory reactivation (Schiller & Phelps, 2011; see also Chapter 2). As such, without memory reactivation for the film, memory would not be predicted to become labile and susceptible to the interference effects of playing the computer game Tetris. Similar forecasts are made in relation to undertaking the memory reactivation task in the absence of Tetris. Memory, even when reactivated, will not demonstrate interference effects if a task has not been recruited to alter it while labile.

Experimentally dismantling the 'memory reactivation task + Tetris condition' into its constituent parts allows for a precise test of both tasks in isolation and their relative impact on flashback development for the trauma film. Findings pertaining to this might be particularly relevant given the negative nature of the memories under investigation within the thesis e.g. traumatic flashbacks, i.e. perhaps the 'memory reactivation task condition' predicted to 'reactivate' memory for the trauma film is harmful (e.g. exacerbates flashbacks) when presented in isolation.

In conclusion, next steps should replicate findings from the current experiment in addition to extending them in order to ascertain whether Tetris in combination with a prior memory reactivation task is necessary to reduce flashbacks, or whether Tetris or the memory reactivation task in isolation would have any effect.

CHAPTER 5

A Cognitive Task at 24 Hours (Memory Reconsolidation): Dismantling Possible Task Components Associated with a Reduction in Flashbacks



Procedural overview adapted from Holmes et al., 2009

A Cognitive Task at 24 Hours (Memory Reconsolidation): Dismantling Possible Task Components Associated with a Reduction in Flashbacks

Overview

In Experiment 1 it was shown that, 24 hours after viewing a traumatic film, participants who played the cognitive task Tetris after a memory reactivation task for the film reported fewer flashbacks over the subsequent week, relative to a no-task control condition. In addition to flashback frequency in a diary, at one week participants in the Tetris condition reported fewer flashbacks following the Intrusion Provocation Task (IPT; a method of inducing flashbacks in the laboratory) and lower scores on the intrusion subscale of the Impact of Event Scale (IES-R; Weiss & Marmer, 1997). In addition to a test of replication for findings, Experiment 2 sought to dismantle those components of the task responsible for the effects. Thus, the current experiment sought to replicate the findings from Experiment 1 by showing that memory reactivation for the trauma film *plus* Tetris is required to reduce flashbacks to the film, relative to a no-task control condition. Further to this, Experiment 2 extended the findings from Experiment 1 to test the prediction that playing Tetris without prior memory reactivation for the film, or memory reactivation without subsequently playing Tetris would not result in a reduction in flashbacks, relative to a no-task control. Findings indicate that memory reactivation in combination with Tetris is required to modify a consolidated (24 hour old) memory for an analogue trauma.

Introduction

The memory reconsolidation literature has indicated that the reactivation of a memory is essential in order to render that memory labile and vulnerable to subsequent interference effects (Nader & Einarsson, 2010; Nader & Hardt, 2009; Schiller & Phelps, 2011). Thus, Experiment 1 tested whether a consolidated (24 hr. old) memory for traumatic film material would be amenable to interference effects via the computer game Tetris when memory for the film had been reactivated beforehand (e.g. via the memory reactivation task). Key predictions were confirmed, with a reduction in flashbacks being apparent in those participants who underwent the memory reactivation task followed by Tetris, relative to the no task control condition. However, with the use of a control condition which was simply ‘no-task’ in the laboratory, Experiment 1 was not able to test whether playing Tetris without the memory reactivation task beforehand, or the memory

reactivation task without Tetris, would also have resulted fewer flashbacks. The reconsolidation literature would suggest that neither the memory reactivation task nor the cognitive task Tetris in isolation should not be sufficient to modify memory, and that both tasks in combination would be required to demonstrate a reduction in flashbacks as found in Experiment 1.

Therefore, the main aim of the current experiment was to give a more precise test of the conditions under which flashback frequency for a 24 hour old analogue trauma can be reduced using the cognitive task Tetris. To that end, the current experiment had two main objectives: first, to provide a test of replication in order to strengthen confidence in the findings observed from Experiment 1; second, to extend the findings from Experiment 1 by dismantling the constituent parts of the 'active' Tetris condition, i.e. testing the effect of each component alone - the memory reactivating task and the Tetris task. If memory reconsolidation theory is correct then undertaking the memory reactivation task *in combination* with Tetris would be necessary in order to reduce flashback frequency. Crucially however, the memory reactivation task or Tetris game play when completed in isolation should have no effect, ostensibly being comparable to a no-task condition.

Hypotheses

Twenty four hours after viewing a traumatic film, participants assigned to a memory reactivation task + Tetris condition relative to a no-task control condition will experience;

- No difference in flashback frequency between conditions on day 1 in the intrusion diary (flashbacks recorded in the diary 24 hour *prior* to assignment to experimental condition).
- Significantly fewer flashbacks of the film over the subsequent week (as recorded in an intrusion diary) on days 2-8, and on convergent measures:
    - The Intrusion Provocation Task (IPT) on day 8
    - Impact of Event Scale-Revised: Intrusion subscale (Weiss & Marmer, 1997) on day 8

Furthermore, and fundamental to the current experiment, no difference is predicted between the Tetris only and memory reactivation task only conditions, relative to the no-task control conditions for any of the main outcome measures, i.e. (1) flashback frequency in the intrusion diary days 2-8, (2) IPT flashback frequency on day 8 or (3)

scores on the IES-R: Intrusion subscale on day 8.

Method

Approval was obtained from the University of Oxford Central University Research Ethic Committee [MSD/IDREC/C1/2010/104; Appendix 4.1].

Design

A between-subjects design was used where participant were randomly assigned to one of four conditions (n = 18 per condition); (1) Memory reactivation task followed by Tetris (replication of Experiment 1), (2) No-task control (replication of Experiment 1), (3) Tetris only (extension of Experiment 1) or (4) Memory reactivation task only (extension of Experiment 1). Participants attended repeated sessions over 3 time points identical to Experiment 1 (day 1, day 2 and day 8; yielding a total of 216 sessions across all participants).

Participants

Sample size estimation. Based on the effect size of d = 1.17 from Experiment 1, the current study assumed a large effect size of .8; A sample size of n = 18 per condition was required to ensure an 80% power to detect this difference at the 5% significance level.
72 healthy volunteers (25 male) took part in the study. Remuneration, recruitment methods and inclusion criteria were the same as that of Experiment 1.

Trauma Film

The 12 min trauma film was the same as that used in Experiment 1 (for a description of film clips see appendix 4.5).

Tasks

The tasks used within each of the four experimental conditions were the same as those used in Experiment 1, with the addition of manipulation ratings for participants who were assigned to conditions which involved playing the cognitive task Tetris (e.g. ratings for game attention, enjoyment and difficult). Conditions 1 and 2 were a test of replication for Experiment 1. Conditions 3 and 4 extended Experiment 1 by each isolating one of the components from the Memory Reactivation Task + Tetris condition; thus Condition 3 required participants to play Tetris only and Condition 4 required participants to undergo

the Memory reactivation task only. Tasks were administered on Session 2 (Day 2). Table 5.1 provides an overview of tasks contained in each experimental condition.

Table 5.1. *Simple Overview of Tasks in each Experimental Condition*

Condition 1: Memory Reactivation Task + Tetris	**Condition 2:** No-task Control	**Condition 3:** Tetris Only	**Condition 4:** Memory Reactivation Task Only
Memory Reactivation task	-	-	Memory Reactivation task
Music Filler task [10 min]	Music Filler task [10 min]	-	Music Filler task [10 min]
Tetris * [12 min]	No-task break [12 min]	Tetris * [12 min]	-

Condition 1: Memory Reactivation Task + Tetris. Participants in the memory reactivation task + Tetris condition underwent the following procedure (the same as Experiment 1). Participants underwent the memory reactivation task, followed immediately by a 10 min music filler task. Following the filler task participants then played 12 min of Tetris. Following Tetris game play ratings were taken:

Tetris manipulation ratings

Tetris performance. Scores were recorded through game play by the experimenter as in Experiment 1

Tetris attention to game. Following game play participants were instructed to '*please indicate how much attention have you paid to the game you just played*' from 0 (*none at all*) to 10 (*extreme attention*).

Tetris enjoyment. Levels of enjoyment were rated by participants on a VAS which asked '*how much did you enjoy the game you just played?*' The scale was anchored from 0 (*not at all*) to 10 (*extremely*).

Tetris difficulty. Perceived game difficulty was rated by participants using a VAS which asked participants to estimate '*how difficult/easy did you find the game you just played?'* the VAS was anchored from 0 (*easy to play*) to 10 (*difficult to play*)

Condition 2: No-task Control. Participants in the no-task Control condition underwent the following procedure (the same as Experiment 1). Participants undertook the 10 min

music filler task and then immediately after completed the no-task break (sitting quietly) for 12 min.

Condition 3: Tetris Only. Participants in the Tetris only condition were required to play Tetris for 12 min. Following game-play, self-report ratings for attention to game, game enjoyment and game difficulty were administered, as in Condition 1.

Condition 4: Memory Reactivation Task Only. Participants in the Memory Reactivation Task only condition undertook Memory Reactivation Task followed by the 10 min music filler task.

Baseline Measures

Baseline measures were the same as those used in Experiment 1 and comprised of the following: Beck depression inventory-II (BDI-II; Beck, 1993); State trait anxiety inventory (STAI-T; Spielberger et al., 1983); Eysenck personality questionnaire - neuroticism scale (EPQ-N; Eysenck & Eysenck, 1975); Traumatic experience questionnaire (TEQ; Adapted from Foa et al, 1999); Spontaneous Use of Imagery Scale (SUIS; Reisberg et al., 2003); Proneness to intrusive cognitions Scale (PICS; Davies & Clark, 1998) and Blood phobia VAS.

Mood and Distress Ratings

Mood pre-to post-film. Pre- and post-film mood ratings for sadness, hopelessness and depression were rated on VAS like that of Experiment 1

Film distress. Post-film distress was rated using a single VAS.

Main Outcome Measures: Memory for the Trauma Film (all identical to Experiment 1)

Intrusion diary. The pen and paper, tabular intrusion diary used to capture flashback for the film, was the same as that used in Experiment 1 (Appendix 4.9) as was its instructions for use. Inter-rater reliability was assessed on n = 21 (approximately 30%) randomly selected participant diaries to assess levels of agreement over flashback entries.

Diary accuracy. A single VAS rated diary accuracy

Intrusion provocation task (IPT). The IPT was used as a laboratory method for inducing flashbacks for the film (appendix 4.10).

Impact of event scale – revised (IES-R). The 20-item self-report, IES-R (Weiss & Marmer, 1997) measured subjective distress for the film (appendix 4.11). Only the

intrusion subscale was analysed in the current experiment, as the scale demonstrate significant differences between conditions in Experiment 1

Recognition Memory

Recognition memory tests administered at the final follow up on day 8 were the same as those used in Experiment 1

Verbal recognition memory. A verbal recognition memory test comprised of 32 written statements regarding the film. Participants were asked to write true or false next to each statement as they remembered.

Visual recognition memory. A visual recognition memory test required participants watched 22 static images whilst simultaneously indicating whether or not they recognised the image as being from the film they watched one week earlier.

Manipulation Checks

Film attention. Attention was assessed using the same VAS as Experiment 1.

Sleep duration (24 hr. following film). Sleep duration for the 24 hours in between film viewing and assignment to condition was estimated by participants using same rating as that used in Experiment 1.

Demand ratings. The single VAS was the same as that used in Experiment 1.

Procedure

The procedure for Experiment 2 was the same as that of Experiment 1 except for the addition of two new experimental conditions that participants were randomly assigned to on Session 2 (Day 2). See Figure 5.1 for a procedural diagram.

Session 1 (Day 1). All participants completed a battery of baseline measures then undertook a 3 min practice of Tetris. They then viewed the trauma film. VAS mood evaluations were taken pre and post film. Ratings of distress and attention to the film were taken after film viewing. Participants were given the intrusion diary and were asked to return, with the diary, to the laboratory in 24 hours.

Session 2 (Day 2). Upon their return, participants were randomly allocated to one of four conditions: *Condition 1:* Memory reactivation task + Tetris condition, *Condition 2:* No-task control condition, *Condition 3:* Tetris only condition or *Condition 4:* Memory reactivation task only condition. At the end of session 2 (day 2) all participants were asked to keep a record of their intrusions for the film in the intrusion diaries for a further 7 days before returning for Session 3 (Day 8).

Session 3 (Day 8). One week later participants returned with their completed intrusion diaries. They completed the IES-R as well as two recognition memory tests for the film (verbal and visual). Participants then underwent the Intrusion Provocation Task (IPT) and were debriefed at the end of the experiment.

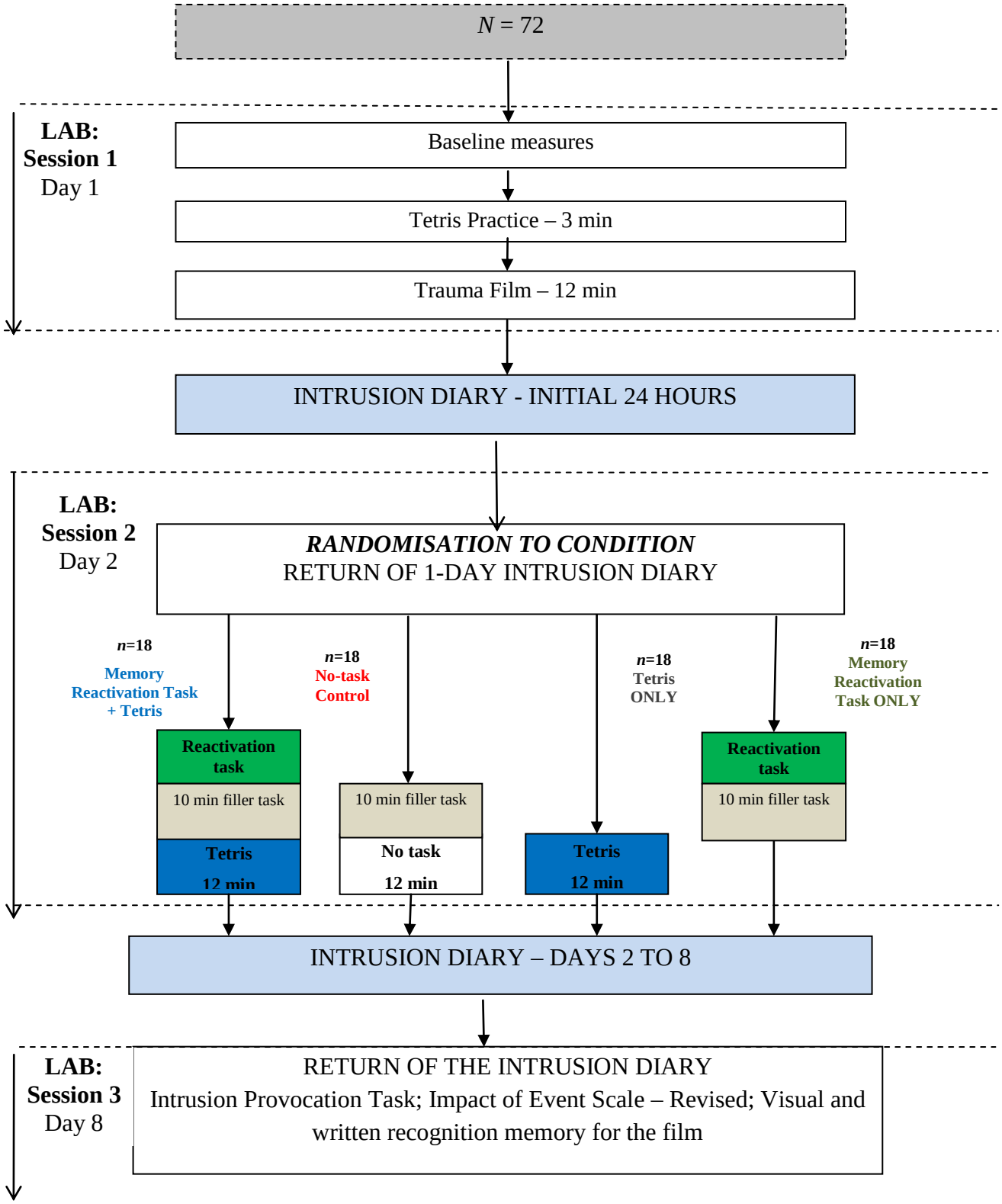


Figure 5.1. Procedural overview of Experiment 2

Results

All data were examined for potential outlying values (+/- 3 SD from the mean) and none were found. Homogeneity of variance was assessed using Levene's statistic and, where necessary, values for which homogeneity of variance is not assumed are reported. One-way between groups ANOVAs were used to compare means between conditions. A-priori planned comparisons were undertaken using Dunnett t-tests (due to the no-task Control condition being compared to all other conditions; Dunnett, 1955; Howell, 2007). Repeated-measures ANOVA was used to compare mood from pre to post film. Nominal data were analysed using the chi-square test with inter-rater reliability assessed using the Kappa statistic. Inferential statistics were analysed using partial correlations. An alpha level of .05 was used for all statistical tests. IMB SPSS statistical package version 19.0 was used to analyse results.

Baseline Measures

There were no significant differences between conditions for baseline measures (Table 5.2).

Table 5.2. *Baseline Characteristics including Mood Measures, Trauma History and Mental Imagery use for each Experimental Condition*

Measure	Memory Reactivation Task + Tetris (N = 18)		No-task Control (N = 18)		Tetris Only (N = 18)		Memory Reactivation Task Only (N = 18)		Analysis	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**	$\chi^2_{(3,68)}$	***p***
Male	9	50	4	22	4	22	8	44	5.07	.16
	M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	$F_{(3,68)}$	***p***
Age (years)	24.44	7.40	23.67	6.82	25.39	7.82	28.39	11.30	0.96	.42
BDI-II	2.67	2.45	3.33	4.58	3.61	4.58	2.06	2.75	0.63	.60
STAI-T	34.67	7.50	32.72	9.70	34.06	8.62	33.61	7.96	0.17	.92
EPQ-N	3.67	3.29	3.33	3.07	2.50	2.36	3.11	2.56	0.54	.66
TEQ	0.78	0.94	0.87	1.08	0.94	0.10	1.00	0.84	0.18	.91
SUIS	38.11	7.81	39.39	8.68	40.56	6.77	41.83	8.07	0.74	.53
PICS	4.71	2.66	4.71	2.80	3.89	2.61	4.36	2.35	0.40	.75
Blood Phobia	2.55	2.27	2.40	2.71	2.30	2.33	3.10	2.52	0.38	.77

Note. BDI-II = Becks Depression Inventory – II (Beck, 1993); EPQ-N = Eysenck personality questionnaire - neuroticism scale (Eysenck et al., 1985); PICS = Proneness to intrusive cognitions (Davies & Clark, 1998) STAI = State trait anxiety inventory – trait (Spielberger et al., 1983); SUIS = Spontaneous Use of Imagery Scale (Reisberg, Pearson & Clark, 2003); TEQ = Traumatic Experiences Questionnaire (adapted from Foa, Ehlers, Clark, Tolin & Orsillo, 1999)

Mood and Distress Ratings

Mood pre-post film. Repeated-measures ANOVA confirmed a main effect of time, indicating that participants' mood significantly deteriorated following the film, but no main effect of group or group x time interaction (Table 5.3).

Table 5.3. *Mood Change from Pre- to Post-Film for each Experimental Condition*

Measure	Memory Reactivation Task +Tetris (*N* = 18)		No-task Control (*N* = 18)		Tetris Only (*N* = 18)		Memory Reactivation Task Only (*N* = 18)		ANOVA		
	M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	**Time**	**Group**	**Group *Time**
VAS Pre-Film Mood	1.81	2.40	1.81	1.49	1.56	1.67	2.52	2.69	$F_{(3,68)}$ =70.36[§]	$F_{(3,68)}$ = 0.43	$F_{(3,68)}$ = .93
VAS Post-Film Mood	6.51	4.53	5.62	4.91	7.74	6.01	6.47	4.76			

Note. VAS (Visual Analogue Scale) mood composite sum of Sadness, Hopelessness and Depressed (Holmes et al., 2009; 2010)

[§] $p < .001$; $\eta\rho^2 = .509$

Film distress. There was no significant difference between groups for self-rated distress of film content: Memory reactivation task + Tetris, *M* = 6.44, *SD* = 1.69; Control, *M* = 6.44, *SD* = 1.89; Tetris only, *M* = 6.11, *SD* = 2.59 and Memory reactivation only, *M* = 6.06, *SD* = 2.48, $F(3, 68) = 0.16$, $p = .92$.

Main Outcome Measures: Memory for the Trauma Film

Intrusion diary flashback frequency: Day 1. At 24 hours (*prior* to experimental manipulation), as expected, all conditions reported a comparable number of flashback memories: Memory reactivation task + Tetris, $M = 3.11$, $SD = 2.40$; No-task control, $M = 3.56$, $SD = 2.41$; Tetris only $M = 3.17$, $SD = 1.58$; and memory reactivation task only $M = 3.44$, $SD = 2.64$, $F(3, 68) = 0.16$, $p = .92$. See Figure 5.2.

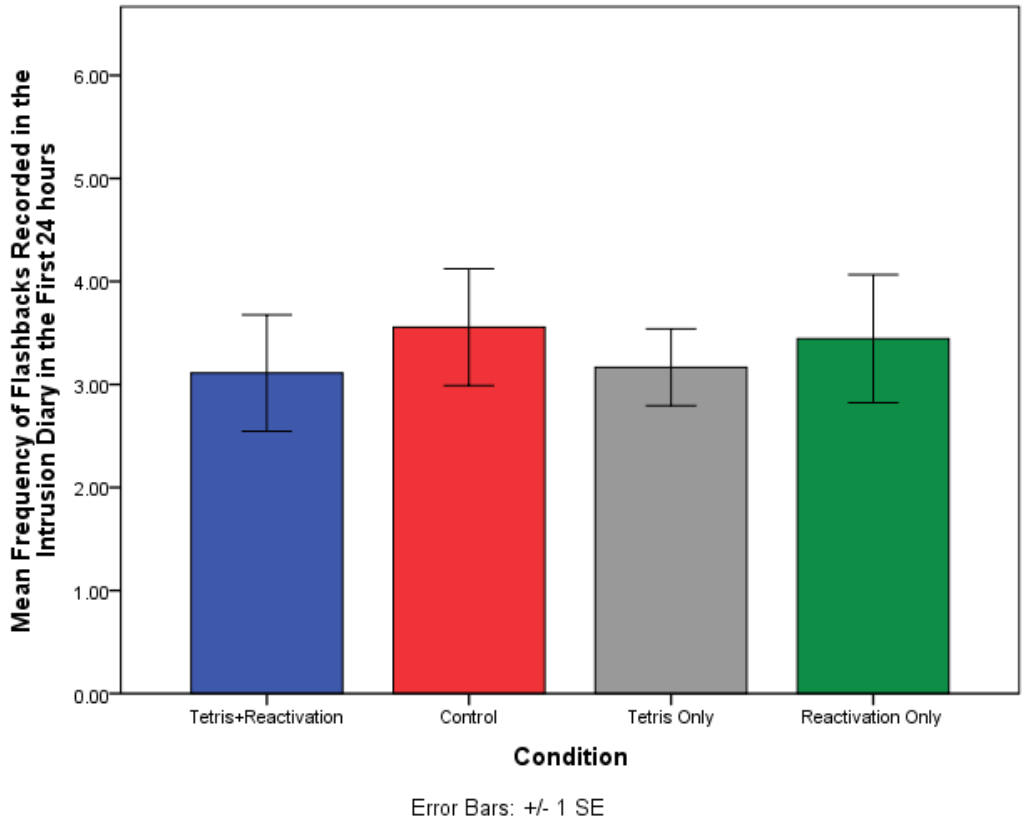


Figure 5.2. Flashback frequency recorded in the intrusion diary for day 1, the first 24 hours following film viewing (and prior to experimental assignment) for each experimental condition (Mean +/-SE of the mean).

There was no significant difference between conditions for intrusive thought (as opposed to image) frequency (labelled T only in the diary); $F(3, 68) = 1.02$, $p = .39$. Exploratory analysis was carried out to test whether key findings relating to flashback frequency remained non-significant between conditions on Day 1 if intrusive verbal thought and flashbacks were combined, which they did; $F(3, 68) = 0.16$, $p = .92$.

Intrusion diary flashback frequency: Days 2 - 8. Central to predictions, there was a significant effect of experimental condition on flashback frequency over 7 days; F (3, 68) = 3.51, p = .02, $\eta\rho^2$ = 0.134[8]. A priori planned comparisons showed significantly fewer flashback memories were reported by participants in the memory reactivation task + Tetris condition (M = 2.00, SD = 1.81) compared to the no-task control condition (M = 5.11, SD = 4.23; Mean difference = 3.11; p = .01).

Moreover, as predicted, planned comparisons revealed comparable numbers of flashbacks between the no-task control condition and the Tetris only condition (M = 3.89, SD = 2.89; Mean difference = 1.22; p = .52) and no task control and the memory reactivation task only condition (M = 4.83, SD = 3.33; Mean difference = 0.28; p = .99). See Figure 5.3.

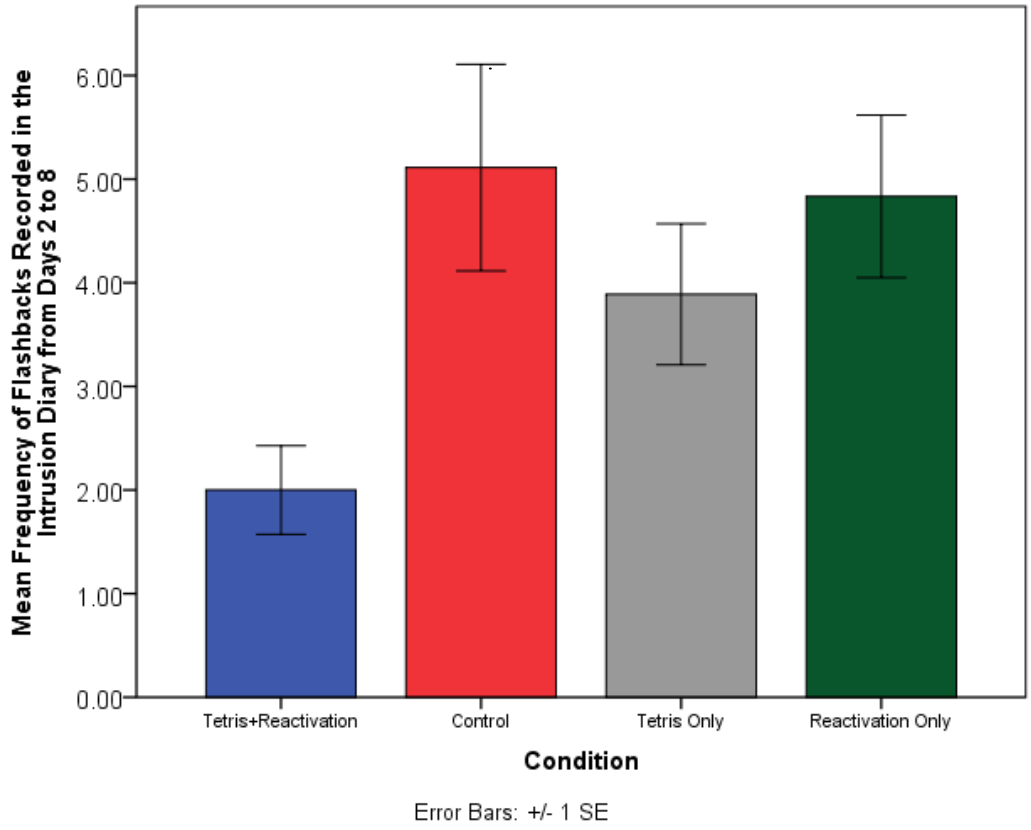


Figure 5.3. Flashback frequency recorded in the intrusion diary for days 2 to 8, for each experimental condition (Mean +/-SE of the mean).

[8] $\eta\rho^2$ (Partial Eta Squared) is standard measure of effect size where 0.01 is taken to be a 'small effect; 0.059 a 'medium' effect and 0.138 a 'large' effect (Cohen, 1988).

Intrusive thought frequency did not differ between conditions between days 2 - 8; $F(3, 68) = 1.26$, $p = .30$. Supplementary analysis found that the main finding relating to frequency remained significant when intrusive thought and flashback frequency were combined; $F(3, 68) = 2.86$, $p = .04$, $\eta\rho^2 = .134$.

Diary accuracy. Participants did not differ significantly for self-rated measures of diary accuracy; Memory reactivation task + Tetris, $M = 8.44$; $SD = 1.29$; No-task control, $M = 8.56$; $SD = .86$; Tetris only, $M = 8.44$; $SD = 1.04$ and Memory reactivation task only, $M = 8.44$; $SD = 0.92$; $F(3, 68) = 0.05$, $p = .99$.

Flashback trajectory. Figure 5.4 illustrates the flashbacks trajectory from days 1 to 8 for all experimental conditions. The dotted line to the left on the graph represents the first 24 hours, prior to assignment to experimental condition.

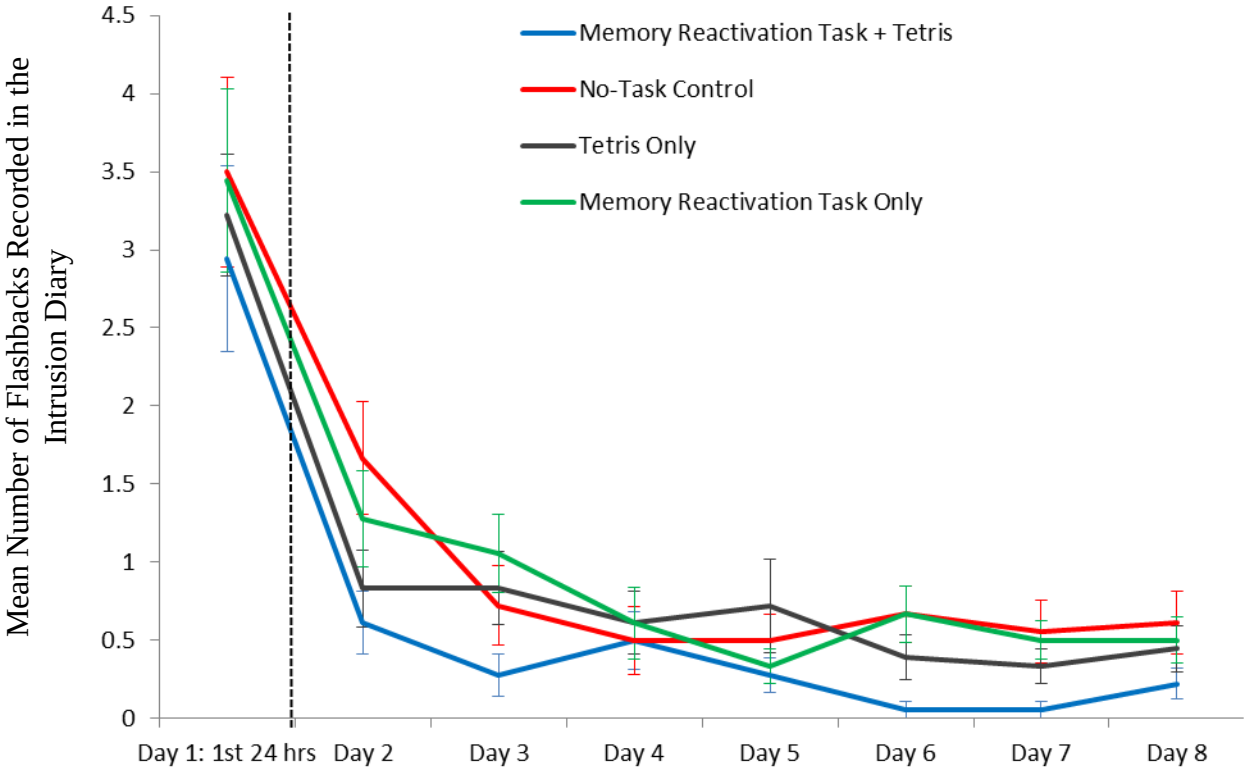


Figure 5.4. Flashback frequency recorded in the intrusion diary for each of the days, 1 through 8, for each experimental condition (Mean +/- SE of the mean)

Subsequent analysis conducted on each day, 2 through 8, indicated a significant effect of condition on flashback frequency for days 2, 6 and 7. Comparisons using Dunnett's t-test indicated that the mean number of flashbacks experienced in the memory reactivation task + Tetris condition was significantly less compared to the no-task control

condition for these three days with no significant differences between any other conditions (Table 5.4).

Table 5.4. *Flashbacks Frequency Recorded in the Intrusion Diary for Days 1 through 8 for each Experimental Condition.*

Day	Memory Reactivation Task + Tetris (N = 18)		No-task Control (N = 18)		Tetris Only (N = 18)		Memory Reactivation Task Only (N = 18)		Analysis	
	M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***f*(3,68)**	***p***
Day 1	3.11	2.40	3.56	2.41	3.17	1.58	3.44	2.64	0.16	.92
Day 2	0.61	0.85	1.67	1.53	0.83	1.04	1.28	1.32	2.69	.03*
Day 3	0.28	0.57	0.72	1.07	0.83	0.99	1.06	1.06	2.16	.10
Day 4	0.50	0.79	0.50	0.92	0.61	0.85	0.61	0.98	0.09	.96
Day 5	0.28	0.46	0.50	0.71	0.72	1.27	0.33	0.49	1.12	.35
Day 6	0.06	0.24	0.67	0.77	0.39	0.61	0.67	0.77	3.79	.01*
Day 7	0.06	0.24	0.56	0.86	0.33	0.49	0.50	0.51	2.82	.03*
Day 8	0.22	0.43	0.61	0.85	0.44	0.62	0.50	0.62	1.16	.33

Note. Day 1 = prior to experimental condition
* = $p < .05$

The nature of intrusions recorded in the diary. An inter-rater reliability analysis was conducted on a random sample of participants' diaries (n = 21), to assess the degree of agreement for flashback entries. Two raters, who were familiar with the trauma film content and the definition of flashback used in the diary, conducted independent ratings. Comparisons between raters indicated 'Excellent' consensus over flashback diary entries; Kappa = .79; $p < .001$.

Day 1: First 24 hrs. following film. Across all 4 conditions a combined total of 259 intrusions were reported in the diary in the first 24 hours. Two-hundred and thirty nine were flashbacks (M = 3.31, SD = 2.25, range: 0 – 12) and 20 were intrusive verbal-thoughts (M = 0.65, SD = 1.06, range: 0 – 4). Three participants (4.2%) reported zero flashbacks; 59 (81.9 %) reported having zero verbal thoughts. Of the intrusions recorded by participants in the 24 hours post-film, 11 (11.1 %) could not be matched to the film and were therefore not included in analyses.

The number of different 'events' (flashbacks that to different film clips) reported in the 24 hour intrusion diary (prior to experimental assignment to condition) did not

statistically differ between condition. Table 5.4 provides the mean number of flashback events per experimental condition, $F(3, 68) = 0.14$, $p = .94$.

Days 2-8: Post experimental assignment to condition. Participants across all conditions reported a combined total of 288 intrusions in the diary from days 2 to 8. Of these, 252 were flashbacks ($M = 3.96$, $SD = 3.35$, range: 0 – 16) and 36 were verbal-thoughts ($M = 0.50$, $SD = 1.03$, range: 0 – 5). Five participants reported having zero flashbacks across days 2 to 8. Only 1 participant had zero flashbacks across the whole 8 days (for both the 24 hour diary and 2-8 day diary). Fifty-four participants reported having zero intrusive verbal thoughts across days 2-8. Fourteen intrusions (3.9%) could not be matched to the film and as such were not included in analysis. The number of intrusions which could not be matched to the film did not differ significantly relative to condition, $F(3, 68) = 1.05$, $p = .38$.

The number of different flashback events reported by participants in the intrusion diary between days 2 to 8 significantly differed between experimental conditions (Table 5.5) , $F(3, 68) = 3.37$, $p = .023$, $\eta\rho^2 = 0.134$.

Table 5.5. *Number of Different Flashback Events Recorded in the Intrusion Diary for each Experimental Condition*

Measure	Memory Reactivation Task + Tetris ($N = 18$)		No-task Control ($N = 18$)		Tetris Only ($N = 18$)		Memory Reactivation Task only ($N = 18$)	
	M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Day 1	2.33	1.64	2.56	1.50	2.39	1.09	2.28	1.07
Days 2 - 8	1.56	1.15	2.83	1.58	2.50	1.34	3.00	1.81
Combined Days	3.89	2.03	5.39	2.43	4.89	2.23	5.28	2.40

Intrusion provocation task (IPT) flashback frequency. At 1 week. IPT frequency was significantly different between conditions, $F(3, 68) = 5.28$, $p = .01$, $\eta\rho^2 = .189$. Planned comparisons confirmed significantly fewer flashbacks were experienced during the IPT in the memory reactivation task + Tetris condition ($M = 1.17$, $SD = 1.86$), compared to the no-task control condition ($M = 3.39$, $SD = 2.81$; Mean difference = 2.22; $p = .01$). As hypothesised, there were no significant differences in flashback frequency found between the no-task control condition and the Tetris only condition ($M = 3.11$, $SD = 2.52$; Mean difference = 0.28; $p = .97$) nor between the no-task control condition and the memory reactivation task only condition ($M = 4.17$, $SD = 2.12$; Mean difference = 0.78; $p = .63$). See Figure 5.5

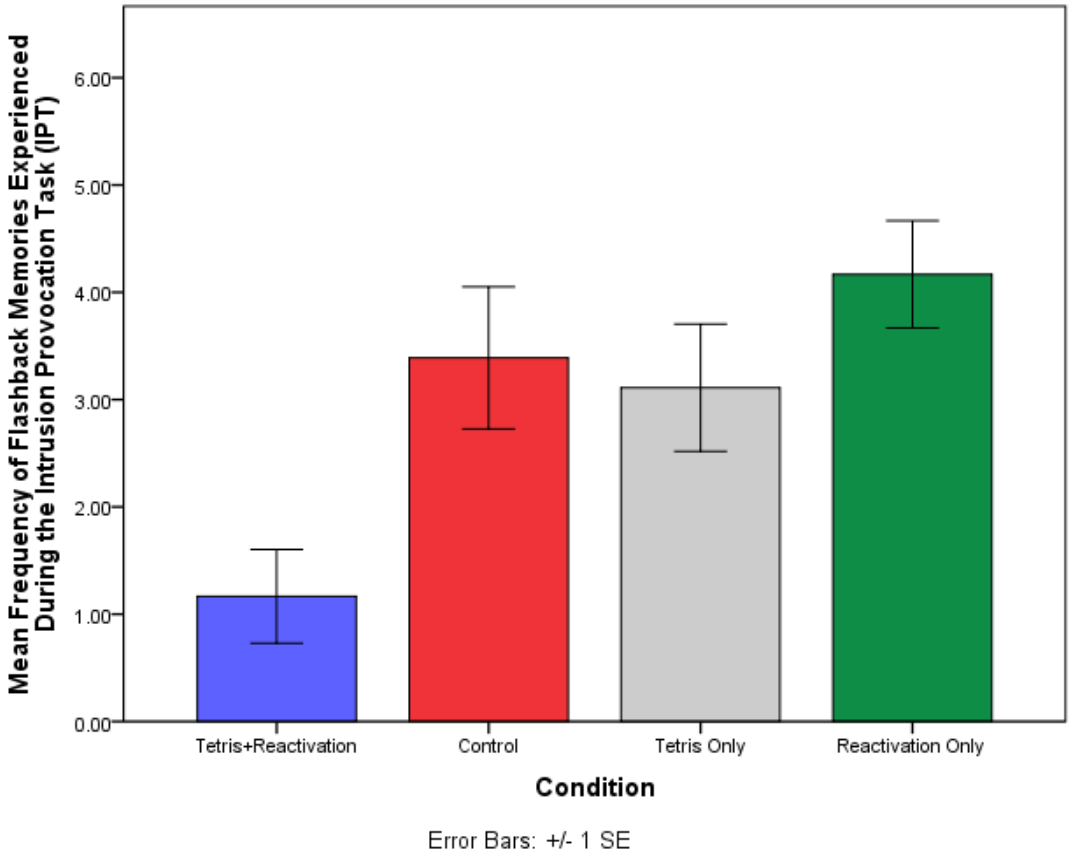


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Figure 5.5. Flashback frequency during the 2 min Intrusion Provocation Task (IPT) for each experimental condition (Mean +/-SE of the mean).

Impact of event scale - revised (IES-R). No significant differences in the IES-R were found for either Total or the Intrusion subscale between experimental conditions (Table 5.6)

Table 5.6. *Impact of Event Scale - Revised, Total and Intrusion Subscale Score for each Experimental Condition*

Measure	Memory Reactivation Task + Tetris (*N* = 18)		No-task Control (*N* = 18)		Tetris Only (*N* = 18)		Memory Reactivation Task only (*N* = 18)		Analysis	
	M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***f*(3,68)**	***p***
Impact of Event Scale - Revised										
Total	0.50	0.25	0.53	0.38	0.56	0.37	0.47	0.26	0.27	.85
Intrusion Subscale	0.61	0.38	0.83	0.56	0.74	0.50	0.81	0.38	0.81	.49

Recognition Memory

Scores on the recognition memory tests did not differ significantly between conditions for the verbal recognition memory test, $F(3, 68) = 0.86$, $p = .47$ (Figure 5.6) or the visual recognition memory test, $F(3, 68) = 2.06$, $p = .11$ (Figure 5.7).

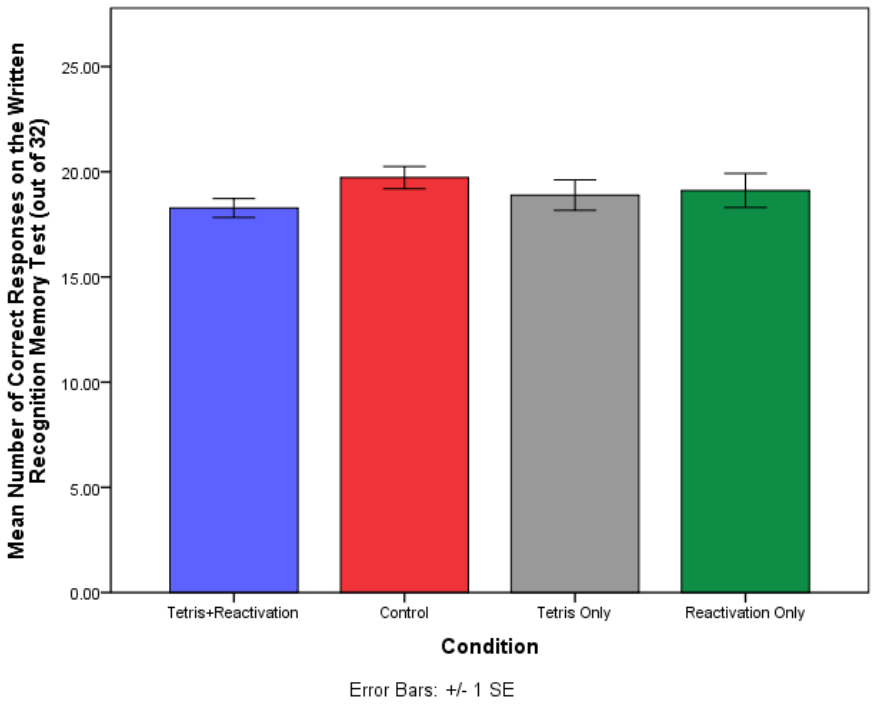


Figure 5.6. Number of correct responses on the verbal recognition memory test for each experimental condition (Mean +/- SE of the mean).

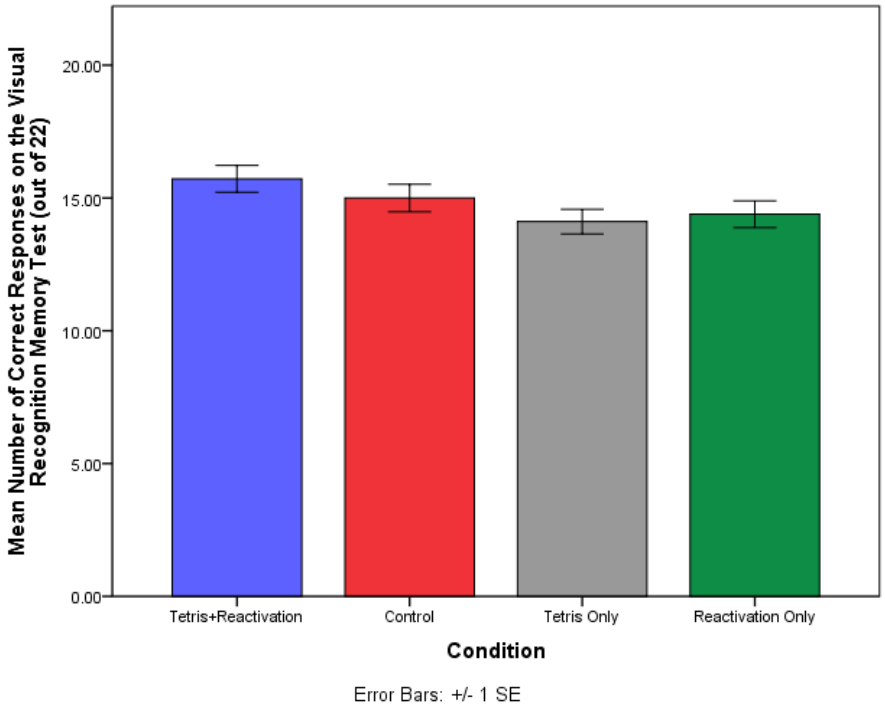


Figure 5.7. Number of correct responses on the visual recognition memory test for each experimental condition (Mean +/- SE of the mean).

Manipulation Checks

Film manipulation measures. Measures taken post trauma film viewing confirmed groups were well matched for attention paid to the film and distress caused by the film (Table 5.7).

Sleep duration (24 hr. post-film). Participants did not report a significant difference in the number of hours sleep between post film viewing and assignment to experimental condition in session 2 (Table 5.7). A partial correlation, controlling for experimental condition, was not significant for number of hours sleep in the first 24 hours and subsequent flashback frequency, $r(69) = -.01$, $p = .96$.

Demand Rating. The overall mean on ratings of demand was $M = -1.25$, $SD = 3.44$. A partial correlation controlling for experimental condition indicated there was no relationship between ratings of demand and flashback frequency reported in the intrusion diary from days 2-8, $r(69) = -.02$, $p = .89$. Ratings did not differ statistically between conditions, see Table 5.7.

Tetris performance and game play manipulation checks. Performance scores did not differ significantly between participants in the memory reactivation task + Tetris and Tetris only conditions. Moreover, they did not differ on ratings of game enjoyment,

difficulty and attention paid to the game following play (Table 5.7). There was no correlation found between Tetris score and flashback frequency, $r(36) = .19$, $p = .27$.

Table 5.7. *Manipulation Checks for each Experimental Condition*

Measure	Memory reactivation Task + Tetris (N = 18)		No-task control (N = 18)		Tetris only (N =18)		Memory reactivation task only (N= 18)		Analysis	
	M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***f*(3,68)**	***p***
Attention to Film	9.28	0.83	9.67	0.49	9.56	0.62	9.44	0.62	1.18	.32
Sleep Duration (hrs.)	7.19	1.09	7.47	1.33	7.36	0.70	7.67	1.06	0.62	.61
Demand Rating	-1.78	3.80	-1.33	2.93	-1.61	3.27	-0.28	3.79	0.68	.57
	M	***SD***			***M***	***SD***			***t*(34)**	***p***
Attention to Game	9.12	.94	-----	-----	8.83	1.07	-----	-----	0.81	.42
Tetris Enjoyment	7.16	2.11	-----	-----	6.74	2.04	-----	-----	0.61	.54
Tetris Difficulty	2.96	1.69	-----	------	3.43	2.23	-----	-----	0.26	.80
Tetris Performance	2805.56	2332.94	-----	-----	2609.60	2255.29	-----	-----	0.23	.82

Discussion

Summary of key results

As predicted, flashback frequency for the first 24 hours, prior to assignment to condition, did not differ between conditions indicating groups were well-matched prior to the experimental manipulation. The major finding from the current experiment was that, 24 hours after viewing a traumatic film participants assigned to a memory reactivation task + Tetris condition relative to a no-task Control condition experienced significantly fewer flashbacks of the film over the subsequent week as reported in the intrusion diary. This replicated the key finding from Experiment 1. Further to this, Experiment 2 also provided a replication of Experiment 1 in showing that participants in the memory reactivation task + Tetris condition experienced significantly fewer flashbacks on a convergent measure, the Intrusion Provocation Task (IPT) administered at follow up on day 8. However the findings of lower scores on the IES-R intrusion subscale was not replicated.

A second major finding from Experiment 2 was that, as predicted, flashback frequency in the intrusion diary did not differ between those assigned to the 'Tetris only' or 'Memory reactivation task only' conditions relative to the no-task Control condition. This was an important extension and dismantling of the findings from Experiment 1. Moreover, as predicted, these conditions did not differ in the frequency of flashbacks

experienced during the IPT or the IES –R at follow up. Thus, Experiment 2 supported the overall prediction that the memory reactivation task *and* Tetris game play in combination are both necessary components required to ameliorate flashbacks for a consolidated memory for traumatic film material. This is supported by the demonstration that, merely playing Tetris alone or being exposed to the memory reactivation task alone was not sufficient to reduce flashback frequency, either across the week following assignment to condition, or at follow up on the IPT.

Other findings – Controlling for extraneous variables

Alternative explanations for differences between conditions were also sought. As in Experiment 1, there were no differences in participants' self-report of depression, trait anxiety, trauma history, imagery use and levels of neuroticism, indicating that these are not likely to be an explanation for findings. Participants also reported comparable scores on manipulation checks (e.g. attention and distress following the film, sleep duration between sessions 1 and 2 and diary accuracy). Importantly mood deterioration from pre to post film did not statistically differ between the two groups making it unlikely that this would account for differences in flashback between conditions (e.g. Clark et al., 2014). Moreover, participants who were allocated to the two conditions involving Tetris game play reported no statistical difference in performance scores, self-report ratings of game enjoyment, difficulty or attention to play.

Participants completed 2 recognition memory tests for the film, 8 days after viewing. Results showed that recognition memory for the film, both in relation to a verbal and visual memory tests did not differ between conditions, suggesting that recognition memory had not been impacted upon by the experimental manipulation. Cognitive models of PTSD differentiate between voluntary (deliberately retrieved) and involuntary (e.g. non-deliberate, spontaneously retrieved) memories (Brewin, 2001; Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000). Such accounts appear compatible with results pertaining to memory for the trauma film in Experiments 1 and 2 within the thesis and previous research (Holmes et al., 2009; Holmes et al., 2010), in that involuntary flashback memories were reduced for individuals who played Tetris following a trauma film relative to a no-task Control condition, whereas voluntary memory remained equivalent between conditions. As such this may suggest that deliberate recognition memory for the film was not impaired relative to the no-task control condition, rather only involuntary 'flashback' memories of the kind analogous with Post Traumatic Stress may have been modified. This

interpretation of results contrasts with neuroscience models of human memory (Hall, Gjedde, & Kupers, 2008; van Kesteren, Ruiter, Fernández, & Henson, 2012) which propose that voluntary (intentional) and involuntary (incidental) memories reflect the same underlying systems in memory and as such are not dissociable. Thus, such accounts would predict that a reduction in involuntary memory would be associated with a reduction in voluntary memory also. However, findings pertaining to this are not conclusive (Ramponi, Barnard, Kherif, & Henson, 2011). In order to understand the impact Tetris has on involuntary flashback reduction and memory processes, future studies would benefit from employing a variety of methods to assess memory in order to understand more precisely how Tetris (following a memory reactivation task) impacts on flashbacks frequency, for example, using refined recognition memory tests, cued-recall tests (as in Holmes et al., 2004), sequential memory tests (e.g. Kindt & van den Hout, 2003) or even further tests of implicit memory which do not make direct reference to the trauma film at all.

The number of flashbacks reported in the intrusion diary pertaining to different 'events' from the film was comparable in Experiments 1 and 2 across the 7-days following Session 2 (M = 3.27; SD = 1.48 and M = 2.83, SD = 1.58 respectively for the Control condition). This was similar to recent research which found participants experienced an average of 3.5 different flashback events over the course of a week in an intrusion diary (Bourne et al., 2013), despite the use a different trauma film. This suggests that participants do not experience flashbacks for the whole film, rather discrete parts from within the film.

Limitations

In contrast to predictions, the current experiment did not find a significant difference in scores between the memory reactivation task + Tetris and no task control condition on the Intrusion subscale of the clinical questionnaire measure of trauma symptomatology the Impact of Event Scale – Revised (Weiss & Marmer, 1997). In clinical practice the IES-R is not used to make a diagnosis of PTSD, however cut-off scores of 1.5 have been suggestive of a possible diagnosis (Creamer, Bell, & Failla, 2003; Griffing et al., 2006). Scores on the IES-R in the current experiment were well below the suggested cut-off score, which might indicate that the IES-R was not sufficiently sensitive to measure differences in symptom response to the *analogue* trauma event i.e. the film materials used in the current experiment. This explanation relating to results obtained on the IES-R: Intrusion subscale may be insufficient though, as Experiment 1 did find significant

differences using the same analogue trauma. Mixed findings from research that has used the trauma film paradigm and the IES (R) as a measure of intrusions suggests that scores do not always corroborate the convergent measures of intrusions. For example, fewer intrusions reported in an intrusion diary was not matched by lower scores on the IES-R intrusion subscale (Logan & O'Kearney, 2012), or a laboratory based monitoring task (Verwoerd et al., 2012). Thus a non-significant result pertaining to the IES-R: Intrusion subscale between conditions in the current experiment, but not Experiment 1, may be a reflection of the measure *per se* within the framework of the current paradigm.

The addition of self-report ratings for attention to the Tetris game, game enjoyment and game difficulty were added to Condition 1 (Memory reactivation task + Tetris) and Condition 3 (Tetris only) in order to control for the possibility that such factors may have influenced subsequent results. These additions mean that Condition 1 in Experiment 2 is not a pure test of replication of Condition 1 (from Experiment 1) in this regard. Previous research comparing game play between 2 conditions used similar ratings scales (Holmes et al., 2010), suggesting that their use is unlikely to have influenced findings.

Previous literature on experimentally disrupting reconsolidation in humans indicates that in order to theorise that memory reconsolidation and subsequent disruption has taken place there needs to be observable evidence of memory modification (Schiller & Phelps, 2011), for example, the erasure of a conditioned physiological fear response to specific stimuli post reconsolidation disruption (e.g. via a measurable blink startle response; Kindt et al., 2009), or the integration of new information into an existing memory observable when comparing memory pre and post-reconsolidation (Hupbach et al., 2007). Furthermore, there also needs to be evidence that memory modification does **not** occur when memory is not reactivated (e.g. when there is presentation of the interference task only), or if memory is reactivated in the absence of an interference task (i.e. when there is presentation of the memory reactivation task only). Experiments 1 and 2 both demonstrated that a behavioural memory modification took place. This was operationalised by a reduction in flashbacks for the trauma film (both in an intrusion diary and at 1-week following the IPT) for those participants exposed to the memory reactivation task followed by Tetris game play, compared to a no-task condition. Further to this, Experiment 2 also showed that Tetris and the memory reactivation task *per se* did not modify memory, as those participants who undertook these tasks in isolation demonstrated flashback memory frequency levels comparative to a no-task condition.

Animal models provide evidence of memory reconsolidation by demonstrating that a consolidated (typically conditioned) fear memory requires protein synthesis following its retrieval in order to persist, as during this phase memory is vulnerable to disruption using protein synthesis inhibitors (e.g. anisomycim; Nader et al., 2000a). Disrupting a reconsolidating memory while it is in a protein synthesis-dependent state has been shown to prevent the return of a fear response – i.e. it is not subject to reinstatement, renewal or spontaneous recovery (e.g. Schiller et al. 2010). This is taken to imply that the original memory trace has been modified, i.e. its reconsolidation has been disrupted, as opposed to a new trace being formed (Delgado, Olsson, & Phelps, 2006). Crucially, inhibitors will only work if the memory is reactivated (i.e. if it is in protein synthesis-dependant state). Although the findings derived from Experiments 1 and 2 indicate that Tetris was able to disrupt the memory reconsolidation for a 24 hour old trauma film *if* the memory was reactivated first, caution should be taken in interpreting these findings as firm proof, as alternative theories are available (e.g multiple trace theories of memory; Nadel, Samsonovich, Ryan, & Moscovitch, 2000; Sederberg, Gershman, Polyn, & Norman, 2011). However, in the absence of being able to conclusively prove reconsolidation is taking place by, for example, the administration pharmacological agents (as used in animal models) and in light of promising emerging research purporting to disrupt reconsolidation using behavioural approaches in human participants, the findings from Experiments 1 and 2 suggests that Tetris game-play is able to disrupt memory reconsolidation for a 24 hour old aversive film, if memory for that film is reactivated first.

Future Experiments

Future experiments should try to understand the boundary conditions which are purported to impose limits on whether memory reconsolidation will take place for emotional memories using the trauma film paradigm. Dismantling Experiment 1 allowed for the identification of the components required in order for Tetris to reduce flashbacks to a 24 hour aversive memory (e.g. film), such as the necessity of a preceding memory reactivation task. Further dismantling of the memory reactivation task + Tetris condition may identify additional elements which contribute toward the conditions' effectiveness. For example, it may be worthwhile to explore the relevance of the 10 minute gap in-between the memory reactivation task and Tetris game play, to see whether there is an 'optimal' time during which memory is labile following its reactivation.

The further identification of boundary conditions derived from experimental work and analogue models may also contribute towards understanding the effectiveness of practices used within clinical settings. For example, Experiment 1 and 2 have tested the relevance of 'reactivating' a memory proper prior to intervention (e.g. Tetris game play). This perhaps links to the clinical practice of focusing on 'hotspots' of a traumatic memory prior to therapeutic intervention in therapy for established PTSD (Holmes et al., 2005; Nijdam et al., 2013), as this might be a form of memory 'reactivation'.

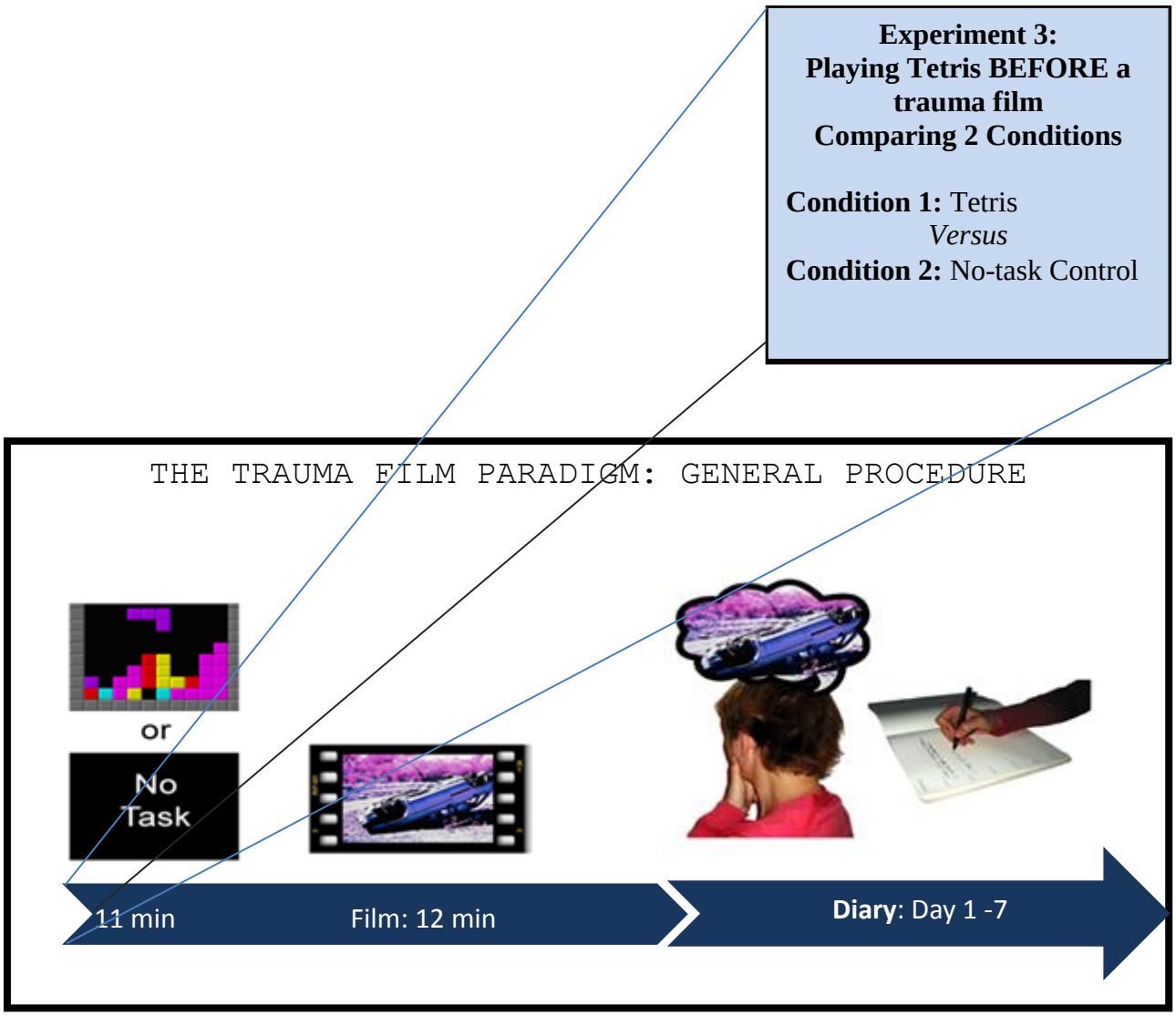
Context effects play an important role in serving as memory retrieval cues to 'reactivate' memory and in initiating reconsolidation processes (see Chapter 2; Hupbach et al., 2011; Hupbach et al., 2008). For this reason, situational context cues are also thought to play in important role in the maintenance of pathological memory, e.g. drug addiction and 'cue-induced relapse' (Milton & Everitt, 2010), underscoring the importance of context effects in research which aims to capitalise on memory reconsolidation processes. In the current study, the 'Tetris only' condition was able to demonstrate that Tetris without a prior memory reactivation task did not significantly reduce flashback frequency relative to the no-task condition, as predicted, even though participants were tested in the same laboratory and with the same experimenter for all sessions. However, visual inspection of the graphs shows a reduced number of flashbacks in the Tetris Only condition indicating that in this instance the situational context per se was not sufficient to reactivate memory allowing for a significantly reduction in flashbacks, but that context may have reactivated the memory in part. Further studies should provide a more precise test of the role of situational context in in memory reactivation processes, e.g. would the memory reactivation task be sufficient if it was used in a different situational context to trauma film viewing; is it possible to enhance context effects to reactivate a memory fully thus initiating memory reconsolidation processes. Findings may aid our understanding of the best methods to intervene using Tetris to reduce flashbacks.

Future studies should also explore an extension in the time frame between analogue trauma and Tetris beyond 24 hours following memory reactivation, or what happens to memory for a trauma film that is repeatedly reactivated and modified using Tetris, as previous research suggest that a memory for still images can be 'reactivated' and subsequently modified on numerous occasions (e.g. Wichert et al., 2013; see Table 2.1, Chapter 2).

Studies exploiting the malleability of memory thus far have investigated playing the computer game Tetris in terms of retroactive interference, i.e. the tendency for more recently acquired information to impede similar, remote memories. This has been explored previously during memory consolidation (Holmes et al., 2009; Holmes, James, et al., 2010) and within the current thesis, following memory reconsolidation. Another question is to explore the impact of Tetris in relation to *proactive* interference, the ability of remote memories to interfere with newer or recent memory acquisition. Thus, Experiment 3 will investigate whether playing Tetris immediately *before* a trauma film would interfere with memory for the film resulting in fewer flashbacks across the subsequent week, relative to a no-task control condition. Findings would have potential implications in terms of developing preventative measures to target flashback build-up in individuals who are at high-risk for their development, e.g. emergency services personnel, the police service etc.

CHAPTER 6

EXPERIMENT 3: Can a Cognitive Task Before a Trauma Film Reduce Flashbacks?



Procedural overview adapted from Holmes et al., 2009

Can a Cognitive Task Before a Trauma Film Reduce Flashbacks?

Overview

Experiments 1 and 2 within the thesis investigated whether playing the computer game 24 hours after viewing traumatic film material would result in fewer flashbacks of the film. The current experiment explored whether memory for the trauma film would be susceptible to interference from Tetris if played *before* viewing a trauma film again resulting in fewer flashbacks of the film. A visuospatial Tetris condition was compared to a no-task Control condition to test whether memory for the trauma film would be vulnerable to proactive interference (i.e. the interference of previous information on subsequent learning), via Tetris game play.

Introduction

Forgetting as a consequence of interference has been widely researched and is proposed to be a primary source of forgetting (e.g. Dewar, Cowan, & Della Salla, 2007; Muller & Pilzecker, 1900). Retroactive interference and proactive interference are two common forms of interference observable in memory (Wixted, 2004). Retroactive interference describes incidences where new learning impedes upon previously learned information. Thus, old information has difficulty in being kept in mind as the new learning impinges on the memory (Wixted, 2005). Retroactive interference effects on memory corresponds with early research which demonstrated that playing Tetris **after** viewing traumatic film material (during the time window where in memory is consolidating and is thus malleable) results in a fewer flashback memories of the trauma film, compared to if Tetris is not played (Holmes et al., 2009; Holmes, James, et al., 2010).

In contrast to retroactive interference, the term proactive interference describes instances where prior learning interferes with more recent learning. On such occasions there may be deficits in the recollection of new information as a result of previously learned information impinging on memory. Proactive interference has been studied in relation to visuospatial working memory. Research has demonstrated that a decrease in proactive interference lead to an increase in recall on a working memory digit span-task (Blalock & McCabe, 2011). In addition, in a series of experiments that used a visual *n*-back task (where a participant has to indicate whether the current stimulus matches that of stimuli *n* number of trials previously) it was shown that information held in visual working memory was subject to interference from previously held information (Makovski & Jiang, 2008). Proactive interference effects have also investigated in the context of more verbal-

based memory using the A-B, A-C associate cued-recall tests (Dunsmore, Martin, & LaBar, 2012) and implicit memory using word fragment-completion tasks (Lustig & Hasher, 2001).

Greater working memory capacity is associated with reduced vulnerability to proactive interference (Kane & Engle, 2000). As such, lowering working memory capacity, for example by dividing attentional resources and increasing the demand on working memory capacity, can result in greater proactive interference effects on memory (Kane & Engle, 2000). In addition, research demonstrated that a low level ability to resist proactive interference (indexed by performance on California Verbal Learning Test) was associated with intrusion development for an analogue trauma, i.e. individuals with lower ability to resist proactive interference experienced more intrusions to a trauma film (Verwoerd et al., 2011; Wessel et al., 2008).

In summary, research suggests that different types of memory are susceptible to proactive interference (Jonides & Nee, 2006), and that effects may be, in part, due to limited resources in working memory capacity. The current study sought to test whether playing Tetris before viewing a trauma film (during memory consolidation) would also lead to proactive interference effects. Findings have an implication in terms of treatment for individuals who are routinely exposed to trauma and are therefore at 'high-risk' for developing flashback symptoms and PTSD.

Hypotheses

Participants assigned to a visuospatial Tetris condition, where participants play the computer game Tetris immediately *before* viewing traumatic film, relative to participants in the no-task control condition (participants do not play Tetris but instead sit quietly for the equivalent period of time prior to the film) will experience;

- Significantly fewer flashbacks of the film over the subsequent week (as recorded in an intrusion diary).
- Significantly fewer involuntary flashbacks as a response to the Intrusion Provocation Task (IPT) at 1-week.
- Significantly lower scores on the Impact of Event Scale – Revised: Intrusion subscale (Weiss & Marmer, 1997) at 1-week.

Method

Approval was obtained from the University of Oxford Central University Research Ethic Committee (MSD/IDREC/C1/2011/102; see Appendix 6.1)[9]

Design

A between-subjects design was used, where participants were randomly allocated to one of two conditions; visuospatial-Tetris or no-task control (N = 29 per condition). Participants attended 2 sessions one week apart.

Participants

58 healthy volunteers (24 males) were reimbursed £25 for their participation. Participants were recruited from Oxford University campuses and from the general public via advertisements in an online newspaper and in the community. Informed written consent was obtained prior to testing and all participants were debriefed at the end of the study. Participants were eligible to take part if they were; *a)* between the ages of 18 and 65 years of age, *b)* reported no mental health problems and c) not familiar with and had not taken part in a study of a similar nature

Sample size estimation. Based on an effect size of d = 0.91 found by Holmes et.al. (2009), the study assumed a large effect size of 0.8; A sample size of N = 29 per condition (based on a minimum sample of N = 26) was required to ensure an 80% power to detect this difference at the 5% significance level.

Trauma Film

The 12 min stressful film contained 11 scenes relating to PTSD diagnostic criteria for a traumatic event (DSM; American Psychiatric Association, 2000; Muravieva & Alberini, 2010). The film footage was the same as that used in Experiment 1 and 2 of the thesis.

Tasks

Condition 1: Visuospatial Tetris

[9] I am grateful to Hannah Tickle who was responsible in part for collecting data within the current study during her undergraduate. Additional, subsequent data collection (n=15) was carried out by the author of this thesis, Ella James (EJ). Study design, analysis of the data and write-up for the experiment within this thesis was undertaken by EJ.

Tetris. Participants in the Tetris condition played the computer game Tetris ("Tetris Zone," 2007) immediately prior to film viewing for a duration of 11 min. The game instructions were was the same as those use in Experiment 1 and 2 except participants were given a 1 min practice with experimenter feedback, as opposed to 3 min as in earlier experiments. Following practice, play continued for a further 10 min (the game was not stopped and restarted). If the game ended before 11 min was completed it was restarted immediately by the experimenter. A record of score performance was taken at the end of game play.

Condition 2: No-task Control

No-task break. Participants who undertook the no-task break did not have a 1 min practice of the computer game Tetris but were asked to sit quietly for 11 min (the equivalent period of time to Tetris game play). The experimenter was in the laboratory with the participant for the whole duration.

Baseline Measures

Baseline measures were the same as those used in Experiments 1 and 2 and comprised of the Beck Depression Inventory – II (BDI-II; Beck, 1993); State Trait Anxiety Inventory – Trait (STAI-T; Spielberger et al., 1983); Eysenck Personality Questionnaire - Neuroticism scale (EPQ-N: Eysenck et al., 1985); Spontaneous Use of Imagery Scale (SUIS; Reisberg et al., 2003); Proneness to Intrusive Cognitions Scale (PICS; Davies & Clark, 1998) and the Traumatic Experiences Questionnaire (TEQ; adapted from Foa, Ehlers, Clark, Tolin & Orsillo, 1999)

Mood and Distress Ratings

Pre and post film mood and film distress ratings were the same as those used in Experiments 1 and 2.

Main Outcome Measures: Memory for the Trauma Film

Intrusion diary. The diary was the same as Experiments 1 and 2 (based upon Holmes et al., 2004; Holmes et al., 2009; Holmes, James, et al., 2010) with the following exceptions. Within the current experiment participants were not asked to report on intrusive verbal thoughts (due to their paucity in Experiments 1 and 2). Furthermore the diary only provided tabulation space for 7 days' worth of intrusions, as opposed to 8 in the previous experiments within the thesis.

Diary accuracy. Accuracy was assessed using a single VAS

Intrusion Provocation Task (IPT). Eleven still pictures were selected from the trauma film (one for every scene identical to Experiment 1 and 2; Appendix 4.9). The images were blurred using Gimp software, Gaussian 2.0 (GNU, 2010) and were shown in a fixed randomised order as in Experiment 1 and 2.

Impact of Event Scale – Revised (IES-R). The IES-R (Weiss & Marmer, 1997) anchored to the trauma film rated subjective distress as a result of the film, as in Experiment 1 and 2.

Recognition Memory

The verbal recognition memory test for the film comprising of 32 written statements regarding the film was the same as that from Experiments 1 and 2.

Manipulation Checks

Film attention. Attention was assessed using an 11-point scale, as in Experiments 1 and 2.

Demand rating. A single VAS asked to respond to the question, '*How much do you predict that playing the game Tetris task before viewing a distressing film (rather than watching it normally) would increase or decrease intrusive images of the film of the type you recorded in your diary?*' on a single VAS ranging from -10 (*extreme decrease*) to 10 (e*xtreme increase*) (based upon Holmes et al., 2004; Stuart et al., 2006).

Procedure

Participants were booked in for sessions in advance. Sessions one and two were timed to be 7 days apart. See Figure 6.1 for a procedural diagram of Study 3

Session 1 (Day 1). Upon arrival at the laboratory, participants gave their written informed consent then completed a battery of baseline measures. Following this, all participants in the Visuospatial Tetris conditions had a 1 min practice of the computer game Tetris with experimenter feedback, followed immediately by a further 10 min play with no feedback. Participants in the no-task control condition sat quietly for an equivalent time period (11 min). Participants then watched the trauma film in a darkened room with the experimenter absent. Visual Analogue Scale (VAS) mood evaluations were taken before and immediately after film viewing. Attention paid to the film and distress ratings were given after film viewing. Participants were then provided with detailed instructions

(both verbally and written) on how to keep the intrusion diary and asked to return to the laboratory in 7 days.

Session 2 (Day 7). One week later participants returned to the laboratory with their completed intrusion diaries. Participants completed diary accuracy ratings, the IES-R: Intrusion subscale as well as a verbal recognition memory test for the film. Participants then underwent the Intrusion Provocation Task and were debriefed at the end of the experiment

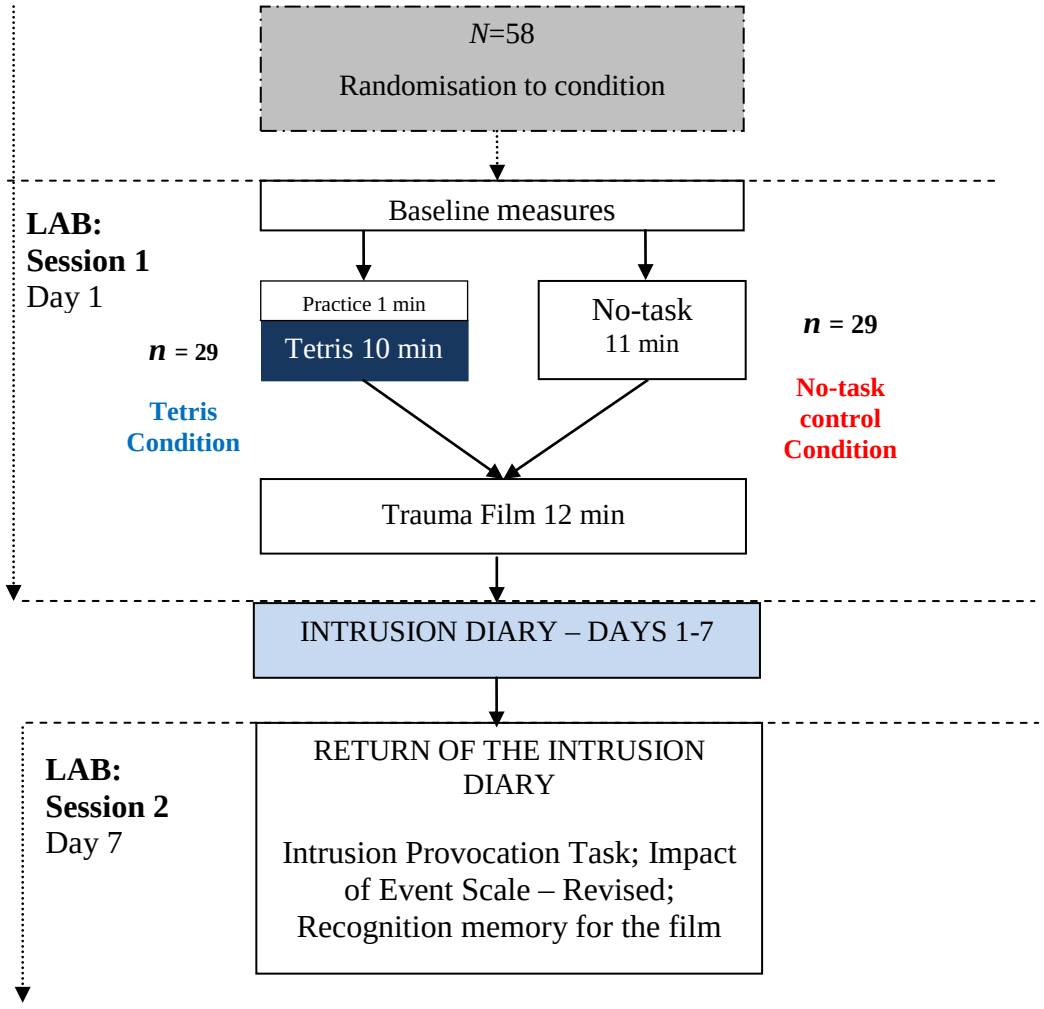


Figure 6.1. Procedural overview of Experiment 3

Results

All data were examined for univariate outliers as in Experiment 1 and 2. One participant (in the Tetris condition) had a score that was more than 3 SD away from the mean (on the variable flashback frequency in the intrusion diary). The scores were

changed to one unit smaller than the next most extreme score in the distribution (based on the procedure described in Tabachnick & Fidell, 1996). This change did not change the overall results. Independent samples *t*-tests were used to compare means between conditions; repeated-measures ANOVA was used to compare mood from pre to post film. Nominal data were analysed using the chi-square test. Inferential statistics were analysed using a Pearson's product-moment and partial correlations. An alpha level of .05 was used for all statistical tests.

Baselines Measures

There were no significant differences between conditions for baseline measures (Table 6.1).

Table 6.1. *Baseline Characteristics including Mood Measures, Trauma History and Mental Imagery use for each Experimental Condition*

Measure	Tetris (*N* = 29)		Control (*N* = 29)		Analysis		
	n	**%**	***n***	**%**	χ^2	**df**	***p***
Male	9	31.0	15	57.7	2.56	1	.11
	M	***SD***	***M***	***SD***	***t*(56)**		***p***
Age (years)	20.59	2.10	20.69	1.51	0.22		.83
BDI-II	7.00	6.98	6.86	5.64	0.08		.93
STAI-T	40.03	11.38	36.34	9.49	1.34		.19
EPQ-N	5.00	3.31	4.69	2.14	0.01		.67
TEQ	0.86	0.83	1.10	1.14	0.92		.36
SUIS	35.83	7.15	39.17	7.83	1.70		.10
PICS	5.68	2.16	4.71	2.46	1.60		.12
Blood Phobia	3.27	2.45	3.62	2.76	0.50		.62

Note. BDI-II = Becks Depression Inventory – II (Beck, 1993); EPQ-N = Eysenck personality questionnaire - neuroticism scale (Eysenck et al., 1985); PICS = Proneness to intrusive cognitions (Davies & Clark, 1998) STAI = State trait anxiety inventory – trait (Spielberger et al., 1983); SUIS = Spontaneous Use of Imagery Scale (Reisberg et al., 2003); TEQ = Traumatic Experiences Questionnaire (adapted from Foa, Ehlers, Clark, Tolin & Orsillo, 1999)

Mood and Distress Ratings

Mood pre- to post-film. Repeated-measures ANOVA confirmed a main effect of time, indicating participants' mood significantly deteriorated following the film, but no main effect of group, nor a group x time interaction (Table 6.2).

Film Distress. There was no significant difference between conditions for ratings of film distress; Tetris condition, *M* = 6.93, *SD* = 1.10; Control condition, *M* = 7.34, *SD* = 2.04, *t*(56) = 0.78, *p* = .44.

Table 6.2. *Mood Change from Pre- to Post-Film for each Experimental Condition*

Measure	Tetris (*N* = 29)		Control (*N* = 29)		ANOVA		
	M	***SD***	***M***	***SD***	**Time**	**Group**	**Group *Time**
Pre film Mood VAS	4.90	5.10	3.80	3.51	$F_{(1,56)}$=45.39[§]	$F_{(1,56)}$= .02	$F_{(1,56)}$=1.88
Post film Mood VAS	8.59	5.51	9.38	6.50			

Note. VAS (Visual Analogue Scale) mood composite sum of Sadness, Hopelessness and Depressed
§ *P*= < .001; ηρ² = .448

Main Outcome Measures: Memory for the Trauma Film

Intrusion Diary flashback frequency. There was no significant difference for flashback frequency reported in the diary in the week following trauma film viewing; Tetris, *M* = 5.45, *SD* = 3.21; Control, *M* = 6.90, *SD* = 5.69, *t*(56) = 1.19, *p* = .24.

Diary accuracy. Participants were comparable for self-rated measures of diary accuracy; Tetris, *M* = 7.62, *SD* = 1.86; Control, *M* = 7.83, *SD* = 1.73, *t*(56) = 0.44, *p* = .66 (Table 6.4).

Intrusion provocation task (IPT). At 1 week, flashback frequency following the IPT did not differ significantly between conditions; Tetris, *M* = 4.86, *SD* = 3.69; Control, *M* = 4.83, *SD* = 3.58, *t*(56) = 0.04, *p* = .97.

Impact of Event Scale-Revised (IES-R). Analysis revealed no significant difference in scores between the Tetris and Control condition on the IES-R intrusion subscale; Tetris, *M* = 0.94, *SD* = 0.64; Tetris, *M* = 0.83, *SD* = 0.52, *t*(56) = 0.78, *p* = .52

Recognition Memory for the Film

Verbal recognition memory. Scores did not differ significantly between conditions on the verbal recognition memory test, Tetris, *M* = 19.76, *SD* = 3.62; Control, *M* = 19.90, *SD* = 3.05, *t*(56) = 0.16, *p* = .88

Manipulation Checks

Attention to film. Participants did not differ on their rating of attention paid to the film (Table 6.3)

Demand rating. The overall mean on ratings of experimental demand was *M* = 0.07, *SD* = 3.89. A partial correlation controlling for condition showed there was not a

significant relationship between ratings of demand and the number of flashback recorded in the diary, $r(55) = -.03$, $p = .82$. Participants' ratings of demand did not differ significantly between conditions (Table 6.3).

Tetris performance. Tetris game playing scores ranged from a minimum of 843 to maximum 78389 ($M = 18755.12$; $SD = 16797.98$). A Pearson's product moment correlation for Tetris score and flashback frequency over one week found no correlation between Tetris score and the number of flashbacks over one week, $r = .21$, $p = .32$

Table 6.3. *Manipulation Checks for each Experimental Condition*

Measure	Tetris (N = 29)		Control (N = 29)		Analysis	
	M	***SD***	***M***	***SD***	$t_{(56)}$	***p***
Attention to Film	9.07	1.03	9.34	0.77	1.55	.25
Demand Rating	0.28	3.49	-0.10	4.31	0.37	.71

Discussion

Summary of results/overview

Results did not support the hypotheses within the current experiment. Contrary to prediction, participants who played the computer game Tetris immediately *before* viewing traumatic film material did not; (1) report a fewer flashbacks for the film in the intrusion diary over 1-week; (2) experience fewer flashbacks in response to the Intrusion Provocation Task (IPT) administered at 1-week and, (3) report lower scores on the Impact of Event Scale – Revised: Intrusion subscale, also administered at 1-week.

At baseline, participants in the Tetris and no-task Control conditions did not statistically differ for self-report ratings of depression, trait anxiety, neuroticism or trait imagery use. Nor did they differ statistically on ratings of blood phobia or the number of traumatic experiences experienced prior to the experiment. In addition, there was no significant difference on the verbal recognition memory score or attention paid to the film. Mood deteriorated from pre to post film, but was not statistically different between conditions. As discussed previously, high levels of mood change from pre to post trauma film viewing have been shown to be predictive of an increase in subsequent flashback frequency (Clark et al., 2014). Participants, being well matched for pre to post film mood rating change and ratings of film distress suggest this is not likely to account for results.

Implications

Multiple Memory Trace models of memory (e.g. Nadel et al., 2000) propose interference effects occurring in memory are due to multiple memory traces competing for the same retrieval cues. This effect is particularly apparent for memory traces that are closely associated due to being acquired in close proximity and the similarity of the memory trace, e.g. both memories containing similar visual aspects (Nadel & Land, 2000; Nadel et al., 2000). Such theories would predict that playing the visuospatial computer game Tetris creates a memory trace which can be sufficient to compete with visual memory traces for the trauma film at a retrieval level, thus resulting in fewer flashbacks to the film across the week in the intrusion diary. Results from the current experiment suggest that this explanation may be insufficient, as playing Tetris immediately before film viewing did not lead to a subsequent flashback reduction. Future studies might try to test whether findings which demonstrate Tetris following a trauma film can reduce flashbacks to a trauma film in the subsequent week are a result of problems at a memory retrieval level (e.g. Tetris is able to successful compete with the trauma film for retrieval cues) or a memory recall level (e.g. Tetris has somehow modified the memory trace for the trauma film, resulting in fewer flashbacks occurring).

Future Experiments

The current study differed from past research that had used Tetris game-play as a method to reduce flashbacks (apart from the order presentation of the film and cognitive task intervention), with regard to a time-delay in-between the presentation of task and film. In the current study there was no delay in-between playing Tetris and film viewing. However, previous research had employed a time-delay of 30 minutes and 4 hours (e.g. Holmes et al., 2009; Holmes et al., 2010 respectively). Further to this, Experiments 1 and 2 within the thesis included a 10 minute time-delay in-between the memory reactivation task for the film and Tetris game play. This may suggest that a short break is beneficial when administering the cognitive task Tetris in order to interfere with flashback memories for a trauma film. However, this explanation does not account for research that has used cognitive tasks, albeit different types other than Tetris, during (Holmes et al., 2004) or immediately after (Deeprose et al., 2012) to modulate flashback frequency following a trauma film, thus indicating a potential avenue for future research.

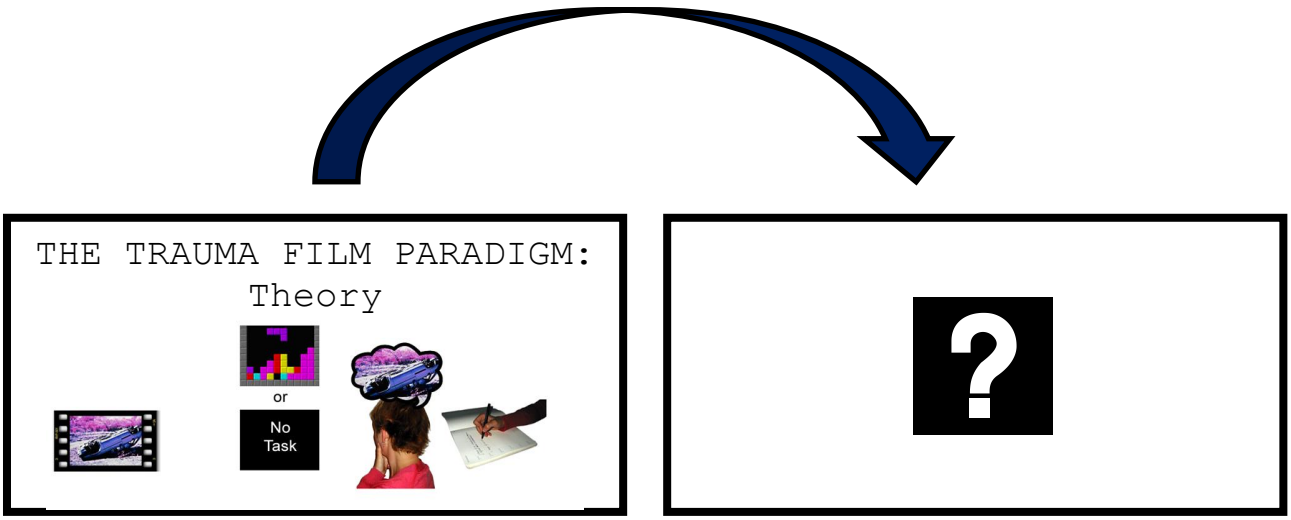
In addition, the current study did not employ a brief 'reminder' task (as used in Holmes et al., 2009) or memory reactivation task (as in Experiments 1 and 2 within the

thesis) between film viewing and Tetris game play. This divergence from previous experiments might suggest the importance of a 'reminder' for intervention purposes. Findings from the current experiment indicate that playing Tetris derives its beneficial effects on flashback frequency *after* memory encoding of analogue trauma, and as such points to the boundary conditions surrounding its use for reducing flashbacks

Experiment 3 was undertaken with the possible clinical implication of pre-emptive preventative strategies for 'at risk' for trauma individuals, such as emergency services personnel or those who are exposed to trauma on a regular basis or because they are in a vulnerable position, such as part of a war zone (Breslau, 2009). The current experiment indicates that playing the computer game Tetris is not promising as an anticipatory method to reduce flashbacks. As such, other preventative approaches should be explored for groups who are at increased risk for developing PTSD and PTSD related symptoms. Despite the null findings from Experiment 3, the use of the cognitive task Tetris as an intervention for the early *aftermath* of (but not before) trauma remains a promising strategy worthy of further development. However, as a treatment strategy to be administered soon after trauma, it may be perceived unusual and perhaps even unfavourably by those who are required to play. The next chapter considers individuals who had emailed us with their experiences of playing computer games, particularly Tetris, spontaneously in response to negative life events. As such, consideration of these emails may offer some insight into the acceptability of computer-game play, post-trauma.

CHAPTER 7

Emails Sent by Individuals who have used Computer Games Spontaneously Following Aversive Experiences



Procedural overview adapted from Holmes et al., 2009

Emails Sent by Individuals who have used Computer Games Spontaneously following Aversive Experiences

Introduction

Some people might argue that getting people to play the computer-game Tetris following a traumatic event is likely to be met with a harsh reaction as a therapeutic intervention, particularly in comparison to the iconic stereotype of the compassionate therapist in such scenarios. However, some talking therapies (e.g. critical instance stress debriefing; a clinician-led treatment given shortly after trauma) are not recommended in the aftermath of trauma (Bisson et al., 2007; Rose et al., 2002). Thus, exploring alternative methods of psychological aid is a viable pursuit (Roberts et al., 2010). Thus far within the current thesis Tetris has been explored in relation to a therapeutic intervention in a laboratory-based experimental context, however a question arises as to whether the widely available computer game Tetris has been actively used by individuals spontaneously following negative experiences? The current chapter considered a small sample of email correspondence in which people had shared their personal experiences of playing Tetris in times of adversity.

Method

Written consent via email was obtained from all individuals' who are quoted within the following chapter, in accordance with CUREC guidance (Appendix 7.1). Initial email correspondence was not solicited. Following contact by an individual relating to their experiences, a structured email was sent requesting permission to use their words (anonymously) in the thesis (Appendix 7.2). No specific questions pertaining to an individuals' experiences was asked, however along with the permission request individuals were told that any additional feedback they would like to give would be welcome. Permission requests were sent to members of the public who wrote between the dates of November 2010 and May 2013.

Results

Email correspondence from individuals who gave their permission was collated and their content inspected for potential themes. Appendix 7.3 provides the anonymised email correspondence, in date order (newest first). Each correspondence has a number and lines of text are numbered for clarity within the chapter. Any identifying

information has been removed including names and email addresses. Further, within the email text itself the phrase <REMOVAL OF IDENTIFYING TEXT> has been used in some places in order to preserve anonymity.

Sample/Population Details

Fourteen unsolicited emails with this subject matter were received. Nine individuals (5 female and one unknown gender)[10] gave written permission for their emails to be used within the thesis. Of those 9, 3 responded with additional feedback yielding a total of 12 emails. The locations of individuals who emailed varied; 6 were from the United States of America, 2 were from Europe and for 1 the location was not given.

Individuals had emailed in response to findings from several sources: 2 from undisclosed public communication articles, 1 from 'Times magazine' article on CNN website; 1 from Los Angeles Times article; 1 from a BBC radio show 'All in the Mind'; 1 from Psyc.org and 1 from the original PLoS ONE article. Two emails did not state where they heard about this body of research. See Appendix 7.4 for examples of links to media outputs, collated by Oxford University press office, relating to previously detailed research, i.e. Holmes et al, 2009; 2010.

Five out the 9 correspondents disclosed having a diagnosis of PTSD; 1 disclosed having mental health problems (excluding PTSD). One individual suffered from a learning disability and 2 individuals did not disclose having any mental health diagnoses or otherwise. Of those 2, 1 commented on how they used Tetris as a 'benchmark' for their current 'brainstate' but that Tetris helped to 'clear my mind' [Appendix 7.3, Correspondence 8; lines 463-465]. The other appeared to have been experiencing a negative mood when they began to play Tetris, 'I don't know if what I had was PTSD, or psychotic depression or just a natural reaction to a German PhD program.'[Appendix 7.3, Correspondence 7; lines 438-439]

Do Individuals play Tetris in Response to Negative Life-Events?

All individuals, bar 2 (who played generally to assess 'brainstate' mentioned previously and another who played it in order to "relax and slow down my brain"

[10] Gender was inferred from the name given with email correspondence

[Correspondence 6, lines 434-435]), appeared to have played the computer game Tetris, and games that were similar, following index negative life events and in times of stress:

"It [*research relating to Tetris to reduce flashbacks*] was of interest to me because I have found playing video games to be quite therapeutic for me in coping with my own mental illness"

[Correspondence 3, lines 292-294. Italics added]

"At the time I began to use Tetris to help me calm down, I was in a very high stress job, that eventually made me very sick"

[Correspondence 4, lines 396-397]

"I came home from that war and soon found myself in the grip of PTSD and PTSD-caused depression. It was awful. Interestingly enough, I played a lot of Tetris from late 1991 through 1995. I found it soothing"

[Correspondence 5, lines 419-422]

"Your findings on Tetris and PTSD and interesting – I spent many hours a few years ago playing Puzzle Inlay (a two-dimensional tetris) while having such issues. The game was very relaxing."

[Correspondence 7, lines 454-456]

"...I was able to talk to her because I knew I could play Tetris at the same time"

[Correspondence 2, lines 56-57]

Symptom Relief from Playing Computer Games

Several emails indicated that playing Tetris was used to help with symptoms associated with trauma;

"I suffer from PTSD and I sometimes get **nightmares**, after them to calm down or zone out I essentially turn to playing Tetris"

[Correspondence 1, lines 6-7. Bold added]

"[I] also suffer from **PTSD symptoms**. I have known for some time that the computer game "marbles" www.netives.com is quite effective at reducing /blocking my symptoms (and actually it is a game akin to tetris.)"

[Correspondence 9, lines 477-480. Bold added]

"(I was sick and traumatized) a month later I could still not be near men, it would induce **fear** and make me **start to sweat and be jumpy**…A lot of people asked me how I could move on after such a terrifying experience; I said 'I don't know, you just get over it' but after reading your article I see that it was probably playing tetris for 2 or more hours a day"

[Correspondence 2, lines 31-46. Bold added]

Other Benefits from Playing Computer Games

Several individuals appeared to find playing Tetris, and similar computer games, beneficial and helpful in terms of being 'soothing' and 'relaxing'. Other beneficial effects were also discussed;

"Experientially it [*playing Marbles, a game similar to Tetris*] feels like what I imagine a morphine drip would feel like for someone with physical pain."

[Correspondence 9, lines 480-482; italics added]

"I went to my room and played this game for an hour. At the end of an hour, I was quite surprised to find that I was much more calm, in control of my feelings, and able to think logically and clearly with much less anxiety…"

[Correspondence 3, lines310-313]

"Hearing about your research coincided with me rediscovering Tetris and finding it useful to help me relax and slow my brain down"

[Correspondence 6, lines 433-435]

Emails, while few, suggest that at least some individuals used Tetris game play as an 'intuitive' method of coping;

"There was a long period (months) of recovery after the initial crisis, when my brain was constantly active. I would lie on the sofa and play these games on

my laptop. Before that I used to read a lot (mostly non fiction) but at this time I did not want to read or watch movies (except psychology books because I wasn't going to let some shrink tell me what's what)"

[Correspondence 7, lines 440-445]

"It's been interesting to me to see the process I went through in discovering ways of coping with the symptoms of my illness I am so glad I discovered how beneficial the games could be to me, in helping me have a more controllable thought life"

[Correspondence 3, lines 375-379]

"I just thought you might like to know that your study had special significance for me, in that it validated (and explained) my own intuitive use of Tetris in the way your study found to be valid for relieving symptoms associated with PTSD."

[Correspondence 4, lines 404-407]

"While I accidently found how effective this computer game was for my symptoms, it is quite validating to see that there is actually research being conducted"

[Correspondence 9, lines 486-488]

Negative Themes Relating to Playing Computer Games

Only one of the emails included in this chapter contained (partial) information that had a negative theme pertaining to playing computer games. In commenting on different video games that were helpful it was also noted that some games were found to be 'frustrating' and 'complicated' to play [Appendix 7.3., Correspondence 3, lines 263-265]. However, within the email there were no aversive symptoms reported as a consequence to this. Moreover, Tetris was not listed as frustrating or complicated, but rather 'enjoyable', 'repetitious' and 'simplistic' [Appendix 7.3., Correspondence 3, line 228]

Discussion

Of the small sample of correspondence reported within the current chapter all expressed beneficial effects of playing the computer games, particularly Tetris. Game play was spoken in relation to times of stress or anxiety and was perceived to have a

calming and soothing effect. Several of those who had corresponded had diagnoses of PTSD and corresponding symptoms, such as nightmares, feeling jumpy and fearful, for which playing Tetris seemed to help. Individuals seemed to 'find' playing the computer game Tetris intuitively, as a way of relieving symptoms.

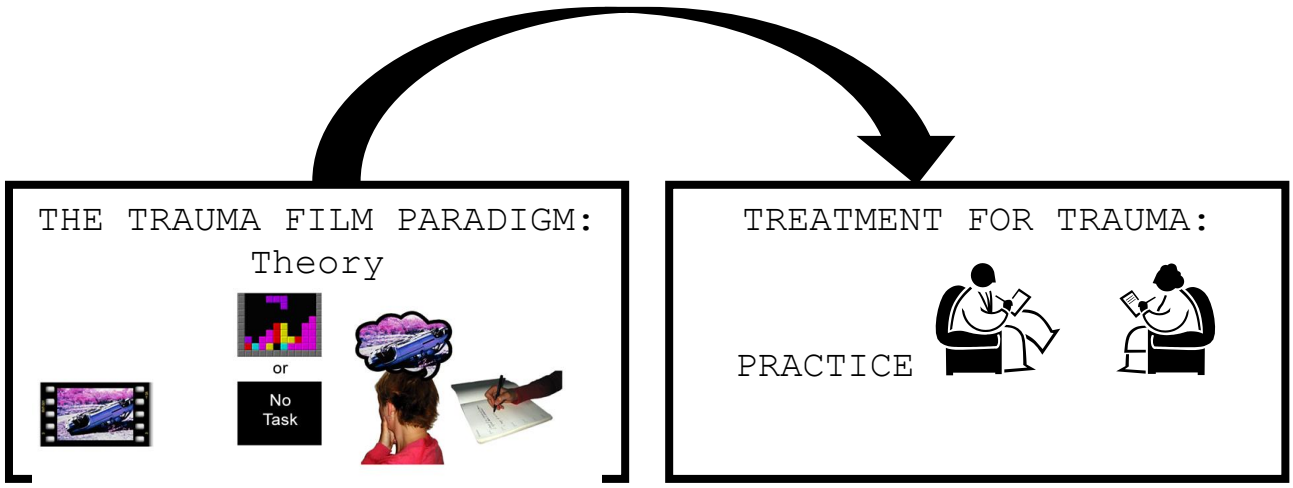
Members of the public rather rarely write in as a response to research so it was interesting to consider the response of individuals who wanted to share their personal experiences of playing computer games in times of adversity. That individuals took the time to write and vocalise how previous research (Holmes et al., 2009; Holmes et al., 2010) resonated and validated their experiences with Tetris and videogames during difficult and stressful times, perhaps communicates it was viewed favourably as a method for alleviating symptoms relating to anxiety. It might also suggest that asking individuals to play Tetris following a trauma may not necessarily be seen as trivialising of their traumatic experiences by the general public (contrary to what a therapist might perhaps think).

It should be noted that the current small sample is self-selected, and as such the topics represented with the current chapter may not be representative. Further future research looking into the acceptability of Tetris for trauma may like to take a more structured approach to assess with more rigour common themes and ideas surrounding the public's perception of using Tetris post-trauma, such as focus groups. In summary, considering emails within the current chapter is illustrative of individuals' experiences with playing Tetris following adversity, and whilst illuminating, a more rigorous and structured approach would need to be taken in order to draw conclusions about the public's perception of playing Tetris following a traumatic event(s).

The following Chapter supplements experimental work within the thesis and provides an example of clinical work within the NHS and the Forced Migration Trauma Service who treat refugees and asylum seekers with PTSD. The aim of the chapter was for me to gain some experience of actual, evidence-based PTSD treatment and the need for language-free treatment interventions.

CHAPTER 8

Trauma Memory: Asylum Seekers and Treatment for Trauma



Procedural overview adapted from Holmes et al., 2009

Trauma Memory: Asylum Seekers and Treatment for Trauma

Overview

The aim of the current chapter was to gain clinical experience of PTSD and treatment practices in a complex group of patients within the NHS – the Forced Migration Trauma Service (FMTS). Up to this point the current thesis has been predominantly concerned with the investigating the development of a cognitive task to reduce flashbacks within a laboratory setting. Thus, in order to supplement experimentally-driven work, the current chapter focuses on the work conducted by the FMTS in London in order to gain a clinical perspective on current treatment practices for PTSD. To that end I was asked to help with the dissemination of the work conducted by the FMTS at the London Assembly. The FMTS provides evidence-based treatment, in order to assess and treat effectively trauma patients who present with multiple and sometimes long-standing traumas. With high levels of need and limited trauma services specifically directed at this population a simple intervention that can reduce trauma symptoms and transcend language and cultural boundaries might be timely.

Introduction

The FMTS is run by Central and North West London NHS Foundation Trust (http://www.cnwl.nhs.uk/service/forced-migration-trauma-servce/). This specialised clinic provides treatment for asylum seekers and refugees who have PTSD resulting from war, torture, violence, rape or other traumatic experiences. The approach used by the FMTS is one of a few within the London area that provides PTSD treatment guided by evidence-based recommendations for this particular population (NICE; National Institute for Health and Clinical Excellence, 2005). Given the recent interest on the importance of adhering to evidence based practice (Baty & Hacking, 2012) it was timely that the FMTS was singled out to publically present the details of their service to the London Assembly (February 24th, 2012).

The challenge I was presented with was to prepare a presentation to be given at the London Assembly (See Appendix 8.1 for the slides from the presentation). The key messages that the FMTS wanted to portray were that; *i)* asylum seekers and refugees are at high risk for PTSD; however, their symptoms, including trauma memories, *are* treatable, even for traumas that may have been experience years ago; *ii)* The most effective way to treat this group is with evidence-based practice, in this case a phased

model of intervention with Narrative Exposure Therapy (NET; Schauer, Neuner, & Elbert, 2012) at its core; *iii)* using effective, evidence-based treatments such as those within FMTS will have a positive impact on both an individual level and, subsequently, a societal level.

The Scale of the Problem

Refugees and asylum seekers are more likely than the general population to experience PTSD, due to the nature of their experiences (torture, war etc.). There are estimated to be over 18 million refugees worldwide ("US Committee for Refugees and Immigrants," 2009). Between the years 2005 and 2007 there were 24,250 asylum applications in the UK (S. W. Turner & Herlihy, 2009) and in 2010 alone there were 17,916 applications ("British Refugee Council," 2012). In an investigatory study conducted in 2006 of London Community Mental Health Teams (CMHTs), 11 % of patients assessed were asylum seekers or refugees, with PTSD being one of the most common diagnoses (at 41%) for this patient group (McColl & Johnson, 2006). These levels of PTSD prevalence were still apparent in a later study from 2008 which demonstrated that refugees and asylum seekers were 10% more likely to suffer from PTSD than those of an equivalent age in the general population in the same give area. Overall, exploratory investigations into refugee and asylum seeker's mental health demonstrated high levels of need, yet limited trauma services specifically directed at this population (McColl & Johnson, 2006; McColl, McKenzie, & Bhui, 2008; McColl, McKenzie, & Kamaldeep, 2008; Schauer et al., 2012).

Table 8.1. *Definition of UK Terminology for Refugees and Asylum Seekers* (Forced Migration Online: Refugee study centre, University of Oxford, 2012; McColl, McKenzie, & Bhui, 2008)

Term	*Definition*
Forced migration	A general term used to describe the forced movement of people displaced within their own countries. There are 3 broad categories for why displacement may occur; *1)* conflict, *2)* development policies and projects and *3)* disasters
Refugee	A person residing outside their country of origin who has been granted permission to stay in UK by the Home Office
Asylum Seeker	A person waiting for a formal acceptance from the Home Office

	for asylum status. Applications are successful if the person seeking asylum is unwilling to return to their country for fear of persecution because of their race, religion, nationality, political opinion or social group membership

Evidence-based Research and Practice

The National Institute for Clinical Excellence (NICE) is an agency which promotes clinical excellence within the NHS in the UK. One of its responsibilities is to provide a series of guidelines to ensure safe, consistent and high quality *evidence-based* practice for patients of the NHS by systematically identifying and reviewing high quality evidence. The MRC guidance for complex interventions in mental health (Medical Research Council, 2008) provides a framework with which to adopt appropriate methods for the development and evaluation of complex intervention treatments. Adherence to this framework allows treatment developments to be rigorously evaluated for their effectiveness.

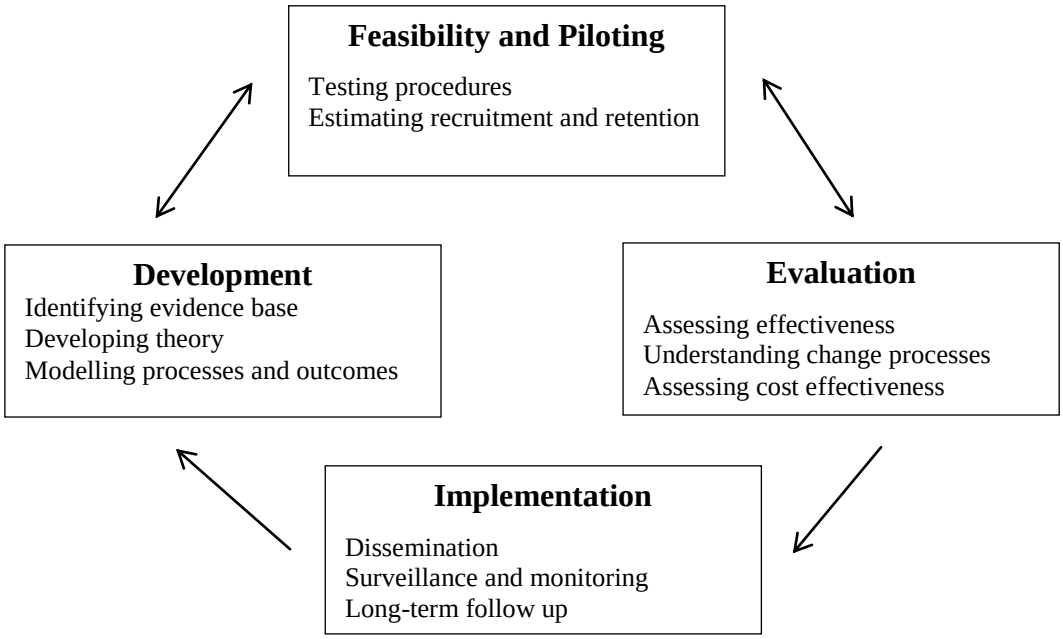


Figure 8.1. Key stages in the MRC guidelines for the development and evaluation of complex interventions; [Adapted from the Medical Research Council, 2008]

Translating basic science into treatment practice – translational gaps. Translating basic science into tangible benefits that eventually manifest in clinical health care settings may not necessarily be a straight forward or a linear process. Translational research has been investigated in and of itself. Findings indicate several restrictions which may obstruct the production of useable outcomes to improve patient

outcomes (Sung et al., 2003; Woolf, 2008). Broadly speaking, these boundaries can conceptually be placed in two main translational gaps, both of which may impede evidence-based research being subsequently adopted as best practice. Figure 8.2 provides a simplified diagram demonstrating the pathway of evidence-based treatments from 'bench to bedside', i.e. from their inception and early development in the laboratory through to clinical research and finally to health-care services (Sung et al., 2003; Woolf, 2008). The diagram also illustrates where gaps in knowledge may occur that may consequently block evidence derived best-practice in health care settings. Translational Gap 1 represents the implementation of basic science in the laboratory to clinical research. Gap 2 represents the translation from clinical research into health-care practice. These translational gaps may occur for a variety of reasons, including lack of funding, incompatibility of databases, high research costs and current clinical practice limitations (Sung et al., 2003). Parallels can also be drawn with the MRC guidelines for the development and evaluation of complex interventions, with gaps in transferable knowledge occurring principally between Stage 1: Development and Stage 2: Feasibility and Piloting i.e. translational gaps occur in the movement of basic science (such as that conducted in the current thesis) into a clinical research setting. Similarly, Stage 3: Evaluation, and Stage 4: Implementation i.e. translational gaps from clinical research to health-care settings.

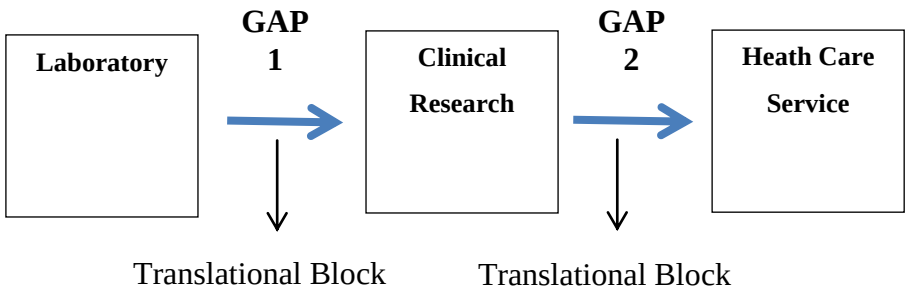


Figure 8.2. Simplified diagram of the pathway to evidence-based treatments and potential gaps where transferable knowledge blocks may occur.

Evidence-based Practice for Refugees and Asylum Seekers with PTSD

Current NICE guidelines for the treatment of PTSD (National Institute for Health and Clinical Excellence, 2005) recommend that trauma-focused therapies should be used for the effective treatment of PTSD symptoms in adults. More specifically, in the case of refugees and asylum seekers, the model of best practice should include trauma-focused therapy, such as Cognitive Behavioral Therapy (CBT; Beck, 1976) or

Narrative Exposure Therapy (Schauer et al., 2012), in conjunction with a stabilization phase.

A recent systematic review on PTSD in adult refugees demonstrated two main treatment approaches (Nickerson, Bryant, Silove, & Steel, 2011); *trauma-focused therapies* (using CBT) and *multimodal interventions* (general counseling, medical, and practical help). The review highlighted that the dominant approach used was *not* that of evidence-based practice recommended by NICE guidance, i.e. trauma-focused therapies, (National Institute for Health and Clinical Excellence, 2005; Nickerson et al., 2011), but that of the multimodal approach. In addition, the multimodal approach had no identifiable treatment components, thus the approach could not be measured accurately for effectiveness. This scarcity of evidence-based practice may represent a barrier in the translation of knowledge or information from clinical research through to health care service provision from Gap 2 (Sung et al., 2003; Woolf, 2008).

An example of what may happen if evidence-guided practice is not employed is that of Critical Incident Stress Debriefing. This treatment approach previously used in the early aftermath of trauma was subsequently found to be ineffective at reducing trauma symptoms (Rose et al., 2002). Indeed, in some cases it exacerbated symptoms, thereby causing more harm than good. Such findings suggest that it is not the case that *any* treatment is better than no treatment following trauma, and that it is necessary to be aware of the knowledge surrounding best practice, informed by carefully considered evidence which is further supported by research (Engelhard, 2012). Recently, an ethically appropriate and systematic investigation using a laboratory-based analogue model of trauma (the trauma film paradigm) has sought to understand processes behind critical incidence stress debriefing (Devilly & Varker, 2008; Varker & Devilly, 2012), illustrating a key role that basic, laboratory-based science may play treatment development. It further underscores the importance of iterative feedback between stages of development.

Forced Migration Trauma Service: A Phased-Model of Treatment

Patients admitted to the FMTS are confronted by debilitating trauma symptoms in addition to adapting to life in a new country. Research suggests that forced migration has a significant impact on psychological wellbeing (McColl, McKenzie, & Bhui, 2008). Problems in adaptation may include difficulty in communicating due to language barriers, feelings of isolation, having to have left loved ones and family behind. A

phased-model treatment intervention tackles both trauma symptomatology and adaptation issues resulting from forced migration to a new country. This integrative approach to treatment has been shown to lead to successful patient outcomes. The impact of such a treatment may be felt on an individual level, e.g. reduction on trauma symptoms, and may impact on a societal level with refugees relying less on general healthcare services and thus freeing up these resources.

The model of best practice recommended by NICE (2005) and administered by the FMTS is a 3 phased approach; Phase 1: *Stabilisation and Support.* This phase, facilitated by support and social workers, primarily aids patients by establishing a sense of safety and stability in their new environment. This may involve helping with formal applications of asylum status, helping with housing and financial difficulties and increasing community integration (e.g. learning English, socialising). If some form of stability can be established then it is more likely that the second phase: *Trauma-focused therapy* will be successful because the patient's full attention can be given to focusing on the treatment of their trauma history and symptoms Finally, Phase 3: *Re-settlement/re-integration* helps patients integrate into society by continuing work from the stabilization phase and focusing on adjusting to life in the UK.

Trauma Memories are Treatable

Victims who have experienced multiple traumatic events may prove difficult to treat in terms of finding the worst event in the patient's trauma history and tackling those memories, which may be months, years or even decades old (Schauer et al., 2012). That is why it is crucial, in this complex and vulnerable group, to use evidence-based best practice. Research has established that, in terms of the time elapsed between experiencing a traumatic event and that of treatment, there was no relationship concerning time and effectiveness of recommended treatments (Gillespie, Duffy, Hackmann, & Clark, 2002; National Institute for Health and Clinical Excellence, 2005). Therefore, given the right treatment, refugee and asylum seekers' trauma memories *are* treatable. According to NICE guidelines, trauma-focused therapy such as Narrative Exposure Therapy (NET; see Box 2 for a summary of NET) has the best evidence for success in terms of patient outcome for refugees and asylum seekers, although it should be acknowledged that there is a lack of evidence in this group compared to the general population (McColl & Johnson, 2006; Schauer et al., 2012).

NET involves exposure therapy, thereby habituating patients to the emotional responses of the trauma memory in addition to the reconstruction of autobiographical memory into a consistent chronicle. This approach therefore encompasses exposure therapy whilst acknowledging that this component is not the sole active mechanism for successful treatment outcome, i.e. exposure therapy without the additional treatment phases such as stabilisation and support do not result such effective treatment outcomes. Cognitive theories of PTSD (Ehlers & Clark, 2000) suggest that trauma memories lack a coherent time code due to faulty processing at the time of the index trauma, therefore subsequent trauma memories may be accompanied by a sense of 'nowness' which leads patients to feel like their trauma is being re-experienced again and causing distress. By integrating trauma experiences into a narrative time line of their lives patients are able to, with the help of their therapist, weave the trauma experience into their autobiographical memory where it becomes less pathological. Throughout the therapy psycho-education is continually adopted to help patients understand their symptoms and how their therapy aids their recovery.

Whilst using the phased-model approach to PTSD treatment, the FMTS also adopt an evaluated treatment procedure whereby multiple patient assessment measures are taken to ensure improved patient outcomes (Figure 8.3). This not only ensures consistent high-quality care, but is also a critical part of evidence-based best practice (Weisz, Chu, & Polo, 2004).

Table 8.2. *A summary of Narrative Exposure Therapy* (NET; Schauer et al., 2012)

Narrative Exposure therapy (NET)
Developed as a treatment of PTSD resulting from family or organised violence and/or multiple traumatic experiences or stressors.
Patients construct a narration of their lives from birth to the present with help and guidance of a therapist
The narration's focus is that of the patient's traumatic experiences or 'hotspots' (including feelings, cognitions, sensory impressions, meaning attached to the event) as well as positive events (for mental support).
The creation of a patient narrated time-line helps to identify traumas and their associated cognitive and emotional responses as being from the past in order to create a coherent time line in autobiographical memory. This aids patients in distinguishing the difference between **events** that are in the past and the activation of **memories** for the past.

Narration of events allows for repeated exposure and eventual habituation to the emotional responses elicited by the trauma memory. Eventually trauma memories lose their emotional impact resulting in a subsequent reduction of PTSD symptoms.

From Theory to Practice – Tetris as a Future Strategy to Target Flashbacks?

Exploring the feasibility of using Tetris game play to reduce flashback memories of trauma may represent an opportunity to help vulnerable populations as part of a treatment package. Early steps taken within this thesis suggest that it may possible to reduce flashbacks for a previously-consolidated trauma memory if the memory is reactivated successfully before-hand using the computer game Tetris. Its portability and familiarity may make it a useful tool that can overcome situations where language or cultural differences may hinder treatment, as may be the case with refugees and asylum seekers. These points were discussed with the clinical team at the FMTS[11] where it was suggested that a relatively simple task that individuals, some with chronic PTSD, could use to dampen down flashbacks would be beneficial and worthy of exploration.

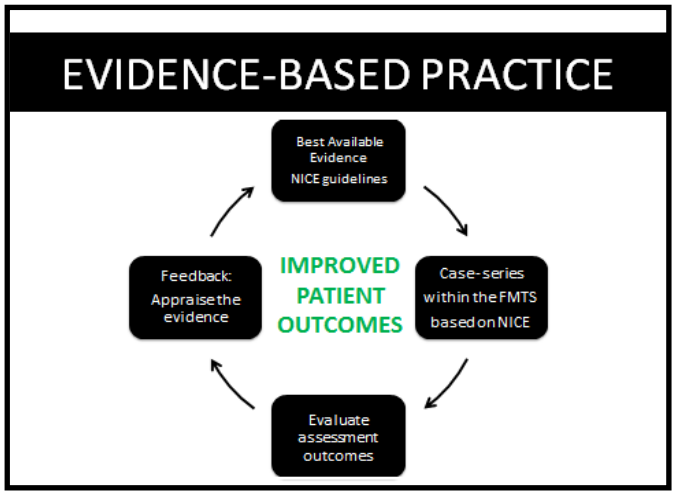


Figure 8.3. Slide from the Forced Migration Trauma Service, London Assembly presentation;' Evidence-based practice'

Conclusion

The opportunity to undertake this assignment on behalf of the FMTS allowed for first-hand enquiry into a practicing health care service, in addition to cementing theory to practice links from Tetris in the laboratory to the clinic. The Service represents a

[11] I would like to thank Dr Kerry Young, the lead clinical psychologist within the Forced Migration trauma Service for providing me with the opportunity to help within the FMTS and for her helpful discussion which helped aid my understanding of PTSD, treatment practices and thoughts about future intervention development.

model of best-practice. Through learning about the FMTS it was possible to see the importance of adhering to evidence-based guidelines for treatment, in order to provide consistent, high quality care. The Service also adheres to a procedure which uses treatment outcome evaluations to ensure the continuation of quality of service and to fuel knowledge of best evidence-based practice (Weisz et al., 2004).

The success of the Service demonstrated that trauma memories are not fixed and are treatable. This finding is more apparent in light of the complex nature of the population being treated (McColl & Johnson, 2006; McColl, McKenzie, & Bhui, 2008; McColl, McKenzie, & Kamaldeep, 2008). Interestingly, successful treatments in this instance involve interventions that combine several active components to improve patient outcomes (Schauer et al., 2012). These outcomes are continually being evaluated in terms of patient outcomes by the Service to provide feedback and a reflexive evidence-based practice, which remains fluid and able to continually supply the best treatment possible for PTSD in refugees and asylum seekers within the London area.

Despite the provision of guidance for clinical excellence within Health Services, the NICE guidelines' treatment approaches for PTSD in refugees and asylum seekers are not the dominant approach. This might suggest that there is a gap transferring knowledge from clinical research to health-care services (Figure 8.2). This gap has been made shorter with the synthesis evidence provided by NICE guidelines; however, wider dissemination of best evidence-based practice is still required. An exploration of the boundaries that restrict services from best evidence-based best practices is warranted. The presentation by the FMTS to the London Assembly represents recognition of how Trauma Services for refugees and asylum seekers should operate to provide best-patient care. Further, in undertaking this task as a DPhil student it was invaluable in helping me understand, 1) PTSD and 2) current treatment approaches, particularly as the predominant approach used within the thesis is laboratory-based.

CHAPTER 9

General Discussion

Overview of the Thesis

The overarching aim of the thesis was to use an experimental approach to investigate the reduction of flashbacks following (analogue) trauma using a cognitive task, playing the computer game, Tetris ("Tetris Zone," 2007). Re-experiencing in the form of "flashbacks" (intrusive, image-based and predominately visual) memories of trauma, is the hallmark symptom of Post-Traumatic Stress Disorder (PTSD; American Psychiatric Association, 2000; Hackmann et al., 2004; Muravieva & Alberini, 2010). Despite effective psychological treatments for PTSD, these are only recommended if symptoms persist for at least 1-month post-trauma (National Institute for Health and Clinical Excellence, 2005). There are currently few treatment options in the early aftermath of trauma (e.g. Rothbaum et al., 2012), indicating a relatively unmet need (National Institute for Health and Clinical Excellence, 2005; Roberts et al., 2010).

Chapter 1 was a literature review of studies that had used the trauma film paradigm to investigate post-trauma reactions, predominately flashbacks (this built on the most recent review in 2008). Chapter 2 was a literature review of studies of memory reconsolidation in human participants. Together, the literature reviews along with pilot-work carried out in Chapter 3 provided the basis for Experiments 1 and 2 (Chapters 4 and 5) within the thesis. These experiments sought to test, for the first time, whether playing Tetris 24 hours following trauma film viewing could be used to disrupt flashback memory *reconsolidation.* The third experiment in the thesis investigated whether playing the computer game Tetris *prior* to film viewing would reduce flashback memories, in order to explore Tetris game play as a pre-emptive strategy for reducing flashback development (it did not).

Chapters 7 and 8 moved focus from experimental work to consider in brief a more clinical perspective and gain a wider context of PTSD. Chapter 7 considered email correspondence from individuals who had spontaneously used the computer game Tetris following aversive events. Chapter 8 explored a PTSD treatment for a complex group within the NHS. Overall, these chapters helped frame a more clinical perspective relating to PTSD symptoms and potential treatment.

The following section provides an overview of the main findings from the experimental chapters within the thesis.

Main Findings of the Thesis

Experiment 1 (Chapter 4) of the thesis utilised the trauma film paradigm in an experiment which provided the first test of a cognitive task (playing the computer game Tetris) administered 24 hours post-trauma film viewing. A two condition, between-groups design was used in which participants were randomly allocated to either a (*i*) 'Memory reactivation task + Tetris' or (*ii*) no-task Control condition. In the first 24 hours after trauma-film viewing, (prior to the experimental manipulation), the frequency of flashbacks of the film between conditions did not statistically differ. The key results indicated that participants in the Tetris condition experienced fewer flashbacks across the following week, recorded in an intrusion diary. Further, this pattern emerged in convergent measures of flashbacks, the Intrusion Provocation Task (IPT; a method of inducing flashbacks within the laboratory) and on the Impact of Event Scale – Revised: Intrusion subscale (IES-R; Weiss & Marmer, 1997) administered 8 days after film viewing.

Experiment 2 (Chapter 5) had two overarching aims: (1) to provide a test of replication of findings from Experiment 1 and (2) extend findings by dismantling the possible task components associated with a reduction in flashbacks. The experiment used the trauma film paradigm with a between-groups design in which participants were randomly allocated to 1 of 4 conditions: (*i*) Memory reactivation task + Tetris game-play, (*ii*) no-task Control, (*iii*) Tetris only, or (*iv*) Memory reactivation task only. Results provided a replication of the key results from Experiment 1 and demonstrated that participants who underwent a memory reactivation task followed by Tetris game play experienced fewer flashbacks in the subsequent week as recorded in an intrusion diary, compared with all other groups. This pattern was shown 8 days after film viewing using the IPT, but the IES-R Intrusions subscale. Critically, the addition of the 2 further conditions in Experiment 2, 'Tetris only' and 'Memory reactivation task only', demonstrated that that neither the memory reactivation task nor Tetris game-play in isolation were sufficient to reduce flashbacks, and were comparable to the no-task Control condition. Thus, results showed that the memory reactivation task *in combination* with Tetris game-play was necessary in order to reduce flashbacks to an analogue trauma (See Figure 9.1 for a graph of flashback frequency for both Experiments 1 and 2). Overall, dismantling the component parts of the 'memory reactivation task + Tetris condition' in Experiment 2 supported propositions made in Chapter 2, that a 'consolidated' (24 hour old memory) is required to be 'reactivated' in order for reconsolidation to be initiated

rendering that memory labile and vulnerable to disruption via interference tasks e.g. Tetris game-play.

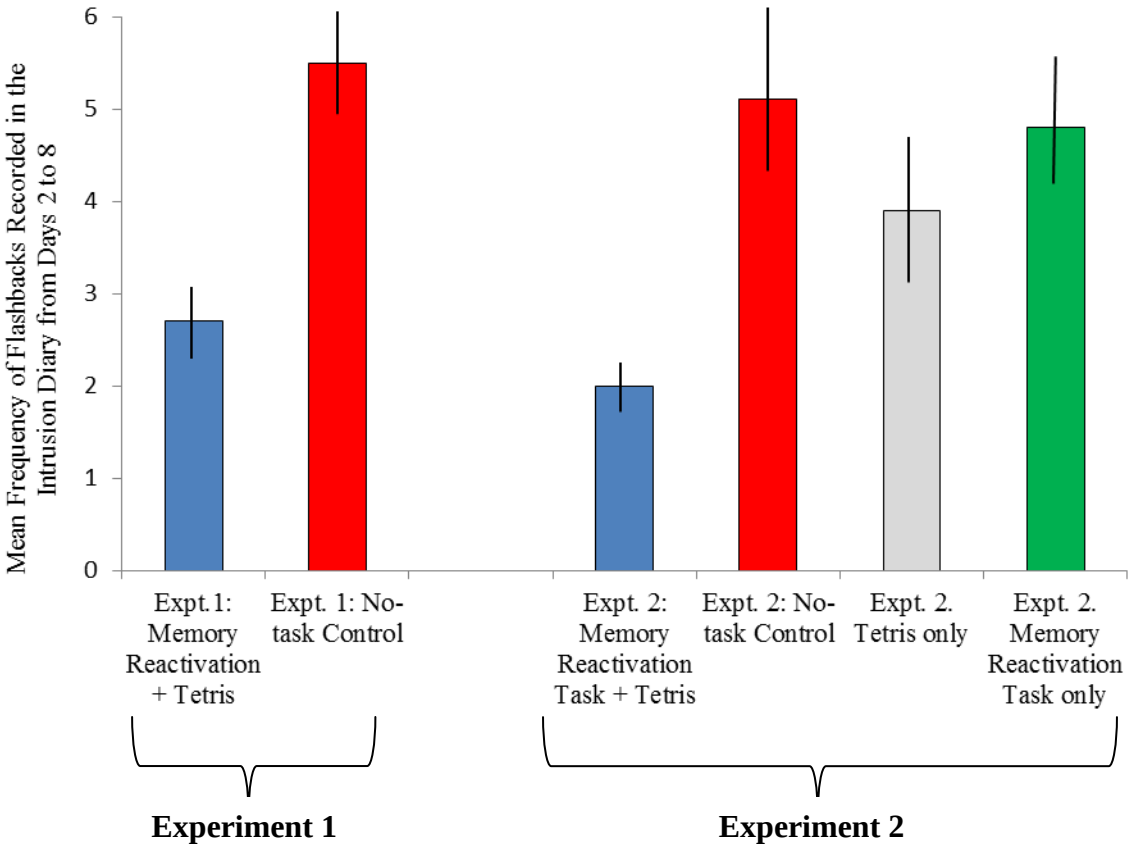


Figure 9.1. Flashback frequency recorded in the intrusion diary for days 2 to 8 for Experiments 1 and 2, for each experimental condition (mean +/- SE of the mean).

Experiment 2 provided a test of replication for Experiment 1 and showed fewer flashbacks were experienced by participants in the memory reactivation task + Tetris, condition (blue bar) compared to the no-task control condition (red bar). Moreover, in Experiment 2 results showed that neither merely playing Tetris nor undertaking the Memory Reactivation task, in isolation, was sufficient to reduce flashbacks to the trauma film.

It should be noted that the experimental procedure was carefully designed, based upon previous studies that had purported to experimentally investigate memory reconsolidation processes in humans. Both experiments 1 and 2 involved participants attending 3 laboratory-based experimental sessions each. Sessions 1 and 2 were timed to be 24 hours apart, to within 2 hours. Further, Session 3 was timed to be 8 days after Session 2, also to within 2 hours. As such, Experiment 1 yielded a total of *n = 156* experimental sessions and Experiment 2 yielded a total of *n* = 216 experimental sessions,

across all participants. By controlling for the time of day that participants attended the laboratory-based experimental sessions it was possible to ensure all participants had a comparable duration in which to fill out flashback entries in the intrusions diary. The experimental design also meant that for the 24 hours between trauma film viewing and return for session 2, flashback frequency and the number of hours sleep could be reported by participants. Thus, it was possible to show that flashbacks *prior* to assignment to experimental manipulation, and the number of hours sleep (sleep being implicated in the consolidation of memory, Walker et al., 2003), were not statistically different between conditions, for either experiment in the first 24 hours (prior to assignment to experimental condition).

In addition, in dismantling Experiment 1, Experiment 2's design was also able to control for the possibility of contextual cues (i.e. same laboratory and same experimenter were used in session 1 and session 2) operating as a method of reactivation for the trauma film memory (in the 'Tetris only' condition). Findings indicated that situational context alone was not sufficient to reactivate memory in order for Tetris game play to impact on subsequent flashback development. This was contrary to previous studies investigating the disruption of human memory reconsolidation that had showed that context-cues can serve as a reminder to reactivate memory (e.g. Hupbach et al. 2009; 2011. See Chapter 2). This might suggest that methods of memory reactivation vary for different types of memory, i.e. emotional flashback memories (as in the current thesis) compared to non-emotional declarative memories (Hupbach et al. 2009; 2011). Findings pertaining to the 'Tetris only' condition also suggest that it is unlikely that results are due to a 'placebo' effect of playing Tetris, i.e. that playing a game was in and of itself beneficial in reducing flashbacks. Experiment 2 also showed that reactivating a memory in and of itself does not reduce flashbacks. This indicates that merely thinking about, or talking about trauma memories without accompanying treatment, would not be sufficient to reduce symptoms.

The conclusion from the first 2 experiments is that a consolidated (24 hr. old) memory for aversive film material is vulnerable to disruption via a cognitive interference task, Tetris, provided the memory is reactivated. This is in line with theories on memory reconsolidation which suggest that following retrieval memory reverts to a labile state (similar to but not identical, to memory consolidation), during which the memory is transiently susceptible to modification. Thus, without retrieval memory will not be plastic and as such not modifiable (Sara, 2000; Schiller & Phelps, 2011).

The final experimental chapter - Experiment 3 (chapter 6) - moved from the realm of memory reconsolidation to memory *consolidation* in order to test whether memory for a trauma film would be vulnerable to proactive interference via Tetris game-play. Findings indicated that playing the computer game Tetris immediately before viewing a traumatic film did not result in those participants experiencing fewer flashbacks relative to a no-task control, either in the intrusion diary across the week following film viewing, or during the IPT or IES-R: Intrusion subscale. This suggests that the order of presentation might be a factor when playing Tetris in the early aftermath of analogue trauma since previous research that had investigated the ability of visuospatial tasks to reduce flashbacks had done so successfully both during (Holmes et al., 2004; Stuart et al., 2006) and immediately after (Bourne et al., 2010; Deeprose et al., 2012) in addition to 30 minutes and 4 hour post-film viewing (Holmes et al., 2009; Holmes et al. 2010).

Implications of the Thesis

Clinical Implications

Memory reactivation. Models of PTSD (e.g. Ehlers and Clark, 2000; see also Brewin & Holmes, 2003 for a review) implicate the role of memory processes in PTSD development and maintenance. Successful evidence-based treatments for PTSD included a 'trauma-focused' component involving exposure to the trauma memory (reactivation) and have been shown to yield better outcomes compared to non-trauma-focused interventions e.g. relaxation techniques (Ehlers, Clark, Hackmann, McManus, & Fennell, 2005). This lends support for the importance of targeting or 'reactivating' a trauma memory prior to intervention treatment and is in keeping with the findings from Experiment 1 and Experiment 2 that showed the importance of 'reactivating' memory in order to reduce flashback memories via Tetris game-play. Specifically, the 'Tetris only' condition in Experiment 2 showed that playing Tetris without prior memory reactivation did not lead to a significant reduction in flashbacks. Likewise, memory reactivation in isolation did not reduce flashbacks.

Experiments 1 and 2 used a memory reactivation task comprising of still images, 1 for each of the 11 film clips from the trauma film. Still images were of the moment immediately prior to the worst moment or 'hotspot' from the traumatic film. Hotspots, defined as '*moments of peak emotional distress during a traumatic event*' (p.3; Holmes et al., 2005) often manifest as flashbacks (Grey & Holmes, 2008; Holmes et al., 2005) and identifying a patients 'hotspot' in their trauma memory has been shown to be useful in

providing successful trauma-focused treatments for established PTSD (Nijdam et al., 2013). Within Experiments 1 and 2 of the thesis, the average number of different 'events' (i.e. flashbacks to each of the 11 different clips from the trauma film) a participant experienced across the 8 days post-film viewing ranged from $M = 5.62$ (Control condition, Experiment 1) and $M = 5.39$ (Control condition, Experiment 2) supporting the supposition that participants had hotspots to particular parts of the trauma film, rather than the whole film itself manifesting as flashback memory.

Overall, findings from Experiments 1 and 2 indicate it may not be necessary to 'relive' traumatic episodes in their entirety in order to introduce a treatment intervention and reduce haunting flashback memories. Rather, findings suggest that selectively 'reactivating' particular parts of the trauma memory, e.g. hotspots, as an adjunct to Tetris game play would be sufficient.

Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (DSM-V). Since the commencement of this thesis a new edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) has been published (June 2013).

Amendments have been made to the diagnostic criteria of PTSD. In particular, the DSM-V has revised what previously constituted a criterion-A 'traumatic event' so as to include exposure to electronic media, television, movies or pictures in the line of work.

> "A4: Experiencing repeated or extreme exposure to aversive details of the traumatic event(s) (e.g. first responders collecting human remains; police officers repeatedly exposed to details of child abuse).
>
> Note. Criterion A4 does not apply to exposure through electronic media, television, movies, or pictures, unless the exposures is work related"
>
> p.271; DSM-V; APA, 2013

This addition to diagnostic criteria for PTSD has clinical relevance in that it establishes that there is actual risk of developing PTSD from electronic media, film footage and the like. The new DSM-V guideline revision draws attention to vulnerable occupational groups, who are routinely exposed to trauma in the work-place. These might include individuals in the police service who have to view images of child abuse and law professionals exposed to traumatic media as part of their work. Such groups may directly benefit from a simple intervention that can reduce flashback memories experienced as a

result of viewing traumatic electronic media, television or movies. If an individual suffered from flashbacks to as a result of viewing traumatic film footage in their line of work; it might be possible to obtain an image(s) from the footage of the moment just prior to their reported flashback (s), in order to reactivate that memory rendering it vulnerable to interference via Tetris game-play.

Research is currently being undertaken to test the clinical application of playing Tetris as a method to reduce flashback to trauma in the Emergency Department (ED) for individuals who have experienced a Road Traffic Accident (RTA). Key to the protocol, based upon 'hotpots' literature (Grey & Holmes, 2008) and supporting experimental findings within the thesis, is to reactivate the memory before administering Tetris game-play. This is done by asking individuals to identify and then 'picture' their worst moments, which may be multiple, from the trauma;

> *"In a moment I am going to ask you to close your eyes and picture the worst moments of the accident for 30 seconds each. I'd like you to bring to mind the images of those moments as vividly as possible* [Time with stopwatch 30 second for each of the worst moments and prompt participant to move on to the next]."
>
> (experimental protocol from Iyadurai, Geddes, Nobre, & Holmes, 2013)

This method of reactivating memory, while different from taking still images from moments immediately prior to 'hotspot' moments demonstrates how memory reactivation plus Tetris game play may be utilised in clinical populations and represents next-steps in the development of a cognitive task, Tetris, to reduce flashbacks to trauma. Findings from the clinical research may also illuminate public perceptions surrounding the use of Tetris as a method to treat symptoms post-trauma; as such a method may be viewed as unusual compared to more traditional methods centred on the idea of the compassionate therapist.

A small sample of emails indexing public reaction to playing the computer game Tetris following negative events (Chapter 7) indicated game play was viewed favourably by individuals who had spontaneously discovered the game, albeit in a relatively small and self-selecting sample. Interestingly, Tetris is increasingly being investigated in relation to potential therapeutic benefits relating health-related issues (other than flashback reduction), for example in relation to memory plasticity and changing thinking styles associated with negative bias (Xue et al., 2012) and training eyes to work together as an

treatment for 'lazy eye' (Li et al., 2013). The volume of coverage that Tetris receives in relation to its potential therapeutic benefits might imply that the well-known and widely available computer game is viewed in favourable light by the public more generally, and thus might be considered acceptable if it were to be used as part of a treatment package.

Theoretical implications

Memory consolidation and reconsolidation. Previously it was thought that once a memory had consolidated it was relatively impervious to disruption (McGaugh, 2000). Recently, studies in animal models suggested that this might not be the case (Nader et al., 2000b), driving theories of memory reconsolidation (Alberini, 2005). The processes and boundary conditions surrounding memory reconsolidation have been studied extensively in various animal models, including in rats (Lee et al., 2004), Crabs (Chasmagnathus; Pedreira & Maldonado, 2003) and snails (Lymnaea stagnalis; Sangha, Schelbenstock, & Lukowiak, 2003). More recently, memory reconsolidation has been studied in humans (see Chapter 2 for a review). Methods of modifying a human memory during its reconsolidation have included pharmacological approaches, such as using propranolol to 'erase' a conditioned fear response (Kindt et al., 2009; Soeter & Kindt, 2010) as well as real life fear responses following psychological trauma (Brunet et al., 2008). In addition, behavioural methods, such as interference due to competing information, have also been used to disrupt the reconsolidation of different types of memory. Examples include, episodic and declarative (Forcato et al., 2007; Hupbach et al., 2007), procedural (Walker et al., 2003) and emotional- episodic memories (Schwabe & Wolf, 2009), as well as conditioned fear responses (Argen et al., 2012; Schiller et al., 2010). The modification of emotional, involuntary flashback memories, using a memory reactivation task plus Tetris game-play as a method to disrupt reconsolidation, is novel to the current thesis. Experiments 1 and 2 therefore represent the next-steps in the development of a cognitive-task intervention for use in the early aftermath of psychological trauma, since the longer the time frame in-between experiencing a trauma and being able to deliver an intervention to ameliorate flashbacks, the greater the number of individuals who are able to receive that intervention and benefit from it.

Involuntary and voluntary memory. Chapter 5 discussed findings from Experiments 1 and 2 in relation to participants' involuntary (flashback) memory and their voluntary/declarative (recognition) memory for the trauma film. Participants who played the computer game Tetris (following the memory reactivation task) experienced fewer

involuntary flashbacks; yet voluntary recognition memory for the film was not significantly altered, compared to all other conditions. From a clinical perspective, retaining intact voluntary memory for a trauma that can be deliberately retrieved is important; as 'erasure' of such memories can lead to increased levels of distress (Holmes, Sandberg, & Iyadurai, 2010). Memory 'erasure' may also impact on other areas pertaining to the trauma such as court-case proceedings, for example in instances of rape (Hardy, Young, & Holmes, 2009). However findings from experiments within this thesis appear contrary to general models of memory that postulate that involuntary and voluntary memory are not dissociative (Henson & Gagnepain, 2010; van Kesteren et al., 2012). Such models would predict that the reduction in involuntary flashback memories should result in a corresponding reduction in voluntary (recognition) memory scores. This was not the case; furthermore, in addition to studies within the thesis, an earlier study using the trauma film paradigm (Bourne et al., 2010, see Chapter 1) found that participants who had significantly *more* flashbacks also had significantly *lower* scores on a memory test for the film.

Relatedly, previous research investigating the neural basis of emotional learning indicates the potential dissociation between the amygdala and hippocampus, e.g. in patient lesion studies where there are specific lesions to either the amygdala or hippocampus (LeBar & Phelps, 2005) and in human fear conditioning paradigms where the physiological arousal to a conditioned stimulus is removed, leaving episodic memory (e.g. declarative knowledge of the contingency between the conditioned stimulus and the unconditioned stimulus) intact (Kindt et al., 2009; Soeter & Kindt, 2010). Such research indicates it is possible to remove the emotional aspects of memory (e.g. physiological) whilst leaving episodic memory (e.g. declarative knowledge, or what we might term voluntary memory) for an aversive event intact. As such it might be that Tetris is able to specifically target the emotional elements of a trauma memory that later flashback to mind, whilst leaving episodic memory intact. Future studies could investigate this further by introducing psychophysiological measures to try to disentangle the mechanisms behind findings which indicate that reactivating a trauma memory followed by Tetris game play specifically targets emotional memory, leaving recognition memory intact.

Taken together, findings indicate that involuntary and voluntary (declarative) memory requires more detailed investigation in order to understand the mechanisms behind the cognitive task Tetris' ability to reduce involuntary flashbacks, whilst ostensibly leaving recognition memory intact. Further, investigation of this may also need to identify

the roles of the hippocampus and amygdala and how these two memory systems may be impacting on flashback memory and declarative memory for the trauma film.

Limitations of the Research Presented in the Thesis

Limitations pertaining to each of the Experiments within the thesis have been addressed in each corresponding chapter; however there are some general limitations that relate more generally to the experiments within the thesis and these are addressed in the following section.

Trauma Film Paradigm: Use of an analogue trauma i.e. a film. A limitation of the experimental work within the thesis relates to the use of the Trauma Film Paradigm in a non-clinical sample. The use of the paradigm allows for a controlled setting in which to study post-trauma reactions e.g. flashback development; however, the use of an aversive film as an analogue of real-life trauma may mean that findings cannot be directly extrapolated to clinical populations. However, there is research that supports the validity of an analogue traumatic event (film materials) to study flashbacks. There are several studies that suggest involuntary memories experienced in everyday life are on a continuum with involuntary flashbacks experienced following trauma (Berntsen, 2001; Berntsen & Hall, 2004; Holmes, 2004). Further to this, research suggests that vicarious trauma, e.g. in the form of viewing traumatic material, such as the events of 9/11, on television, can induce flashback symptoms of the kind experienced by those with PTSD (Ahern, Galea, Resnick, & Vlahov, 2004; Holmes, Creswell, & O'Connor, 2007; Schlenger et al., 2002; Updegraff, Cohen Silver, & Alison Holman, 2008; Zimering, Gulliver, Knight, Munroe, & Keane, 2006). In addition, research using the trauma film paradigm has shown that film material is able to elicit physiological responses akin to that which might be experienced following an actual stressful or traumatic event, e.g. changes in heart rate (Roelofs, Hagenaars, & Stins, in press) skin conductance (Holmes et al., 2004; Lazarus, 1964) and cortisol levels (Henckens et al., 2009).

The new edition of the *Diagnostic and Statistical Manual of Mental Disorders* Fifth edition (DSM-V; 2013), discussed earlier in this chapter, specifies that work-related exposure to traumatic material through electronic media, television, or pictures may be classified as a criterion A 'traumatic event'. This provides additional support for the view that film footage, as used in the trauma film paradigm, may elicit PTSD symptoms. As such, findings from this experiment may offer insight into mechanisms behind flashback

reduction from an experimental medicine perspective, despite being laboratory-based and using analogue trauma in a healthy population.

In summary, it is not ethical to induce real-life trauma in individual, thus, analogue studies represent a useful tool to with which to study PTSD and the early-stage development of treatments and their clinical translation (Ehring, Kleim, & Ehlers, 2011); whether that is using mouse models to investigate novel pharmacological treatment methods for PTSD (e.g. Andero et al., 2013) or behavioural methods such as those used within the thesis.

Diary method as a way of capturing flashbacks. The study of flashbacks following an analogue trauma film typically uses a pen and paper, tabular intrusion diary to measure their subsequent frequency (e.g. see Chapter 1). However there are strengths and weaknesses related to this approach. Berntsen and Hall (2004) cite the diary methodology as being a very useful way of capturing involuntary memories in everyday life because it allows records to be taken naturalistically (i.e. the diary is portable and thus entries can be filled out away from the laboratory in their natural context) and so reduce retrospection that can contaminate self-reports. However, research in patient populations suggests that the capture of 'in the moment' data may not be accurate, with findings suggesting low levels of compliance with retrospective entries still occurring (Stone et al., 2003).

Alternative methods using mobile phone technology, e.g. SMS text messaging (Malik, Goodwin, & Holmes, 2012), offer an alternative method to measure flashback frequency. Within the context of the trauma film paradigm a participant may find the presence of a pen and paper intrusion diary intrusive and in-and-of itself a trigger for flashbacks to the film, as such the use of a participants' own mobile phone might make this less likely (as an individuals' mobile phone would not be associated with the trauma film *per se*). Further to this, electronic diary formats can time-stamp data entries which may also be beneficial in assessing diary compliance and to ensure diary entries are not filled out retrospectively in one go. However, a comparison of paper and pen with electronic diary formats found comparable levels of compliance for both indicating the pen and paper method to be a useful, and cheaper alternative to hand-held electronic diary formats (Green, Rafaeli, Bolger, Shrout, & Reis, 2006).

Future Experiments

Results derived from experimental work in the current thesis provide a number of directions for future work, described in the following section.

Task specificity during memory *re*consolidation

Research discussed previously in Chapter 1 described how, using the trauma film paradigm, a series of experiments had shown how certain types of tasks can influence subsequent flashback frequency differently. Compared to control conditions, visuospatial-based tasks led to a reduction in flashbacks – hypothesised to be due to their ability to selectively compete with the resources required for flashback formation, whereas other types of tasks, e.g. verbal-based, did not (for example, Bourne et al., 2010; Deeprose et al., 2012; Holmes, James, et al., 2010). Findings from these experiments were purported to be due to a cognitive task's ability to tap into a particular modality in working memory (Baddeley, 1990; see also Chapter 1). In contrast to this, an alternative explanation for the findings has been suggested which posits that general task distraction, rather than modality specific interference, accounts for a flashback reduction (Dewar et al., 2007). To date, modality-specific effects of cognitive interference tasks have been demonstrated during memory encoding (e.g. tasks completed concurrently with viewing a trauma film; Holmes, Hennessey & Brewin, 2004) and shortly after (e.g. Bourne et al, 2010; Holmes et al. 2010) trauma film viewing. However, task specificity has yet to be tested during memory reconsolidation. Future research should seek to compare the memory reactivation task followed by a verbal interference task (for example, the computer game Pub Quiz; Holmes et al., 2010) in order to test task specificity effects on flashback memories. This may be of importance, in light of research reviewed in Chapter 2 that indicates that although memory consolidation and reconsolidation are similar, they are in fact distinct processes (Alberini, 2005); thus, findings that hold for research using the trauma film paradigm during memory consolidation may not apply to reconsolidation. Further to this, in order to understand and potentially increase the efficacy of Tetris game play as a procedure to reduce flashbacks future studies should seek to unpick the elements of Tetris e.g. whether its effects are due to taxation of the central executive in working memory or modality specificity to try an understand how it derives its beneficial effects.

Involuntary and voluntary memory processes following reconsolidation

Future studies should seek to understand more precisely the effect of playing Tetris on both involuntary and voluntary memory due to reasons outlined earlier in the chapter. Results indicate that undertaking a memory reactivation task followed by playing Tetris reduces flashback memories but not recognition memory. Since hitherto only recognition memory tests have been used to investigate voluntary memory, alternative memory tests may help to test more precisely the impact of playing Tetris on emotional memory.

Exploring time-frames associated with memory reconsolidation

Future experiments should explore extending the time frame further between film viewing and Tetris game play, to explore if there is an optimum time frame for which Tetris can successfully reduce flashbacks to trauma. In investigating whether it is possible to disrupt memory for a trauma film that is greater than 24 hours old, it might also be possible to explore whether older memories require alternative or stronger methods of memory reactivation, as might be suggested by some research using animal models to explore memory reconsolidation (e.g. Suzuki et al., 2004).

Fear conditioning paradigms applied in the context of memory reconsolidation have shown that the extinction of a physiological fear response during memory reconsolidation is not subject to re-instatement or spontaneous recovery (even though explicit memory for the fear associated stimuli remains intact). Further effects are persistent for up to 1 year post-training (Argen et al., 2012; Schiller et al., 2010). This indicates that disrupting memory reconsolidation as a strategy to modify memories may offer longer-term, more permanent benefits. Future studies may want to assess whether there are longer-term benefits of memory reactivation followed by Tetris game-play after trauma.

Individual differences

Individual differences that have been implicated in vulnerability associated with increased symptomatology following a psychological traumatic event, these include levels of emotional response to a traumatic event (Clark, Mackay, & Holmes, 2014) as well as increased levels of hypomanic traits (Malik, Goodwin, Hoppitt, & Holmes, in press) for example. As such it might also be worthwhile to ascertain whether individual differences such as these are also correlated with the impact of Tetris on flashback frequency

following analogue trauma. This line of research on individual differences may help with understanding the suitability of Tetris for to reduce flashbacks.

The relevance of a reminder task (during memory consolidation)

Experiments 1 and 2 within the thesis have demonstrated that a reminder is required to reactivate a 24 hour memory for the trauma film prior to intervention using Tetris game play. Experiment 3, Tetris prior to a trauma film, did not have any form or reminder task due its design (change of order between film and task) and as such its null findings may be due to a lack of a reminder-cue. Early experiments that used Tetris as a cognitive task to reduce flashbacks, upon which the studies in this thesis are based, have all used some form of brief 'reminder' prior to game play (Holmes et al., 2009; Holmes et al., 2010). Thus, it is still to be tested whether a memory reminder for the film is necessary during the time-window during which memory is consolidating (postulated to be within 6 hours following memory acquisition; Walker et al., 2003).

Recent research has used *f*MRI in the context of the trauma film paradigm (Bourne et al., 2013) to show that the pattern of brain activation during flashback encoding differed between parts of the film scenes that flashed back in relation to potential scenes (those from the 'worst moment' that could, but did not, flashback). Findings suggested that there was a difference at encoding for those events that later return as flashbacks, compared to those that do not. Future studies could utilise *f*MRI techniques to investigate neural correlations associated with how Tetris able to reduce flashbacks. As discussed in Chapter 1, Tetris has been shown to occupy brain regions associated with visual areas in the brain, as well as has inhibiting amygdala activity (Price et al., 2012). Using *f*MRI it might also be possible to show the role of the memory reactivation task at a neurological level.

The use of modality-specific cognitive tasks (i.e. visuospatial-based) on flashbacks has been studied in clinical populations. Imagining the worst moment of an index trauma event whilst concurrently undertaking side-to-side eye movements was associated with a significant reduction in emotionality and vividness of the image compared to a verbal-based counting task or mere exposure (just holding the memory in mind with no intervention) in a population awaiting treatment for PTSD symptomatology (Lilley, Andrade, Turpin, Sabin-Farrell, & Holmes, 2009). Further, the cognitive task Tetris (following memory reactivation) is currently being investigated as an early (within 6 hours post trauma) method to reduce flashbacks in individuals who have experienced a RTA (as discussed previously in this chapter). Findings from Experiments 1 and 2 within the thesis

indicate a future experiment should be to test the use of a memory reactivation task followed by Tetris game play in individuals whose trauma occurred at least 24 hours previously. This longer time window allows for a more realistic time frame for potential clinical intervention to reduce flashbacks, and remains to be tested in a clinical population.

The current thesis explored the boundaries relating to the time-frame during which human, involuntary memory for negative emotional events can be modified using the cognitive task Tetris. Key findings from Experiments 1 and 2 indicated that a 24 hour old (analogue) trauma memory is vulnerable to modification resulting in fewer flashbacks - but *only* providing the memory to be modified is reactivated. Findings were in line with memory reconsolidation theory, and add to this growing body of research, since the results from the thesis were the first to show that it is possible to use a non-invasive cognitive task to disrupt memory reconsolidation for a clinically relevant (i.e., emotional involuntary memories of the type experienced following trauma) memory in humans. Findings from experimental work suggest that memory reactivation followed by Tetris game-play as an intervention to reduce flashbacks is promising as a post-trauma "cognitive vaccine".

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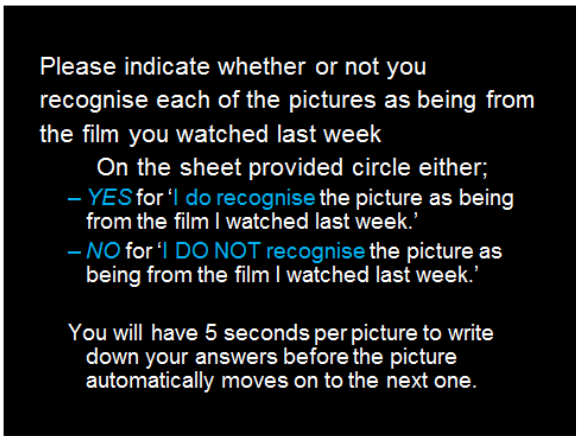
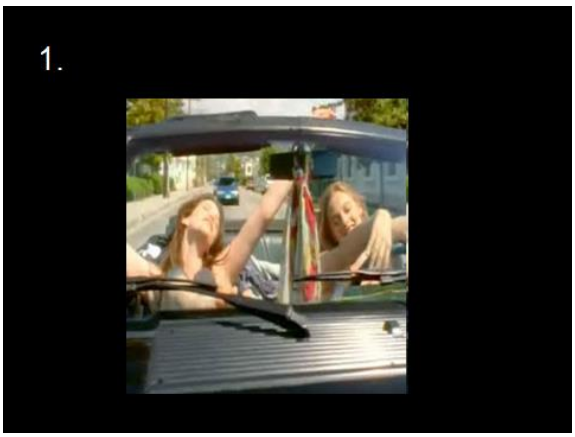
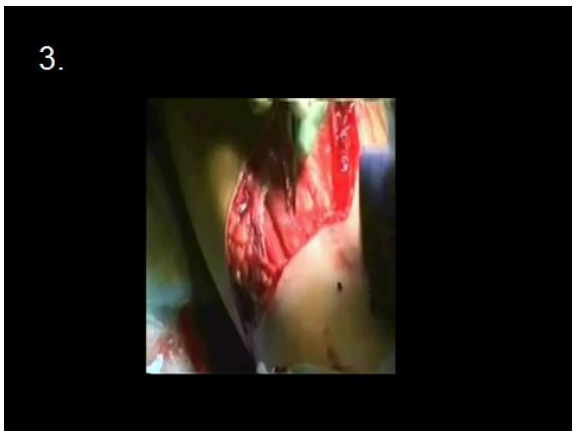
Appendix 3.1. Still Images From the Visual Recognition Memory Test (1/4)







Appendix 3.1. Still Images from the Visual Recognition Memory Test (2/4)

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Appendix 3.1. Still Images from the Visual Recognition Memory Test (3/4)

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Appendix 3.1. Still Images from the Visual Recognition Memory Test (4/4)

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Appendix 3.2. Recruitment Email Template; Information given to Participants [3-Session Design]

Dear <INSERT NAME>,

Thank you for your email and interest in volunteering to take part in my research. Here is some more information on the study I'm currently recruiting for:
My research is on involuntary memories (memories that just pop into mind) and your participation would involve three separate short sessions (approx. 30 min maximum) at the Department of Psychiatry (directions below). You will be reimbursed £30 if you decide to take part.
Here is a little bit more information about what each session would involve:
Session one: During your first visit to the department you will be asked to fill in some simple questionnaires and view a short film (12 minutes). You should be aware that the film will contain scenes of a stressful nature, such as surgical procedures. Upon finishing session one you will be asked to keep a very simple diary for the next 24 hours.
Session two [24 hours after session one, within 2 hours]: During this visit you will be asked to fill in some short questionnaires and perform some simple tasks. Following this you will be asked to carry on keeping the simple diary for another 7 days.
Session three [7 days after session two, within 2 hours]: In the final visit to the department I will collect the diary from you and ask you about your memory for the film from session one.

Please be aware, to be eligible to take part you need to be between 18 and 65 years old and have no current or history of psychological illness. If you have taken part in a study involving watching a stressful film in the past you will also not be eligible to take part.

If you would be interested in taking part please email me back
Look forward to hearing from you!
Very best wishes,

Where is the Dept. of Psychiatry and how would I get there?
Directions to the Warneford Hospital Department of Psychiatry from St. Clements (just down from the High Street):

- Go down St. Clements (away from the city centre) and turn RIGHT at the T-Junction onto **Morrell Avenue**
- Continue up **Morrell Avenue** (this road turns into **Warneford Lane** at the roundabout).
- At the traffic lights and intersection with Gypsy Lane turn RIGHT into **Roosevelt Drive.** Walk up the slightly curved main drive to the big building which is the main hospital. Follow the sign posts round to the LEFT to the **University Department of Psychiatry.**
-

Recommended bus routes: No. 4: to Warneford Lane. You can get this bus from the High Street or St. Clements and it will take you to the point where Morrell Avenue becomes Warneford Lane (slightly before the crossroads with Gypsy Lane and Roosevelt Drive)

EXPERIMENTAL PROTOCOL

SESSION 1, DAY 1

Text in italics = spoken to the participant

1) Greet Participant:
   Good morning/afternoon. Thank you for coming. Would you mind turning off your mobile phone before we start – thank you! Before we begin can I ask you to please read this information sheet? If you are happy could you sign the consent form? Feel free to ask any questions.

2) Give **Information Sheet** to read:
   Do you have any further questions?

3) Give **Informed Consent Form** to them to fill in:
   Would you like a copy?

4) Give **Becks Depression Inventory-II** (BDI-II)
   *This questionnaire asks about how you have been feeling **for the past two weeks, including today.***

5) Give **State trait anxiety inventory - trait** (STAI-T)
   *In contrast this one is **about how you generally feel***

6) Give **Spontaneous use of Imagery Scale** (SUIS)
   This questionnaire is about how you use imagery in your everyday life

7) Give **Eysenck personality questionnaire - neuroticism scale** (EPQ-N)

8) Give **Proneness to intrusive cognitions** (PICS) and **Blood Phobia**

9) Give **Traumatic experience questionnaire** (TEQ)

10) Tetris game play:

TETRIS GAME PLAY EXPLANATION

Ensure Tetris programme is loaded with sound turned OFF.
Explanation:
I'm now going to ask you to have a 3 minute practice of the computer game Tetris. Have you heard of this game or played it before?

(Even if yes, give the explanation. If no, then give the same explanation and ask if they require a demonstration of the game at the same time):
The game consists of 7 different shaped blocks which fall randomly one at a time from the top of the playing screen. The aim of the game is to move and rotate the blocks to make a complete horizontal line with no gaps that line will then disappear and give you points. The aim is to make as many of these lines disappear as possible before the playing screen is filled completely.

When you play this particular game I want you to concentrate, not just on the block that is falling, but also the block that is coming up next which will show in an icon on the top right of the playing screen
That way you can try and work out in your mind's eye where best to place all the blocks in order to make maximise your performance and make the most complete lines.
The blocks are moved using the 4 arrow keys. Left and right using the left and right cursor keys and rotated using the up cursor key. Each press of the up key rotates the block 90° clockwise. If you are confident that you have the block at the desired rotation and position, you can speed up its descent by pressing the down key.
Now before you try, do you have any questions?

Time 3 min while they play the games, Tetris

Give pre-film **VAS mood ratings**:
*Please fill in this short questionnaire about how you are feeling **right now**. Do not think about your answers too much, but give the first response that comes to mind.*

12. Film explanation:

FILM VIEWING
[Post-Tetris practice]
The computer and projector should be ready to play the film. Make sure sound is ON. Close the blinds and move the participant so they can see the projection area.
Explanation of film:
*You will now see a short film of about 12 minutes. Please sit and pay close attention. Watch the film and try not to look away or shut your eyes. **Imagine you are there, as a bystander at the scene**. Really try to immerse yourself in the film.*
I'm going to be just outside throughout the whole film so please ring the bell or open the door if you want to stop the film at any point. I will come in when the film ends. Do you have any questions?
Press start for the film and stopwatch.
Turn off the lights
Experimenter exits room and waits outside. Stay outside of the room for the duration of the film
After the film has finished
Experimenter enters room.
Turn on the lights and turn off film/projector
Give film manipulation measures: **VAS post-film mood, attention and distress due to the film**
Note for experimenter: Explanation of the film is important. Participants are told to imagine they are there, a bystander at the scene and to not look away. Work by Lazarus ('96) indicates that individuals will try to 'distance' themselves when confronted by a stressor (e.g. in this case the film) and this may impact on subsequent responses to the film. Participants should watch the film alone and in the dark so they are able to immerse themselves fully in the film.
REF: Lazarus, R. S (1993). Coping theory and research: past present and future. *Psychosomatic Medicine, 55*(3), 234-247/

13. Instructions for participants on how to keep the intrusion diary
DIARY EXPLANATION
[MAIN OUTCOME MEASURE FOR MEMORY OF THE FILM]

(Demonstrate in the diary as you go through the explanation and emphasise how important it is that they participate fully)

*It may be that over the next few days images or thoughts about the film you have just seen will **spontaneously** pop into your mind without you deliberately thinking about the film. This is called an intrusion. 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 in your mind's eye they can actually include any of the five senses, so you can imagine sounds too.*
*Mental images can be fuzzy or fragmented as well as clear; they can also be brief and very fleeting – like a quick flashback of the film. We are interested in knowing about **all** these types of images*

[Check participants understands by asking one or several of following & giving feedback]
Do you understand what I mean by mental images?
Have you had any at all since the film? Can you give me an example of a mental image you have had **[if not of the film then ask for one from another time].**
Please can you give example of a verbal thought?

So, if you have any intrusions of the film you have just watched over the next week, please record each one as soon as possible in this diary. Keep the diary in your bag or next to your bed and start filling it in from now. It's really important that you keep it as accurately as possible.

[Explanation on how to fill out the diary]
On page 3 and page 4 [of the diary], fill in one of the little boxes every single time you have an intrusion **[demonstrate what to do on the diary]**; ***I** for image, **T** for thought or **I/T** if it was both. So if you have 3 intrusions in the afternoon, then 3 of the little boxes should be filled. If you have had none during that time period then write zero or cross that section of the day out. Make sure that you have completed each of the three time periods (Morning, Afternoon and Evening/Night) as they occur. If you are unable to complete the diary at the time when you experience an intrusion please make sure you have completed each time period at least once a day.*

Next, fill in the details of each intrusion you have had on page 5, putting down the day and time, whether it was an image, thought or both. We then need to know the content of the intrusion. This can be brief but we need to be able to match any intrusions you have to the film so please be as clear as possible. For <u>every box you fill in after having an intrusion there should be a matching line in the back of the diary</u>.

If you are unsure of any of the details, please just make a note in the diary anyway and we will go over it with you later when you return. Day 1 is today, which is XXX **[Fill in <u>all</u> boxes with the day and date for the participant]**. *My details are also on the diary – if you have any questions please get in contact with me. This diary is vital for the study as we won't be able to get any results without it.*
Remember, if you don't have any intrusions; please still return it as we are interested in those results too. Do you understand how to use it? Do you have any questions?

So remember, mental images can be pictures in your mind but also sounds and sensations. Mental images maybe fuzzy, very brief or almost like a flash in your minds eye. Even if you have several intrusions that are the same please record each individual one in the diary every single time it occurs
Re-emphasise the importance of keeping the diary
That is the end of the first session.
Write time participants are due to return the next day write the appointment on the diary for a reminder – NB. Within 2 hours of current session time, check participant understands importance of this.
Don't forget, please bring this diary with you when I see you tomorrow

SESSION 2, DAY 2 [24 hours after film viewing]

Prior to participants return, obtain participants experimental condition allocation
Upon participants return to the laboratory:
Check diary entries and make photo copy
Give **number of hours sleep** rating
Note for experimenter: Look at the diary to see if there are any obvious problems (e.g. are participants understanding the difference between thought and image, is there a corresponding entry for every 'I' or 't' put in the table in the content section on page five etc. At this stage do not go over the actual content of each entry with the participant. Elaborating and describing images can have the effect of integrating them into a coherent memory, thereby improving health outcomes and reducing intrusion frequency (Pennebaker, 1993; Pennebaker & Segal, 1999; van der Kolk & Fisler, 1995). As flashbacks are the main outcome measure it would not be advisable to do this at this stage in the experiment.
This early look at the diary is to try to see if further elaboration is required over parts of the diary and how it is being used, it may be viewed as a 'run in' for the subsequent week. NB. Take a photocopy of the diary.
REFS: Pennebaker, J. W. (1993). Putting stress into words: health linguistic, and therapeutic implications. *Behavioral Research Therapy, 31*(6), 539-548.
Pennebaker, J. W., & Segal, J. D. (1999). Forming a story: The health benefits of narrative. *Journal of Clinical Psychology, 55*(10), 1243–1254
van der Kolk, B. A., & Fisler, R. (1995). Dissociation and the fragmentary nature of traumatic memories: Overview and exploratory study. *Journal of Traumatic Stress, 8*(4), 505-525

Assignment to experimental condition (Go to relevant section of the protocol)
No-task Control [Experiments 1 and 2]
Memory reactivation task + Tetris [Experiments 1 and 2]
Tetris only [Experiment 2 only]
Memory reactivation task only [Experiment 2 only]

NO-TASK CONTROL CONDITION
There is no memory reactivation task prior to the no-task control condition
Give participant the **music rating score sheet** and say:
Let me explain what is going to happen next. I'm now going play for you a selection of music clips which I would like you to listen to a rate how pleasant you find them. Please use the whole scale from 1 'extremely unpleasant' right the way through to 9 'extremely pleasant'. You should be able to tell when one section ends and the next begin quite easily. Any questions?

Start Music clips and stopwatch for 10 min (reduce the media playing screen so this does not distract the participant). The score sheet is just for the participants' benefit so they feel like they are undertaking a task. The ratings are not analysed.

1) After music rating has finished (10 min) say:

We are now going to have a short break, during which time I would like you to sit quietly and not talk or play with mobile phones. You are welcome to think about whatever you would like completely unrestricted. I will let you know when the break is finished.

2) Start timer (duration 12 min).

End of experimental condition

MEMORY REACTIVATION TASK + TETRIS CONDITION

Computer and projector to be set up and the reactivation task ready to go when you press the start space bar key.

Participant should be in the same laboratory with the same experimenter as 24 hours previously. As with the film viewing, whilst the participant is in the room close the blinds and get them to move so they are able to see the projector. The reactivation task is shown on the same display devise and conditions as the initial film viewing 24 hours earlier.

1) Say:

I am about to show you a selection of pictures from the film you watched yesterday. During this time I would like you to sit still and pay close attention. Try not to look away or shut your eyes. ***Imagine you are there, a bystander at the scene****. Really try to immerse yourself in the film.*

2) Turn off lights

3) Play the reactivation task

4) Turn lights back on when images have been shown

5) Give participant the **music rating score sheet** and say:

Let me explain what is going to happen next. I'm now going play for you a selection of music clips which I would like you to listen to a rate how pleasant you find them. Please use the whole scale from 1 'extremely unpleasant' right the way through to 9 'extremely pleasant'. You should be able to tell when one section ends and the next begin quite easily. Any questions?

Start Music clips and stopwatch for 10 min (reduce the media playing screen so this does not distract the participant). The score sheet is just for the participants' benefit so they feel like they are undertaking a task. The ratings are not analysed.

6) Tetris instructions:

You are now going to play the Tetris game that you practiced yesterday. Are there any parts of the game about which you would like to be reminded? Do not forget to try and manipulate the blocks to form the most complete lines, playing close attention to the blocks that are coming up displayed at the top right hand part of the playing screen, and how they might be rotated and moved to fit best [at this point emphasise that it is not important what score they get, but to enjoy themselves and keep trying all the way through]

Start timer (duration of Tetris: 12 min). Record scores of each game completed – include: time, points, level.

End of experimental condition

TETRIS ONLY CONDITION

Participants do not have the 10 min break in the event that if memory were to be reactivated due to situational context alone. This hopes to minimise the occurrence of retrieval induced plasticity, [thought to take approx. 10 min to become optimally developed] for this particular condition

1) Say:

You are now going to play the Tetris game that you practiced yesterday. Are there any parts of the game about which you would like to be reminded? Do not forget to try and manipulate the blocks to form the most complete lines, and pay attention to the blocks coming up displayed at the top right hand part of the playing screen, and how they might be rotated and moved to fit best [at this point emphasise that it is not important what score they get, but to enjoy themselves and keep trying all the way through]

2) Start timer (duration of Tetris: 12 min). Record scores of each game completed – include: time, points, level.

End of experimental condition

MEMORY REACTIVATION TASK ONLY CONDITION

Make sure computer and projector are set up and working. Open up reactivation task PowerPoint so it is ready to go when you press the start space bar key.

Make sure participant is the same laboratory with the same experimenter. Similarly participant should be sitting in same seat, with lights off and task is being shown on the same display devise as the initial film viewing 24 hours earlier when the task is undertaken.

1) Say:

I am about to show you a selection of pictures from the film you watched yesterday. During this time I would like you to sit still and pay close attention. Try not to look away or shut your eyes. ***Imagine you are there, a bystander at the scene****. Really try to immerse yourself in the film.*

2) Turn off lights
3) Play the reactivation task
4) Turn lights back on when images have been shown
5) Give participant the **music rating score sheet** and say

Let me explain what is going to happen next. I'm now going play for you a selection of music clips which I would like you to listen to a rate how pleasant you find them. Please use the whole scale from 1 'extremely unpleasant' right the way through to 9 'extremely pleasant'. You should be able to tell when one section ends and the next begin quite easily. Do you have any questions?

Start Music clips and stopwatch for 10 min (reduce the media playing screen so this does not distract the participant)

End of experimental condition

POST- ASSIGNMENT TO EXPERIMENTAL CONDITION

Give experimental task **manipulation ratings**
[Ensure that you give the correct version from the participant pack, e.g. ratings for game enjoyment/difficultly for those who play Tetris]

Give back the **intrusion diary for the remaining 7-days**
[Ensure it has been photocopied first so there is a separate reference to the first 24 hours' worth of flashbacks]
Reminder instructions for the intrusion diary.

[Remember: demonstrate in the diary as you go through; get them to actively say if they have no intrusions; emphasise how important it is that they participate fully]

Say:

After yesterday's first session I got you to fill in a diary of any intrusions you had of the film up until this session. How did you find doing that, did you have any problems?
[If they did try to address these for the participants so they are able to continue to fill out the diary accurately. Don't engage them in intrusion content]
I would like you to do a similar exercise over the upcoming week.
As I explained yesterday, it may be that over the next few days images or thoughts about the film you have just seen will pop into your mind. These intrusions that go through our minds can either take the form of words and phrases ("verbal thoughts"), or it can be like mental images.
So, if you have any intrusions of the film you have just watched over the next week, please record each one as soon as possible in the remaining boxes of the diary. So on page 3 and page 4, please fill in one of the little boxes every single time you have an intrusion. ***I*** *for image,* ***T*** *for thought or* ***IT*** *if it was both. One of the little boxes should be filled in every single time you have an intrusion as you did in the 1-day diary yesterday.*
Then on page 5 I would like you to fill in the details of each intrusion you have had by putting down the day and time [e.g. morning, evening etc], whether it was an image, thought or both. I also want you to note down the content of the intrusion in brief so we can match it to the film and how much distress you felt after experiencing each intrusion from 0 'none at all' to 10 'extremely'.
If you should happen run out of space feel free to use additional paper to note down your intrusions.
Today is, XXX [Fill in all boxes with the day and date for the participant] *so you will finish in 7 days' time on XXX. Please try to remember that this diary is vital for the study as we won't be able to get any results without it.*

- Fill in time and date on Diary for when to return with it
Note date the follow up in order for you to be able to contact them in 6 days with a reminder about coming in with their diary.
Show participant out.

SESSION 3, DAY 8

[8 days post-film, 7 days post assignment to experimental condition]

DIARY INSTRUCTIONS – RETURN OF THE DIARY

Note for Experimenter:
When a participant returns with their diary, you must go though it straight away. Do not leave it until the participant has gone, this way you can check the details in person while the information is still fresh in their minds.

Check diary is completed correctly. Complete any missing information, with the participants help if necessary, e.g. check there is a description for every single box checked with an intrusion on page 3 and 4 of the diary. If not then ask the participant if they can remember and describe the intrusion that went with the checked box, or mark if not.

Read all the intrusion descriptions in the diary. If they are unclear or you don't recognise them ask for more details until you can identify it with the film sequence. If the intrusion is not from the film it cannot be included. Do not ask leading questions.

Only score/ analyse Image based intrusions (labelled I or IT in the diary) not thoughts only (T) since in these are the analogues for PTSD flashbacks.

Upon participants' return to the laboratory

RECOGNITION MEMORY MEASURES [FOR THE FILM]

Written recognition memory test [to be administered first]
Say:
I am now going give you some written statements depicting events that may be from the film you watched last week and I would like state whether you remember these to be true or false

Visual Recognition memory
Say:
I am now going to show you some other pictures from the film you watched last week. Using the sheet provided please circle either YES for 'I do recognise the picture as being from the film I watched last week' or NO' I do not recognise the picture from being from the film I watched last week'.
The pictures will automatically move on from one another every 5 seconds. Do you have any questions?

Give **Demand and Diary Accuracy** VAS ratings

CONVERGENT FLASHBACK MEMORY MEASURES

Give **IES-R**
Say:
*Please indicate how you felt over the past 7 days about the film (**Emphasise it is about their feelings of the film, not in general**)*

Give **IPT**
Open PowerPoint **Intrusion Provocation Task (IPT)** and put to slide show
Opening instructions will be on screen.

Say:
I am about to show you a selection of pictures from the film you watched last week, please sit still and pay close attention to the pictures. There will then be a short break where I want you to close your eyes. You can think about anything, with no restrictions.
*If images of the film happen to spontaneously pop into your mind during this period I'd like you to press a key [*number 1*] on the key pad, I will show the images first then the break will begin. Do you have any questions?*

A click on the first slide begins the slide show (pictures will come automatically after this, the first slide has instructions and prompts the participant to press a key when they're ready)

Make sure participants understand the instructions at the end of PPT)
Close/reduce the power point.
Switch to Word file, named [participant condition then number]
Say:
Please rest your fingers on the keyboard pad. Remember, press the 1 key for every spontaneous image you have of the film. Now please close your eyes.

Start timer (2 min)—use square keypad on the right hand side of keyboard.

At end of 2 min get participants to stop and save file

Debrief participant and check they have no concerns and have had any questions answered to their satisfaction
Ask the participant to sign **end of the experiment form** and **payment form**
Thank participants for taking part.
Show participant out.

Appendix 4.1. University of Oxford Central University Research Ethic Committee Approval Letter [for Pilot Work, Experiment 1 and Experiment 2]

University of Oxford

Medical Sciences Office
John Radcliffe Hospital, Headington, Oxford OX3 9DU

From Carol Green

CONFIDENTIAL
Ms Ella James
c/o Dr Emily Holmes
Department of Psychiatry
Warneford Hospital

Ref.
MSD/IDREC/C1/2010/104

20 October 2010

CUREC checklist

I am writing to acknowledge receipt of your CUREC/1 form for your project: The Effect of the Cognitive Task Tetris on the Development of Intrusive Imagery 24 Hours after Viewing a Stressful Film.

On the basis of the information you have provided this has now been approved by the Medical Sciences IDREC **subject to:**

(a) receipt of a hard copy of your application signed by your head of department (Please note that should this not appear or the head of department is unwilling to sign then this approval would not be valid);

(b) your following the methods previously used by Dr Holmes using a stressful film.

The reference number for this project is MSD/IDREC/C1/2010/104 and may I remind you that your project may be reviewed at some stage during an annual audit of projects.

Amendments

Should you at some stage alter some of the techniques or procedures then you should first undertake a checklist (CUREC/1) to see whether these changes alter the ethics of the research. If these remain the same then the committee will require notification of the changes to lodge with the project. If they do not remain the same then you may need to complete a CUREC/2 form and undergo further scrutiny by the committee.

Please do not hesitate to contact me if you have any queries about this.

Yours sincerely,

Carol Green (Miss)
Secretary to the
MSD IDREC

E-Mail: ethics@medsci.ox.ac.uk

UNIVERSITY OF OXFORD
DEPARTMENT OF PSYCHIATRY

WARNEFORD
HOSPITAL
OXFORD
OX3 7JX

Effect of Tasks Performed 24 Hours after a Film

Information for Participants

Study Ethics Committee Number: MSD/IDREC/C1/2010/104
Study Principal Investigator: Dr. Emily Holmes
Study Researcher: Ella James

Invitation

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Thank you for reading this.

What is the purpose of the study?

The purpose of the study is to examine the effect of computer tasks on consolidation of emotional memory. This has implications for therapy approaches and aiding people after distressing events.

Who is eligible to take part?

Any person aged between 18 and 65 with no history of mental illness.
You are **NOT** eligible to take part if:

- You have received treatment for a mental health problem, including medication, psychological therapy or counselling.
- You are planning to undertake a university examination in the next week.
- You have participated in a similar study.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you would be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

What would happen to me if I take part?

The experiment will take place in three sessions, all of which will last approximately 30 minutes and take place at the Department of Psychiatry. The first two sessions are spaced 24 hours apart. In the first session, you will be asked to fill in some short psychological questionnaires including questions regarding your mood. You will then watch a film. This is a short film of about 12 minutes, containing footage of scenes of trauma and injury which may be distressing. You will then be asked to keep a simple diary for the next 24 hours of any spontaneous intrusions/memories of the film that you watched. This will complete the first session. You will then be required to return after a period of 24 hours. When you return for the second session, you will fill in some short questionnaires and return your 1-day diary. You may be asked to do some additional simple tasks. These are not a risk to your health or onerous. They will take no more than 15 minutes of your time and are straightforward. For the following week after session two you will be required to keep another simple diary of any spontaneous intrusions/memories concerning the film that you watched. At the end of 7 days you will need to return to the Department of Psychiatry with your diary and complete some follow-up questionnaires about your mood and memory for the film.

We will then debrief you and give you more information about the purpose of study. You will then be paid. All your responses will be kept confidential.
You will receive £30.00 for participating in this study.
Please note that:

- You can decide to stop the study at any time.
- You need not answer questions that you do not wish to.
- Your name will be removed from the information gathered in the study and it will not be possible to identify anyone from our reports on the study.

What are the possible risks and benefits of taking part?

The experiment involves watching a short film which may be distressing to you. You are free to terminate viewing at any point should you wish to, without being required to give an explanation. It is possible that you will think spontaneously about the film after watching it, and may be distressed by that. This could take the form of intrusive images, thoughts or moods although previous research involving similar films have found no long-standing emotional effects. However, this does not mean there is zero risk to you.

What if something goes wrong?

If you have a concern or complaint about any aspect of the way you have been treated during the course of this study, you may contact the principal investigator of the project: Dr Emily Holmes, University Department of Psychiatry, Warneford Hospital, Oxford, OX3 7JX. In addition, the University procedure for reporting misconduct will also be open to you. Allegations of misconduct can be reported to:
The Registrar, University Offices, Wellington Square, Oxford. OX1 2JD.

Would my taking part in this study be kept confidential?

All information that is collected about you during the course of the research would be kept strictly confidential and would be accessible only to the research team. Any information about you will be assigned a number, and will not have your name on it. We are obliged to keep all research data for a period of 10 years. After this time it will be destroyed. The only circumstances in which confidentiality would be breached would be in the rare situation in which it was judged that you or someone else was at risk of serious harm or if a court applied for the information. In these circumstances we would endeavour to discuss the matter with you and would disclose only information of immediate relevance.

What will happen to the results of the research?

Any research publication would not identify you individually. If you wish to obtain a copy of the published results, please inform the researcher. We would be delighted to send them to you when they are available.

Who has reviewed the study?

This study has received ethical approval from the University of Oxford Central University Research Ethics Committee (approval number: MSD/IDREC/C1/2010/104)

Contact for further information.

If you have any further questions about this research, please contact Ella James on 01865 223950, or email ella.james@psych.ox.ac.uk. If you would like to discuss anything related to the experiment or your reactions to it, please do not hesitate to contact the responsible investigator, Dr. Emily Holmes, at any point in the week after viewing the film or beyond. Dr. Emily Holmes can be contacted at University Department of Psychiatry, Warneford Hospital, Oxford, OX3 7JX, tel: 01865 223912 or emailed emily.holmes@psych.ox.ac.uk.

Thank you for taking the time to read this information sheet and considering whether to take part in this research. You will be given a copy of this Information Sheet and a signed consent form to keep if you do take part.

UNIVERSITY OF OXFORD
DEPARTMENT OF PSYCHIATRY

WARNEFORD HOSPITAL
OXFORD
OX3 7JX

TEL: (01865) 223950

CONSENT TO RESEARCH FORM

Title of project: 'Effect of Tasks Performed 24 Hours after a Film'

Name of Responsible Investigator: Dr Emily Holmes
Study Researcher: Ella James

Psychiatric Research Ethics Committee Application Number: MSD/IDREC/C1/2010/104

[Please circle your answer]

Have you read the Information Sheet? Yes / No

Have you had an opportunity to ask questions and discuss this study? Yes / No

Have you received satisfactory answers to all your questions? Yes / No

Have you received enough information about the study? Yes / No

Who has explained the study to you? Dr/Mr/Mrs/Ms/Miss _____

Do you understand you are free to leave the study:

- **at any time**
- **without having to give a reason for leaving** Yes / No

Are you aware that all information will be kept strictly confidential except in the rare circumstances in which it is judged that you or someone else is at risk of serious harm or when a court applies for the information?

Yes / No

Do you agree to take part in this study? Yes / No

Signature of Participant_____
Date_____
[NAME IN BLOCK LETTERS]_____
Signature of Researcher_____
Date_____
[NAME IN BLOCK LETTERS]_____

UNIVERSITY OF OXFORD
DEPARTMENT OF PSYCHIATRY

WARNEFORD
HOSPITAL
OXFORD
OX3 7JX
TEL: (01865) 223950

Effect of Tasks Performed 24 Hours after a Film
Debriefing Information

Study Ethics Committee Number: MSD/IDREC/C1/2010/104
Study Principal Investigator: Dr Emily Holmes
Study Researcher: Ella James

What is the purpose of the study?

Previous research has shown that doing tasks after viewing potentially distressing film footage can moderate the number of image memories of the film that pop into mind in the following week. With certain tasks (such as playing a game of Tetris) there can be fewer intrusions and with other tasks the number may increase. Each participant was in either a visuospatial condition (Tetris), or a control (no-task) condition. The number of intrusions reported will be compared across the conditions - the results having implications for theories of the encoding and memory storage of emotional events and possible future therapeutic value. Please do not give this information to anyone else as it may influence the results of the study.

What if I have any further questions about the study?

If you have any further questions about this research please contact Ella James, Department of Psychiatry, Warneford Hospital or email ella.james@psych.ox.ac.uk. If you would like to discuss anything related to the experiment, your reactions to it, or if you are experiencing any distress please do not hesitate to contact the principle investigator, Dr Emily Holmes, at any point in the week after viewing the film or beyond. Dr Emily Holmes can be contacted at University Department of Psychiatry, Warneford Hospital, Oxford, OX3 7JX, tel: 01865 223912 or emailed at emily.holmes@psych.ox.ac.uk. Please also see the information sheet that you received at the beginning of the study.

The following contact information is for an anonymous form of support should you feel you require it www.samaritan.org/ or telephone the Samaritans on 08457 909090

What will happen to the results of the research?

Any research publication would not identify you individually. If you wish to obtain a copy of the published results, please inform the researcher. We would be delighted to send them to you when they are available.

Who has reviewed the study?

This study has received ethical approval from the University of Oxford Central University Research Ethics Committee (approval number: MSD/IDREC/C1/2010/104)

Thank you for your participation!

Appendix 4.5. Descriptions of the 11 Film Clips from the Trauma Film

Title	Content
Clip 1 Car crash footage 30 for a Reason	A young girl is shown lying on the ground with blood dripping out of her ear. The voice-over explains that this is a result of being hit by car.
Clip 2 Self-harm footage The Big Shave	An individual is shown cutting themselves with a razor.
Clip 3 Car crash footage Never, Ever Drink and Drive	A drunken driver is shown losing control of his vehicle, crashing through a fence and killing a child.
Clip 4 Medical footage Eye surgery	Clip of eye surgery in close-up, graphic detail.
Clip 5 Car crash footage No Seatbelt, No Excuse	Shows a group of friends travelling in car. A multi-vehicle accident results in the death of three friends and serious injury to a fourth individual.
Clip 6 Genocide documentary footage Ghosts of Rwanda	The opening shots of a documentary on the genocide in Rwanda featuring graphic images.
Clip 7 Public Information footage Drink and Drowning	Shows a group of friends chatting on the beach, interspersed with scenes of one of the men drowning after consuming alcohol.
Clip 8 Car crash footage The Faster the Speed	Shows a driver speeding, losing control of the vehicle and hitting a young couple pinning them against a wall.
Clip 9 Medical footage Orthopaedic surgery	Video and voiceover of orthopaedic surgery featuring graphic, close-up images of flesh and bone.
Clip 10 Car crash footage Texting and Road Cross	Shows a teenage boy and girl flirting with each other. As he sends a text to her he steps into the road and is hit by a van.
Clip 11 Attack footage Elephant Rampage	Shows an elephant attacking men in a circus and rampaging in the street.

Appendix 4.6. Still Images from the Memory Reactivation Task (1/2)

Appendix 4.6. Still Images from the Memory Reactivation Task (2/2)

Appendix 4.7. Adapted Version of the Traumatic Experiences Questionnaire (TEQ)

Traumatic Experiences Questionnaire Participant No: _____

Many people have lived through or witnessed a very stressful and traumatic event at some point in their lives. Below is a sequence of descriptions of traumatic events. When you read an event that has happened to you, or you have witnessed, please circle yes. Otherwise, please circle No.

Have you experienced or witnessed:

1. **A serious accident, fire, or explosion?** *(E.g. an industrial, farm, car, plane or boating accident.)* Yes / No
2. **A Natural disaster?** *(E.g. a tornado, flood or major earthquake)* Yes / No
3. **A Non-sexual assault by a family member or someone you know?** *(E.g. Being mugged, physically attacked, shot, stabbed or held at gunpoint)* Yes / No
4. **A Non-sexual assault by a stranger?** *(E.g. Being mugged, physically attacked, shot, stabbed or held at gunpoint)* Yes / No
5. **A sexual assault by a family member or someone you know?** *(E.g. rape or attempted rape)* Yes / No
6. **Sexual assault by a stranger?** *(E.g. rape or attempted rape)* Yes / No
7. **Military combat or a war zone?** Yes / No
8. **Sexual contact when you were younger than 18 with someone who was 5 or more years older than you?** *(E.g. Contact with genitals, breasts)* Yes / No
9. **Imprisonment?** *(E.g. Prison inmate, prisoner of war, hostage)* Yes / No
10. **Torture?** Yes / No
11. **Life-threatening illness?** Yes / No
12. **Any other traumatic event?** Yes / No
    Please specify:

If you responded "Yes" to any of the above, then please answer the following questions. If you responded "Yes" to more than one then please answer the following questions in relation to the event that has upset you the most:

How long ago did the traumatic event happen? (Please circle one)

1) Less than 1 month
2) 1 to 3 months
3) 3 to 6 months
4) 6 months to 3 years
5) 3 to 5 years
6) More than 5 years

Were you physically injured?	Yes	No
Was someone else physically injured?	Yes	No
Did you think that your life was in danger?	Yes	No
Did you think that someone else's life was in danger?	Yes	No
Did you feel helpless?	Yes	No
Did you feel terrified?	Yes	No

Appendix 4.8. Examples of Flashbacks Reported in the Intrusion Diary by Participants [Verbatim] for each of the Film Clips: Experiment 1

Film Clip	**Intrusion Diary Flashback Entry**
Clip 1 30 for a Reason	• *Little girl lying in the road.* • *Saw a little girl being dragged back across the road.*
Clip 2 The Big Shave	• *Image of a man shaving off his skin.* • *Image of a man shaving cutting himself, blood pouring from his face and neck.*
Clip 3 Never, Ever Drink & Drive	• *Dad cradling his son after the car crashed into their garden.* • *I saw a car swerving out of control and flipping over a fence.*
Clip 4 Eye surgery	• *Saw close up of an eyeball.* • *Saw eye surgery and instruments poking an eye.*
Clip 5 No Seatbelt, No Excuse	• *Saw a crash between 3 cars.* • *I saw a car crash and they hadn't been wearing seatbelts*
Clip 6 Ghosts of Rwanda	• *Scenes of massacred men, women and children in Africa.* • *Saw people in the street being slaughtered by the government*
Clip 7 Drink and Drowning	• *Person drowning.* • *I saw a man struggling to stay above the surface of the sea.*
Clip 8 The Faster the Speed	• *Saw a young couple being crushed by a car in an accident.* • *Image of a girl being crushed by her boyfriend after a car crash.*
Clip 9 Orthopaedic surgery	• *Saw the surgeon cleaning a bone in an operation.* • *I heard the surgeons voice and saw him cutting*
Clip 10 Texting and Road Cross	• *Saw a young boy being hit by a van as he stepped out onto the road.* • *I saw a man crossing the road while messaging*
Clip 11 Elephant Rampage	• *Saw elephant escaping from the circus and trampling over people.* • *Saw an out of control elephant.*

Appendix 4.9. The Intrusion Diary used by Participants to Record flashbacks (1/2)

Thank you for completing the diary. Your participation is very much appreciated. Don't forget to return the completed diary on the dates below, then you will then be given payment and information about the purpose of the study.

Thank you!!!

Follow up Session Appointment Card

Session1 start date:
Date_____ Time_____
Session2 return (24hs later):
Date_____ Time_____
Session3 completion:
Date_____ Time_____

If you have any questions or problems, please do not hesitate to contact me at ella.james@psych.ox.ac.uk
Tel: 01865 223950
If you would like to discuss anything related to the experiment or your reactions to it, please do not hesitate to contact the responsible Investigator, Dr. Emily Holmes, at any point in the week after the film or beyond. Dr Emily Holmes can be contacted at the University Dept of Psychiatry, Warneford Hospital, Oxford, OX3 7JX, tel: 01865 223912 or emailed at emily.holmes@psych.ox.ac.uk.

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PARTICIPANT DIARY

Participant No:

Date started (S1):

Return (S2):

Date completed (S3):

p1

Introduction

- If over the next week you experience any **intrusions about the film you have just watched**, I would be very grateful if you could note them down in the diary.
- What goes through our minds can either take the form of words and phrases ("verbal thoughts"), or it can be like mental pictures ("images") in your minds eye. Although mental 'images' often take the form of pictures they can actually include any of the five senses, so you can imagine sounds too. Please note down all intrusions in this diary.
- For each intrusion, mark 'I' (mental image), 'T' (though) or 'IT' (image and thought) on pages 3 and 4 for the corresponding time of day, or **write down that you have had Zero** in that time frame. Then for every single intrusion you have had fill in the details of the content on pages 5, 6 and 7. **Please write an entry for each intrusion even if you have several the same or intrusions that occur one after the other.**
- If you are, on occasion, unable to record details as they happen, please make sure you record that an intrusion has occurred
- Remember, **intrusions for the film can be very short/fleeting and fragmented**. We still would like to know about them in the diary!

PLEASE KEEP THIS DIARY – IT IS VITAL FOR THE EXPERIMENT.
THANK YOU!!!!

p2

						Date / Day of intrusion
						Was it an Image (I), Thought (T) or both (IT)?
						What was the content of the intrusion? (e.g. subject matter)
						What, if anything, triggered the intrusion?

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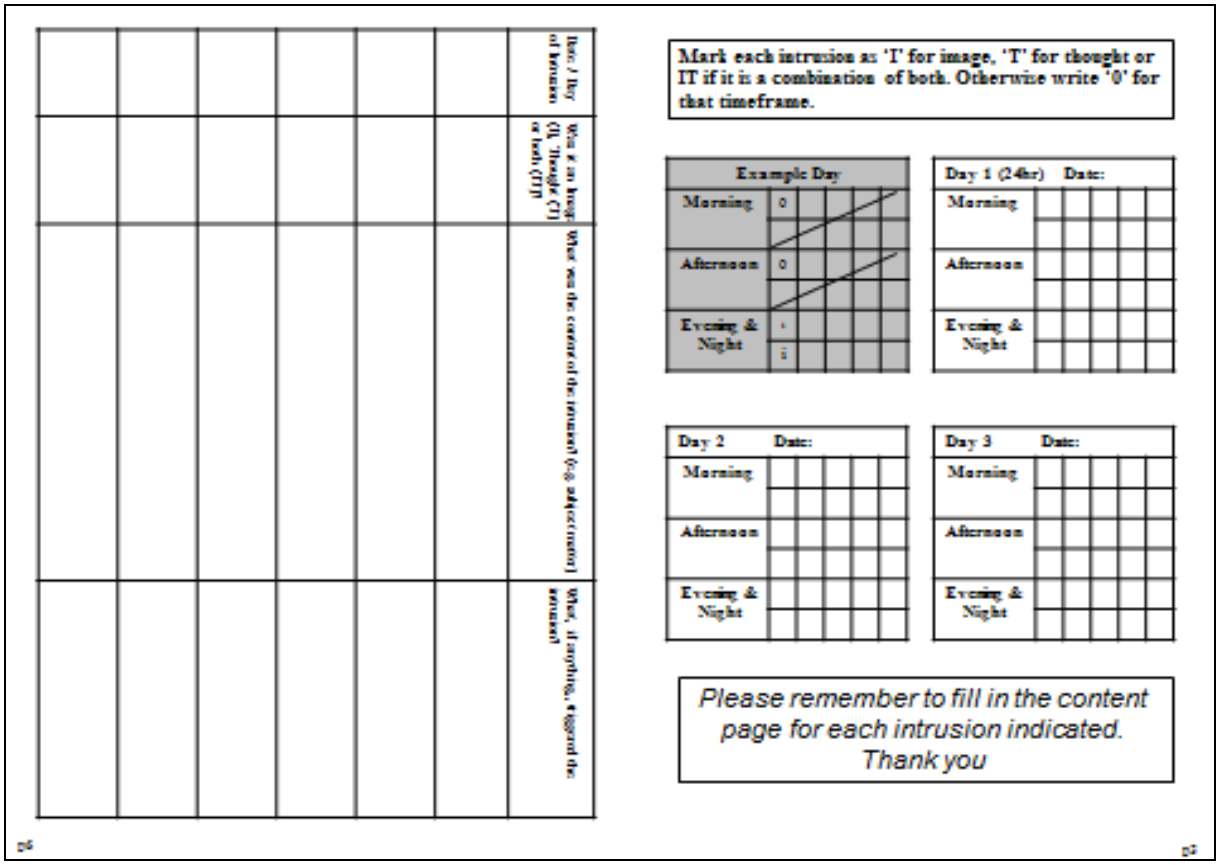
Appendix 4.9. The Intrusion Diary used by Participants to Record flashbacks (2/2)



Date / Day of intrusion	Was it an image (I), Thought (T) or both (IT)	What was the content of the intrusion? (e.g. subject matter)	What, if anything, triggered the intrusion?

Mark each intrusion as 'I' for image, 'T' for thought or IT if it is a combination of both. Otherwise write '0' for that timeframe.

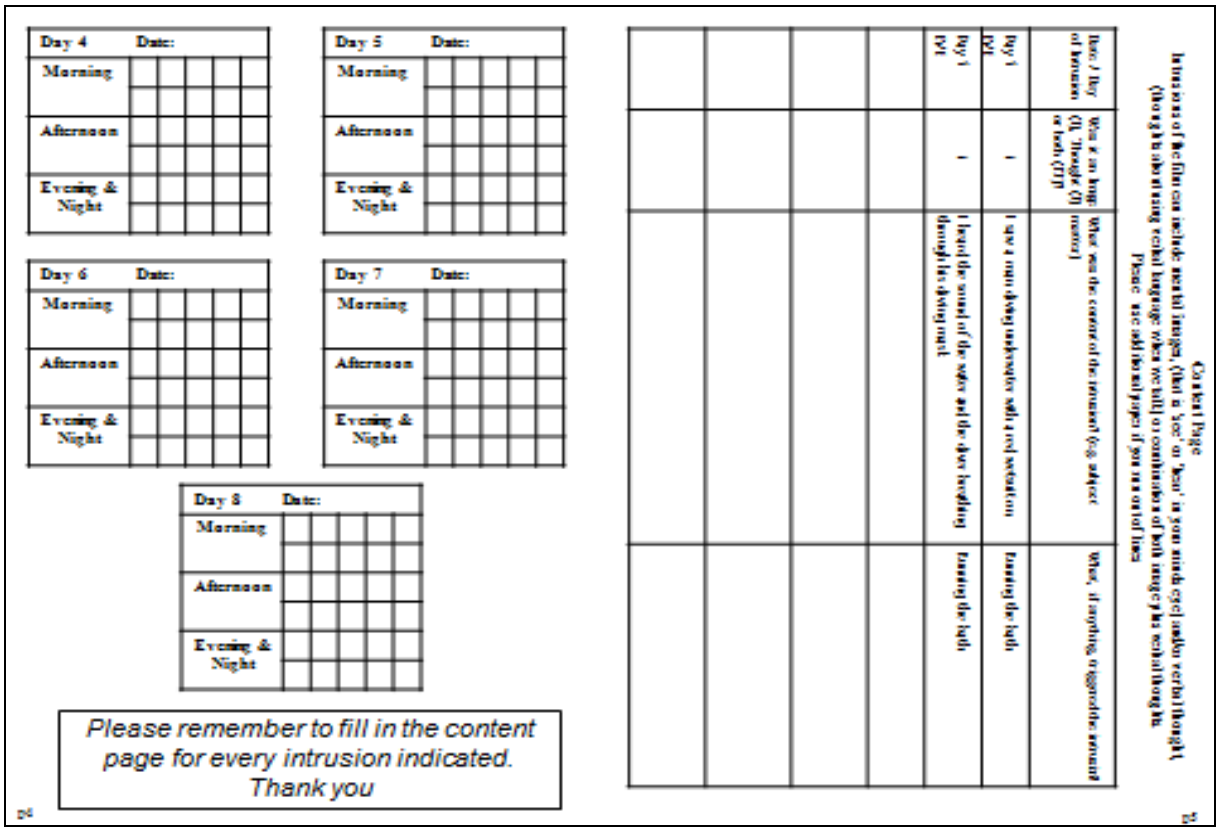
Example Day	
Morning	0
Afternoon	0
Evening & Night	1 1

Day 1 (24hr) Date:	
Morning	
Afternoon	
Evening & Night	

Day 2 Date:	
Morning	
Afternoon	
Evening & Night	

Day 3 Date:	
Morning	
Afternoon	
Evening & Night	

Please remember to fill in the content page for each intrusion indicated. Thank you



Day 4 Date:	
Morning	
Afternoon	
Evening & Night	

Day 5 Date:	
Morning	
Afternoon	
Evening & Night	

Day 6 Date:	
Morning	
Afternoon	
Evening & Night	

Day 7 Date:	
Morning	
Afternoon	
Evening & Night	

Day 8 Date:	
Morning	
Afternoon	
Evening & Night	

Please remember to fill in the content page for every intrusion indicated. Thank you

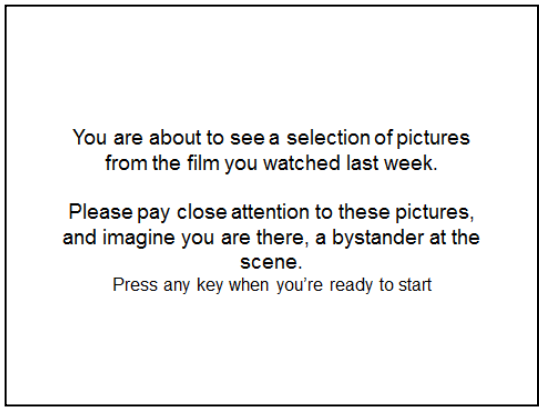
Content Page

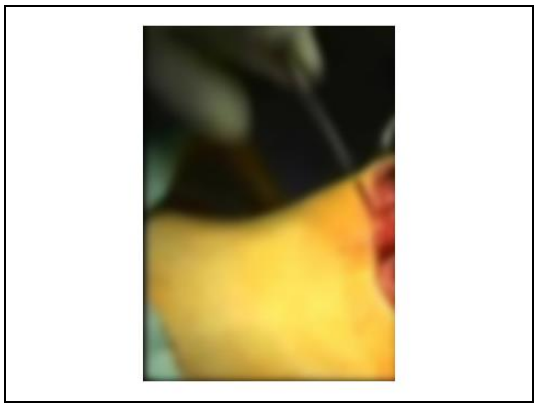
Intrusions of the film can include mental images, (that is 'pics' or 'films' in your mind's eye) and/or verbal thoughts (thoughts about using verbal language when we talk) or combination of both images plus verbal thoughts.

Please use additional pages if you run out of lines

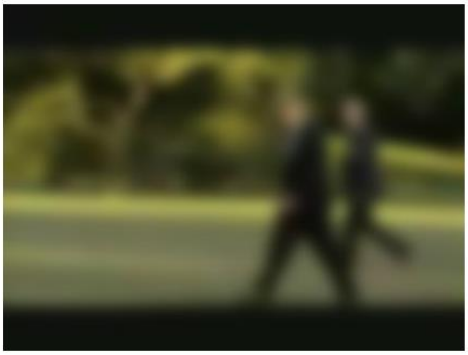
Date / Day of intrusion	Was it an image (I), Thought (T) or both (IT)	What was the content of the intrusion (e.g. subject matter)	What, if anything, triggered the intrusion?
Day 1 PM	I	I saw a man drinking underwater with a red substance	Running the bath
Day 1 PM	I	I heard the sound of the water and the door bangling through his drinking night	Running the bath

Appendix 4.10. Still Images from the Intrusion Provocation Task – IPT (1/2)





Appendix 4.10. Still Images from the Intrusion Provocation Task – IPT (2/2)



Appendix 4.11. The Adapted Version of the Impact of Event Scale-Revised (based upon Holmes et al', 2009)

IMPACT OF EVENT SCALE-REVISED

Instructions: The following is a list of difficulties people sometimes have after stressful life events. Please read each item, and then indicate how distressing each difficulty has been for you during the past 7 days **with respect to the film** you watched last week.

		Not at all	A little bit	Moderately	Quite a bit	Extremely
1	Any reminder brought back feelings about the film	0	1	2	3	4
2	I had trouble staying asleep.	0	1	2	3	4
3	Other things kept making me think about the film	0	1	2	3	4
4	I felt irritable and angry.	0	1	2	3	4
5	I avoided letting myself get upset when I thought about the film or was reminded of the film.	0	1	2	3	4
6	I thought about the film when I didn't mean to.	0	1	2	3	4
7	I felt as if it hadn't happened or wasn't real.	0	1	2	3	4
8	I stayed away from reminders about the film	0	1	2	3	4
9	Pictures about it popped into my mind.	0	1	2	3	4
10	I was jumpy and easily startled.	0	1	2	3	4
11	I tried not to think about the film	0	1	2	3	4
12	I was aware that I still had a lot of feelings about the film, but I didn't deal with them.	0	1	2	3	4
13	My feelings about the film were kind of numb.	0	1	2	3	4
14	I found myself acting or feeling like I was back at that time.	0	1	2	3	4
15	I had trouble falling asleep.	0	1	2	3	4
16	I had waves of strong feelings about the film	0	1	2	3	4
17	I tried to remove the film from my memory.	0	1	2	3	4
18	I had trouble concentrating.	0	1	2	3	4
19	Reminders of the film caused me to have physical reactions, such as sweating, trouble breathing, nausea, or a pounding heart.	0	1	2	3	4
20	I had dreams about the film.	0	1	2	3	4
21	I felt watchful and on guard.	0	1	2	3	4
22	I tried not to talk about the film	0	1	2	3	4

Appendix 4.12. The Verbal Recognition Memory Test for the Trauma Film (1/2)

Recognition memory test

Please tick either ' true' or 'false' for each question as to whether or not you remember it happening in the film you watched last week

Film Clip/Scene	Question	True	False
1. 30 for a reason	i. The little girl has blood coming from one of her nostrils		
	ii. The bones in the girl's legs are seen to fall back into place		
	iii. The girl leans against a tree		
	iv. The girls wears a green vest jacket		
2. The Big Shave	i, The music at the beginning has a female singer		
	ii. Blood drips onto the man's shoes		
	iii. The man shaving has blonde hair		
3. Never ever drink and drive	i. The little girl plays on the swings		
	ii. The little boy shoots at the goal with his father as goalkeeper		
	iii. The boy runs through a sprinkler in the garden		
4. Eye surgery	i. Four small circles are made on the surface of the eye		
	ii. The colour of the eye being operated on is blue		
	iii. The eye is not closed at any point in the scene		
5. No seatbelt, no excuse	i. There were no survivors from the crash		
	ii. Only one of the four was not wearing a seatbelt		
	iii. Three cars were involved in the crash		
6. Rwanda	i. A white man hands an injured child down to an African		
	ii. A man in a yellow T-shirt walks along swinging a ratchet (axe)		

XXX

Continued on other side of page

Appendix 4.12. The Verbal Recognition Memory Test for the Trauma Film (2/2)

	iii. A white doctor dresses a leg wound of an African child		
Film Clip/Scene	**Question**	**True**	**False**
7. Drink and Drowning	i. a man swims out to retrieve a an inflatable lilo		
	ii. The man is wearing a red t-shirt		
	iii. It is daytime in the scene		
8. Faster the speed	i. There is a person riding a horse behind the girl sitting on the wall		
	ii. An old man wearing a hat looks toward the accident in shock		
	iii. A woman runs over and pushes a child in a pushchair away from the accident		
9. Surgery	i. There are two surgeons, each using scalpels		
	ii. The doctor describing the surgery is male		
10. Texting and road crossing	i. A boy is sending a text message saying, “How r u?” when he is hit by a van		
	ii. A girl with straight black hair cries as a coffin is carried past at a funeral		
	iii. Both the boy and the girl are wearing ties		
11. Loose elephant	i. The elephant stands on the bonnet of a car		
	ii. The elephant moves from a circus tent into the street		

Appendix 4.13. Experiment 1: SPSS Output for Baseline and Main Outcome Variables

```
GET: SAVE OUTFILE='C:\Users\ellaj\Desktop\EX1_Final Stats Check\Expt1_final.sav'
  /COMPRESSED.
T-TEST GROUPS=Condition(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=Age BDI STAI_T EPQ_N TEQ SUIS PIC
  /CRITERIA=CI(.95).
```

T-Test. EXPERIMENT 1: BASELINE MEASURES

[DataSet1] C:\Users\ellaj\Desktop\EX1_Final Stats Check\Expt1_final.sav

Group Statistics

	Condition	N	Mean	Std. Deviation	Std. Error Mean
Age (Years)	Control	26	24.8462	5.06511	.99335
	Tetris	26	24.0769	6.97953	1.36880
BDI-II	Control	26	4.5000	4.67547	.91693
	Tetris	26	3.2308	2.92995	.57461
STAI-T	Control	26	35.0769	7.77649	1.52510
	Tetris	26	33.5769	6.92343	1.35780
EPQ-N	Control	26	3.2308	2.86088	.56106
	Tetris	26	2.5769	2.48472	.48729
TEQ	Control	26	.9231	.68836	.13500
	Tetris	26	1.0769	1.57285	.30846
SUIS	Control	26	39.2308	6.88365	1.34999
	Tetris	26	40.1923	8.24630	1.61723
PICS	Control	26	3.9462	2.48825	.48799
	Tetris	26	3.6769	2.55238	.50056

Appendix 4.13. Experiment 1: SPSS Output for Baseline and Main Outcome Variables

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Age (Years)	Equal variances assumed	.406	.527	.455	50	.651	.76923	1.69126	-2.62776	4.16622
	Equal variances not assumed			.455	45.615	.651	.76923	1.69126	-2.63587	4.17433
BDI-II	Equal variances assumed	6.989	.011	1.173	50	.246	1.26923	1.08210	-.90424	3.44270
	Equal variances not assumed			1.173	42.012	.247	1.26923	1.08210	-.91452	3.45298
STAI-T	Equal variances assumed	.153	.697	.735	50	.466	1.50000	2.04194	-2.60136	5.60136
	Equal variances not assumed			.735	49.340	.466	1.50000	2.04194	-2.60272	5.60272
EPQ-N	Equal variances assumed	.053	.818	.880	50	.383	.65385	.74313	-.83878	2.14648
	Equal variances not assumed			.880	49.038	.383	.65385	.74313	-.83951	2.14720
TEQ	Equal variances assumed	4.330	.043	-.457	50	.650	-.15385	.33671	-.83015	.52245
	Equal variances not assumed			-.457	34.238	.651	-.15385	.33671	-.83795	.53025
SUIS	Equal variances assumed	.479	.492	-.456	50	.650	-.96154	2.10664	-5.19285	3.26977
	Equal variances not assumed			-.456	48.453	.650	-.96154	2.10664	-5.19620	3.27312
PICS	Equal variances assumed	.012	.915	.385	50	.702	.26923	.69907	-1.13488	1.67335
	Equal variances not assumed			.385	49.968	.702	.26923	.69907	-1.13491	1.67337

Appendix 4.13. Experiment 1: SPSS Output for Baseline and Main Outcome Variables

```
T-TEST GROUPS=Condition(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=Flashbacks_in_Diary_First_24_Hours Flashbacks_In_Diary_Days_2_to_8
  /CRITERIA=CI(.95).
```

T-Test. EXPERIMENT 1. FLASHBACK FREQUENCY REPORTED IN THE INTRUSION DIARY [1st 24 HRS. AND DAYS 2-8]

[DataSet1] C:\Users\ellaj\Desktop\EX1_Final Stats Check\Expt1_final.sav

Group Statistics

	Condition	N	Mean	Std. Deviation	Std. Error Mean
Mean Frequency of Flashbacks Recorded in the 1-Day Diary	Control	26	3.2308	1.83973	.36080
	Reactivation + Tetris	26	3.3077	2.42931	.47643
Mean Frequency of Flashbacks Recorded in the Diary from Days 2 to 8	Control	26	5.5000	2.67208	.52404
	Reactivation + Tetris	26	2.6538	2.18984	.42946

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mean Frequency of Flashbacks Recorded in the 1-Day Diary	Equal variances assumed	2.209	.144	-.129	50	.898	-.07692	.59763	-1.27730	1.12345
	Equal variances not assumed			-.129	46.578	.898	-.07692	.59763	-1.27948	1.12564
Mean Frequency of Flashbacks Recorded in the Diary from Days 2 to 8	Equal variances assumed	.396	.532	4.201	50	.000	2.84615	.67753	1.48529	4.20702
	Equal variances not assumed			4.201	48.142	.000	2.84615	.67753	1.48398	4.20832

Appendix 4.13. Experiment 1: SPSS Output for Baseline and Main Outcome Variables

```
T-TEST GROUPS=Condition(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=IES_R_Intrusions IES_R_Total IES_R_Avoidance IES_R_Hyperarousal Intrusion_Provocation_Task
  /CRITERIA=CI(.95).
```

T-Test: EXPERIMENT 1. CONVERGENT FLASHBACK MEMORY MEASURES [IES-R AND IPT]

[DataSet1] C:\Users\ellaj\Desktop\EX1_Final Stats Check\Expt1_final.sav

group Statistics

	Condition	N	Mean	Std. Deviation	Std. Error Mean
IES-R Intrusion subscale	Control	26	1.0023	.41912	.08220
	Tetris	26	.6750	.50814	.09966
IES-R Total	Control	26	.6169	.25749	.05050
	Tetris	26	.5162	.40654	.07973
IES-R Avoidance subscale	Control	26	.6804	.62302	.12218
	Tetris	26	.6077	.61940	.12147
IES-R Hyperarousal subscale	Control	26	.0904	.15845	.03108
	Tetris	26	.1858	.24546	.04814
Intrusion Provocation Task (IPT)	Control	26	3.4231	3.11349	.61061
	Tetris	26	1.0385	1.61197	.31613

Appendix 4.13. Experiment 1: SPSS Output for Baseline and Main Outcome Variables

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
IES-R Intrusion subscale	Equal variances assumed	.251	.619	2.534	50	.014	.32731	.12918	.06784	.58677
	Equal variances not assumed			2.534	48.253	.015	.32731	.12918	.06761	.58700
IES-R Total	Equal variances assumed	4.658	.036	1.068	50	.291	.10077	.09438	-.08879	.29033
	Equal variances not assumed			1.068	42.278	.292	.10077	.09438	-.08965	.29119
IES-R Avoidance subscale	Equal variances assumed	.683	.412	.422	50	.675	.07269	.17229	-.27337	.41875
	Equal variances not assumed			.422	49.998	.675	.07269	.17229	-.27337	.41875
IES-R Hyperarousal subscale	Equal variances assumed	4.331	.043	-1.665	50	.102	-.09538	.05730	-.21047	.01970
	Equal variances not assumed			-1.665	42.753	.103	-.09538	.05730	-.21095	.02019
Intrusion Provocation Task (IPT)	Equal variances assumed	5.292	.026	3.468	50	.001	2.38462	.68759	1.00355	3.76568
	Equal variances not assumed			3.468	37.504	.001	2.38462	.68759	.99206	3.77717

Appendix 4.13. Experiment 1: SPSS Output for Baseline and Main Outcome Variables

```
T-TEST GROUPS=Condition(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=Verbal_Recognition_Memory_Score Visual_Recognition_Memory_Score
  /CRITERIA=CI(.95).
```

T-Test. EXPERIMENT 1: RECOGNITION MEMORY TEST SCORES

[DataSet1] C:\Users\ellaj\Desktop\EX1_Final Stats Check\Expt1_final.sav

Group Statistics

	Condition	N	Mean	Std. Deviation	Std. Error Mean
Verbal Recognition Memory Test Score	Control	26	19.6538	3.35788	.65854
	Tetris	26	18.2692	3.02731	.59370
Visual Recognition Memory Test Score	Control	26	14.3077	2.88124	.56506
	Tetris	26	15.4615	2.43690	.47791

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Verbal Recognition Memory Test Score	Equal variances assumed	1.340	.253	1.562	50	.125	1.38462	.88665	-.39628	3.16551
	Equal variances not assumed			1.562	49.472	.125	1.38462	.88665	-.39675	3.16598
Visual Recognition Memory Test Score	Equal variances assumed	1.051	.310	-1.559	50	.125	-1.15385	.74006	-2.64031	.33261
	Equal variances not assumed			-1.559	48.660	.125	-1.15385	.74006	-2.64132	.33363

Appendix 5.1. Examples of Flashbacks Reported in the Intrusion Diary by Participants [Verbatim] for each of the Film Clips: Experiment 2

Film Clip	**Intrusion Diary Flashback Entry**
Clip 1 30 for a Reason	• *Saw girls hand going back into place.* • *I saw a girl with blood going back into her ear.*
Clip 2 The Big Shave	• *The image of a man shaving and blood oozing out.* • *I saw a man shaving and cutting himself (pouring blood).*
Clip 3 Never, Ever Drink & Drive	• *I saw a kid in a garden getting hit by a drunk driver.* • *Saw little boy getting squished.*
Clip 4 Eye surgery	• *Saw a close up of an eye.* • *I saw surgery on an eye.*
Clip 5 No Seatbelt, No Excuse	• *I saw two white cars crash together.* • *Visualised boy hitting his girlfriend so hard in a car crash.*
Clip 6 Ghosts of Rwanda	• *Images of African children lying on the ground.* • *Children and bodies on the ground.*
Clip 7 Drink and Drowning	• *Saw man drowning.* • *Person drowning.*
Clip 8 The Faster the Speed	• *I had an image of a couple hit by a car.* • *Saw the car pinned the couple to the wall outdoors, killing the guy and smashing/pinning the girl to the wall.*
Clip 9 Orthopaedic surgery	• *I saw the inside of a body cut open and lots of blood.* • *I saw bone sticking out of a limb.*
Clip 10 Texting and Road Cross	• *A boy got hit by a van whilst texting.* • *I saw a car crashing into a man texting on his phone.*
Clip 11 Elephant Rampage	• *I saw a circus elephant trampling people.* • *Elephant stomping on performers in circus.*

Appendix 5.2. Experiment 2. SPSS Output for Baseline and Main Outcome Variables

```
GET
  FILE='C:\Users\ellaj\Desktop\EX2_Final Stats Check\Exp2 dataset_FINAL.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
ONEWAY Age BDI STAI_T EPQ_N TEQ SUIS PIC Blood_Phobia BY Condition
  /STATISTICS DESCRIPTIVES
  /MISSING ANALYSIS.
```

Oneway: EXPERIMENT 2 BASELINE VARIABLES

[DataSet1] C:\Users\ellaj\Desktop\EX2_Final Stats Check\Exp2 dataset_FINAL.sav

Descriptives

						95% Confidence Interval for Mean			
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Age (years)	Control	18	23.6667	6.81693	1.60677	20.2767	27.0566	18.00	46.00
	Tetris+Reactivation	18	25.4444	7.39811	1.74375	21.7655	29.1234	18.00	47.00
	Tetris Only	18	25.3889	7.81506	1.84203	21.5026	29.2752	18.00	54.00
	Reactivation Only	18	28.3889	11.30403	2.66438	22.7675	34.0102	18.00	62.00
	Total	72	25.7222	8.50720	1.00258	23.7231	27.7213	18.00	62.00
BDI-II	Control	18	3.3333	4.57615	1.07861	1.0577	5.6090	.00	15.00
	Tetris+Reactivation	18	2.6667	2.44949	.57735	1.4486	3.8848	.00	8.00
	Tetris Only	18	3.6111	4.57794	1.07903	1.3346	5.8877	.00	18.00
	Reactivation Only	18	2.0556	2.75408	.64914	.6860	3.4251	.00	9.00
	Total	72	2.9167	3.69526	.43549	2.0483	3.7850	.00	18.00
STAI-T	Control	18	32.7222	9.70025	2.28637	27.8984	37.5460	21.00	58.00
	Tetris+Reactivation	18	34.6667	7.49902	1.76754	30.9375	38.3958	24.00	51.00
	Tetris Only	18	34.0556	8.61921	2.03157	29.7693	38.3418	21.00	54.00
	Reactivation Only	18	33.6111	7.96418	1.87717	29.6506	37.5716	23.00	54.00
	Total	72	33.7639	8.33539	.98233	31.8052	35.7226	21.00	58.00

Appendix 5.2. Experiment 2. SPSS Output for Baseline and Main Outcome Variables

EPQ-N	Control	18	3.3333	3.06786	.72310	1.8077	4.8589	.00	10.00
	Tetris+Reactivation	18	3.6667	3.28991	.77544	2.0306	5.3027	.00	9.00
	Tetris Only	18	2.5000	2.35772	.55572	1.3275	3.6725	.00	7.00
	Reactivation Only	18	3.1111	2.56421	.60439	1.8360	4.3863	.00	8.00
	Total	72	3.1528	2.81675	.33196	2.4909	3.8147	.00	10.00
TEQ	Control	18	.8722	1.07911	.25435	.3356	1.4089	.00	4.00
	Tetris+Reactivation	18	.7778	.94281	.22222	.3089	1.2466	.00	3.00
	Tetris Only	18	.9444	.99836	.23532	.4480	1.4409	.00	3.00
	Reactivation Only	18	1.0000	.84017	.19803	.5822	1.4178	.00	2.00
	Total	72	.8986	.95202	.11220	.6749	1.1223	.00	4.00
SUIS	Control	18	39.3889	8.68494	2.04706	35.0700	43.7078	20.00	51.00
	Tetris+Reactivation	18	38.1111	7.81318	1.84158	34.2257	41.9965	21.00	55.00
	Tetris Only	18	40.5556	6.76689	1.59497	37.1905	43.9207	30.00	56.00
	Reactivation Only	18	41.8333	8.06773	1.90158	37.8213	45.8453	27.00	54.00
	Total	72	39.9722	7.82011	.92161	38.1346	41.8099	20.00	56.00
PICS	Control	18	4.7056	2.79884	.65969	3.3137	6.0974	.60	7.90
	Tetris+Reactivation	18	4.7111	2.66124	.62726	3.3877	6.0345	1.10	9.50
	Tetris Only	18	3.8889	2.60901	.61495	2.5915	5.1863	.90	7.80
	Reactivation Only	18	4.3556	2.34652	.55308	3.1887	5.5225	.00	7.60
	Total	72	4.4153	2.57571	.30355	3.8100	5.0205	.00	9.50
Blood phobia	Control	18	2.4000	2.71250	.63934	1.0511	3.7489	.00	9.30
	Tetris+Reactivation	18	2.5500	2.26956	.53494	1.4214	3.6786	.00	7.40
	Tetris Only	18	2.3000	2.32910	.54897	1.1418	3.4582	.10	7.50
	Reactivation Only	18	3.1000	2.52424	.59497	1.8447	4.3553	.00	7.80
	Total	72	2.5875	2.43235	.28666	2.0159	3.1591	.00	9.30

Appendix 5.2. Experiment 2. SPSS Output for Baseline and Main Outcome Variables

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Age (years)	Control	18	23.6667	6.81693	1.60677	20.2767	27.0566	18.00	46.00
	Tetris+Reactivation	18	25.4444	7.39811	1.74375	21.7655	29.1234	18.00	47.00
	Tetris Only	18	25.3889	7.81506	1.84203	21.5026	29.2752	18.00	54.00
	Reactivation Only	18	28.3889	11.30403	2.66438	22.7675	34.0102	18.00	62.00
	Total	72	25.7222	8.50720	1.00258	23.7231	27.7213	18.00	62.00
BDI-II	Control	18	3.3333	4.57615	1.07861	1.0577	5.6090	.00	15.00
	Tetris+Reactivation	18	2.6667	2.44949	.57735	1.4486	3.8848	.00	8.00
	Tetris Only	18	3.6111	4.57794	1.07903	1.3346	5.8877	.00	18.00
	Reactivation Only	18	2.0556	2.75408	.64914	.6860	3.4251	.00	9.00
	Total	72	2.9167	3.69526	.43549	2.0483	3.7850	.00	18.00
STAI-T	Control	18	32.7222	9.70025	2.28637	27.8984	37.5460	21.00	58.00
	Tetris+Reactivation	18	34.6667	7.49902	1.76754	30.9375	38.3958	24.00	51.00
	Tetris Only	18	34.0556	8.61921	2.03157	29.7693	38.3418	21.00	54.00
	Reactivation Only	18	33.6111	7.96418	1.87717	29.6506	37.5716	23.00	54.00
	Total	72	33.7639	8.33539	.98233	31.8052	35.7226	21.00	58.00
EPQ-N	Control	18	3.3333	3.06786	.72310	1.8077	4.8589	.00	10.00
	Tetris+Reactivation	18	3.6667	3.28991	.77544	2.0306	5.3027	.00	9.00
	Tetris Only	18	2.5000	2.35772	.55572	1.3275	3.6725	.00	7.00
	Reactivation Only	18	3.1111	2.56421	.60439	1.8360	4.3863	.00	8.00
	Total	72	3.1528	2.81675	.33196	2.4909	3.8147	.00	10.00

Appendix 5.2. Experiment 2. SPSS Output for Baseline and Main Outcome Variables

TEQ	Control	18	.8722	1.07911	.25435	.3356	1.4089	.00	4.00
	Tetris+Reactivation	18	.7778	.94281	.22222	.3089	1.2466	.00	3.00
	Tetris Only	18	.9444	.99836	.23532	.4480	1.4409	.00	3.00
	Reactivation Only	18	1.0000	.84017	.19803	.5822	1.4178	.00	2.00
	Total	72	.8986	.95202	.11220	.6749	1.1223	.00	4.00
SUIS	Control	18	39.3889	8.68494	2.04706	35.0700	43.7078	20.00	51.00
	Tetris+Reactivation	18	38.1111	7.81318	1.84158	34.2257	41.9965	21.00	55.00
	Tetris Only	18	40.5556	6.76689	1.59497	37.1905	43.9207	30.00	56.00
	Reactivation Only	18	41.8333	8.06773	1.90158	37.8213	45.8453	27.00	54.00
	Total	72	39.9722	7.82011	.92161	38.1346	41.8099	20.00	56.00
PICS	Control	18	4.7056	2.79884	.65969	3.3137	6.0974	.60	7.90
	Tetris+Reactivation	18	4.7111	2.66124	.62726	3.3877	6.0345	1.10	9.50
	Tetris Only	18	3.8889	2.60901	.61495	2.5915	5.1863	.90	7.80
	Reactivation Only	18	4.3556	2.34652	.55308	3.1887	5.5225	.00	7.60
	Total	72	4.4153	2.57571	.30355	3.8100	5.0205	.00	9.50
Blood phobia	Control	18	2.4000	2.71250	.63934	1.0511	3.7489	.00	9.30
	Tetris+Reactivation	18	2.5500	2.26956	.53494	1.4214	3.6786	.00	7.40
	Tetris Only	18	2.3000	2.32910	.54897	1.1418	3.4582	.10	7.50
	Reactivation Only	18	3.1000	2.52424	.59497	1.8447	4.3553	.00	7.80
	Total	72	2.5875	2.43235	.28666	2.0159	3.1591	.00	9.30

Appendix 5.2. Experiment 2. SPSS Output for Baseline and Main Outcome Variables

```
ONEWAY Flashbacks_First_24_hours BY Condition
  /STATISTICS DESCRIPTIVES
  /MISSING ANALYSIS.
```

Oneway: EXPERIMENT 2 FLASHBACK FREQUENCY IN THE INTRUSION DIARY FIRST 24 HOURS

[DataSet1] C:\Users\ellaj\Desktop\EX2_Final Stats Check\Exp2 dataset_FINAL.sav

Descriptives

DAY 1: Flashbacks in the intrusion diary

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	18	3.5556	2.40642	.56720	2.3589	4.7522	.00	10.00
Tetris+Reactivation	18	3.1111	2.39826	.56527	1.9185	4.3037	1.00	10.00
Tetris Only	18	3.1667	1.58114	.37268	2.3804	3.9529	.00	6.00
Reactivation Only	18	3.4444	2.63957	.62215	2.1318	4.7571	1.00	12.00
Total	72	3.3194	2.25067	.26524	2.7906	3.8483	.00	12.00

ANOVA

DAY 1: Flashbacks in the intrusion diary

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.486	3	.829	.158	.924
Within Groups	357.167	68	5.252		
Total	359.653	71			

Appendix 5.2. Experiment 2. SPSS Output for Baseline and Main Outcome Variables

```
ONEWAY Flashbacks_days_2_to_8 BY Condition
  /STATISTICS DESCRIPTIVES
  /MISSING ANALYSIS
  /POSTHOC=DUNNETT (1) ALPHA(0.05).
```

Oneway: EXPERIMENT 2. FLASHBACK FREQUENCY DAYS 2-8 [POST ASSIGNMENT TO EXPERIMENTAL MANIPULATION]

[DataSet1] C:\Users\ellaj\Desktop\EX2_Final Stats Check\Exp2 dataset_FINAL.sav

Descriptives

Days 2-8: Flashbacks in the intrusion diary

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	18	5.1111	4.22721	.99636	3.0090	7.2133	.00	16.00
Tetris+Reactivation	18	2.0000	1.81497	.42779	1.0974	2.9026	.00	7.00
Tetris Only	18	3.8889	2.88788	.68068	2.4528	5.3250	1.00	12.00
Reactivation Only	18	4.8333	3.32990	.78487	3.1774	6.4893	1.00	15.00
Total	72	3.9583	3.35016	.39482	3.1711	4.7456	.00	16.00

ANOVA

Days 2-8: Flashbacks in the intrusion diary

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	106.819	3	35.606	3.509	.020
Within Groups	690.056	68	10.148		
Total	796.875	71			

Appendix 5.2. Experiment 2. SPSS Output for Baseline and Main Outcome Variables

A Priori planned comparisons [flashback frequency in the intrusion diary days 2-8]

Multiple Comparisons

Days 2-8: Flashbacks in the intrusion diary

Dunnett t (2-sided)[a]

(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Tetris+Reactivation	Control	-3.11111*	1.06186	.013	-5.6624	-.5599
Tetris Only	Control	-1.22222	1.06186	.523	-3.7735	1.3290
Reactivation Only	Control	-.27778	1.06186	.988	-2.8290	2.2735

```
ONEWAY Intrusion_Provocation_Task BY Condition
  /STATISTICS DESCRIPTIVES
  /MISSING ANALYSIS
  /POSTHOC=DUNNETT (1) ALPHA(0.05).
```

Oneway: EXPERIMENT 2 INTRUSION PROVOCATION TASK [IPT] FLASHBACK FREQUENCY

```
[DataSet1] C:\Users\ellaj\Desktop\EX2_Final Stats Check\Exp2 dataset_FINAL.sav
```

Descriptives

Intrusion Provocation Task [IPT]

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	18	3.3889	2.81046	.66243	1.9913	4.7865	.00	10.00
Tetris+Reactivation	18	1.1667	1.85504	.43724	.2442	2.0892	.00	6.00
Tetris Only	18	3.1111	2.51791	.59348	1.8590	4.3632	.00	8.00
Reactivation Only	18	4.1667	2.12132	.50000	3.1118	5.2216	.00	7.00
Total	72	2.9583	2.55882	.30156	2.3570	3.5596	.00	10.00

ANOVA

Intrusion Provocation Task [IPT]

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	87.819	3	29.273	5.279	.002
Within Groups	377.056	68	5.545		
Total	464.875	71			

EXPERIMENT 2. A Priori planned comparisons [INTRUSION PROVOCATION TASK (IPT) FLASHBACK FREQUENCY]

Multiple Comparisons

Intrusion Provocation Task [IPT]

Dunnett t (2-sided)[a]

(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Tetris+Reactivation	Control	-2.22222*	.78492	.017	-4.1081	-.3363
Tetris Only	Control	-.27778	.78492	.971	-2.1637	1.6081
Reactivation Only	Control	.77778	.78492	.633	-1.1081	2.6637

a. Dunnett t-tests treat one group as a control, and compare all other groups against it.

*. The mean difference is significant at the 0.05 level.

Appendix 5.2. Experiment 2. SPSS Output for Baseline and Main Outcome Variables

```
ONEWAY Verbal_Memory_Test Visual_Memory_Test_Score BY Condition
  /STATISTICS DESCRIPTIVES
  /MISSING ANALYSIS.
```

Oneway: EXPERIMENT 2. RECOGNITION MEMORY TEST SCORES

```
[DataSet1] C:\Users\ellaj\Desktop\EX2_Final Stats Check\Exp2 dataset_FINAL.sav
```

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Verbal (written) Recognition Memory Score	Control	18	19.7222	2.24409	.52894	18.6063	20.8382	15.00	23.00
	Tetris+Reactivation	18	18.2778	1.90373	.44871	17.3311	19.2245	15.00	22.00
	Tetris Only	18	18.8889	3.06573	.72260	17.3643	20.4134	13.00	25.00
	Reactivation Only	18	19.1111	3.42807	.80800	17.4064	20.8158	14.00	25.00
	Total	72	19.0000	2.72185	.32077	18.3604	19.6396	13.00	25.00
Visual Recognition Memory Score	Control	18	15.0000	2.19625	.51766	13.9078	16.0922	12.00	20.00
	Tetris+Reactivation	18	15.7222	2.13667	.50362	14.6597	16.7848	12.00	19.00
	Tetris Only	18	14.1111	1.96705	.46364	13.1329	15.0893	10.00	17.00
	Reactivation Only	18	14.3889	2.14583	.50578	13.3218	15.4560	10.00	18.00
	Total	72	14.8056	2.16007	.25457	14.2980	15.3131	10.00	20.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Verbal (written) Recognition Memory Score	Between Groups	19.222	3	6.407	.860	.466
	Within Groups	506.778	68	7.453		
	Total	526.000	71			
Visual Recognition Memory Score	Between Groups	27.611	3	9.204	2.061	.114
	Within Groups	303.667	68	4.466		
	Total	331.278	71			

Appendix 6.1. University of Oxford Central University Research Ethic Committee (CUREC) Approval Letter for Experiment 3

University of Oxford

Medical Sciences Office
John Radcliffe Hospital, Headington, Oxford OX3 9DU
From Samantha Hatzis

CONFIDENTIAL
Department of Psychiatry
Warneford Hospital
Oxford OX3 7JX

Ref.
MSD/IDREC/C1/2011/102
11 November 2011

CUREC checklist

I am writing to acknowledge receipt of your CUREC/1 form for your project:

On the basis of the information you have provided this has now been approved by the Medical Sciences IDREC **subject to:**

(a) receipt of the hard copy of your application signed by your head of department (Please note that should this not appear or the head of department is unwilling to sign then this approval would not be valid);

(b) it is your responsibility to comply with the requirements for administering any tests or questionnaires and if in doubt to contact the publisher of those tests or questionnaires.

The reference number for this project is MSD/IDREC/C1/2011/102 and may I remind you that your project may be reviewed at some stage during an annual audit of projects.

Amendments

Should you at some stage alter some of the techniques or procedures then you should first undertake a checklist (CUREC/1) to see whether these changes alter the ethics of the research. If these remain the same then the committee will require notification of the changes to lodge with the project. If they do not remain the same then you may need to complete a CUREC/2 form and undergo further scrutiny by the committee.

Please do not hesitate to contact me if you have any queries about this.

Yours sincerely,

Samantha Hatzis (Mrs)
Secretary to the MSD IDREC

-----Original Message-----
From: Divisional EthicsCommittee [mailto:ethics@medsci.ox.ac.uk]

Sent: 18 November 2010 16:00
To: Ella James
Subject: Ethics query

I have managed to get a response from the chair and I hope this will help:

1) a. I think it would be wisest for her to reply to the e-mails with a standard answer saying something like
"Thank you for your interesting e-mail about flashback experiences. It is one of many that I have received and I may want to quote from these in my Ph D thesis, and other scientific articles which may be published. Any quotation would be anonymous, but I would not in any case do this without your permission, so please let me know whether you are happy for your words to appear in print or on-line in this way" and only quote directly those who give permission.

b. If the information is only to be used in summary rather than individual quotations, e.g "Other games mentioned in these volunteered e-mails included Donkey Kong, Mario Brothers, and Grand Theft Auto...." or "48% of these e-mails concerned flashbacks following a physically violent event...." I don't think any permission is necessary.

c. I don't think there would any problem in retaining the e-mail text with individual identifying information stripped off.

Please let me know if this raises any further questions. I summarised the queries for him so let me know if I appear to have misunderstood.

Carol

Appendix 7.2. Email Template sent to Individuals Requesting Permission to use Email Text in the Current Thesis

Dear _____

My name is Ella James and I am writing to you on behalf of Professor Emily Holmes. Thank you for your interesting e-mail about your experiences in response to our research which uses Tetris to dampen down intrusive memories that can occur after experiencing trauma (e.g. PLoS ONE; “Can Playing the Computer Game 'Tetris' Reduce the Build-up of Flashbacks for Trauma? A Proposal from Cognitive Science”).

I am co-author on the above article and I am currently doing a PhD at the University of Oxford with Prof Emily Holmes in the same research area. It would be very helpful if I could collate and include quotes from some of the emails that we have received for my PhD Thesis and possibly other scientific articles that may be published. This could help us understand and develop our research further.

I would be grateful if you could please let me know whether you are happy for your words (from your email below) to appear in print in this way. Any quotation would be anonymous and no-one will be able to link it to you. Similarly, if you have additional comments you would like to make we would be pleased to accept them.

Thank you once again for taking the time to write to us. I look forward to hearing back from you.
Kind regards,

CORRESPONDENCE 1 [1 EMAIL]

Hi,

I came across an article related to your research into playing tetris and it reducing the build-up of flashbacks from trauma. I suffer from PTSD and I sometimes get nightmares, after them to calm down or zone out I essentially turn to playing tetris ,I was wondering what made you think there was link between playing tetris and it blocking things out ?

The article I read also mentioned you were wondering what other games had the same effect. I also play Flight Control (an app for Mobile phones) and find it has similar effects.

CORRESPONDENCE 2 [1/2 EMAILS]

I saw an article based on your article and thought I'd share my story.

In <REMOVAL OF IDENTIFYING TEXT> for 2 months, there I met someone and started a relationship. It turned out he had anger/rage issues. we had one big fight where he was threatening many things, to slice his wrists with knives kill himself various things for hours. The fight ended and a week later after some councelling with friends and a man who was living in a buddhist community <REMOVAL OF IDENTIFYING TEXT> (because of his own personal anger problems) I decided to give him another chance. This was on agreement if it happened again I would leave him. ONe month later it happened, and I eventually did leave him. First I was locked in a room for 4 hours screaming at the top of my lungs for help, none came, he tried to suffocate me and there was a lot of violence, it's a long story which goes on for 4 more hours there, <REMOVAL OF IDENTIFYING TEXT>.

When I arrived <REMOVAL OF IDENTIFYING TEXT>. I moved back in with my parents (I was sick and traumatized) a month later I could still not be near men, it would induce fear and make me start to

sweat and be jumpy. After 2 months my dad had me working for him in his office. I had more than enough time in my day to finish my work so I'd play around on the internet. Tetris has been my favourite internet game since we first got an internet in the 90's, I started playing it on facebook. Looking back I could say that by month 4 of being back <REMOVAL OF IDENTIFYING TEXT> I could receive an email <REMOVAL OF IDENTIFYING TEXT> without flinching <REMOVAL OF IDENTIFYING TEXT> I could be around any man and not care, and within 5 months I traveled <REMOVAL OF IDENTIFYING TEXT> on my own to visit a friend without a care in the world. A lot of people asked me how I could move on after such a terrifying experience; I said "oh I don't know, you just get over it" but after reading your article I see that it was probably playing tetris for 2 or more hours a day.
Thank you for giving me perspective and a very good reason to keep playing, it'll always be my favourite game!

CORRESPONDENCE 2 [2/2 EMAILS]

Hello!
I got your email at work the other day and it made me happy then got caught up in life and now remembered to get back to it! Ask me anything I'm an open book. The week before last I was contacted by a Russian girl who my ex knew, saying he was trying to contact me again, I was able to talk to her because I knew I could play tetris at the same time and knew (now) that I have something, like a ibuprofen, to lower my heart rate, my shaking and let me think rationally when readdressing these old woes.
I sent you an extremely positive email, I'm a happier person, and for what I believe, a better person, because I was able to experience something and learn and grow from it, and had something (tetris) that allowed me to do that. I went on to find my soul mate (getting married in the next couple years).

you can use anything you wish, you have complete liberty with it. I am an open book. I wanted to be able to do something for people who also experienced these things when <REMOVAL OF IDENTIFYING TEXT>, but hadn't yet found an opportunity. I can talk about my experiences liberally, and I find it helps people, which is nice. I've been deemed by many people to be a inspiring person, but to me it's because of many other factors and tools I used, and if I could be of use for others to have and know these tools then that would be great!

CORRESPONDENCE 3 [1/2 EMAILS]

Thank you for your reply to my email on your journal article, "Key steps in developing a cognitive vaccine against traumatic flashbacks: visuospatial Tetris versus verbal Pub Quiz." I went ahead and downloaded the article to my computer in the PDF format because I was intrigued by your references to eye movement involved in playing the game, Tetris.

I've heard of "Eye movement desensitization and reprocessing (EMDR)" therapy, and I'm assuming that the movement of the eye in a particular way might possibly have a key to the reduction in the flashbacks from PTSD. I'm not all that sure that EMDR is a reputable psychotherpy, from what I've read about it, but I don't have a closed mind as to the possibilities. If there is something to the types of movements by the eye while playing the game, Tetris, that works, then I think it's really worth a lot more research into why, Tetris helps, vs another type of modality.

I just happened to listen to a new PBS Nova program on fractals, just last night. I'm not very good in mathematics, but I know enough to understand how groundbreaking the discovery of this form of mathematics is and the possiblities it holds for scientific research in a whole host of areas. I've copied some of the information on the PBS website about fractals for you. On further

down, I've included a link the the page on this TV program so you can read more for yourself.

"Nova: Hunting the Hidden Dimension: An examination of fractal geometry, a field of mathematics based on the intricate patterns found in nature, art, science and even the human heart beat. Included: mathematicians seeking to uncover the rules that govern fractals; the "Father of Fractals," Benoit Mandelbrot; people have used fractals to generate advances in their chosen fields, including Pixar Animation Studios cofounder Loren Carpenter and Boston cardiologist Ary Goldberger, who discovered fractals in heartbeats."

"You may not know it, but fractals, like the air you breathe, are all around you. Their irregular, repeating shapes are found in cloud formations and tree limbs, in stalks of broccoli and craggy mountain ranges, even in the rhythm of the human heart. In this film, NOVA takes viewers on a fascinating quest with a group of maverick mathematicians determined to decipher the rules that govern fractal geometry."

"For centuries, fractal-like irregular shapes were considered beyond the boundaries of mathematical understanding. Now, mathematicians have finally begun mapping this uncharted territory. Their remarkable findings are deepening our understanding of nature and stimulating a new wave of scientific, medical, and artistic innovation stretching from the ecology of the rain forest to fashion design. The documentary highlights a host of filmmakers, fashion designers, physicians, and researchers who are using fractal geometry to innovate and inspire."

Link to the PBS program, Nova, on Fractals: http://www.pbs.org/wgbh/nova/physics/hunting-hidden-dimension.html

On further down on that webpage is a copy of the transcript of the program. Below I have copied a part of the transcript, that "caught my eye," no pun intended!! When I was reading through

the references to articles you accessed in your research, I remembered this particular part of the program. I thought you might be interested in exploring whether or not the study of eye movements as fractals, might have some bearing on why Tetris helps PTSD patients. It seems that it might help you find a key to why the repetative game play of Tetris helps, through this mathematical application. Using the fractal patterns of eye movements as an empirical measurment, might objectively explain why EMDR is or isn't an effective psychotherapy and why certain video games do or don't help in the treatment of PTSD. Here is the part of the transcript I copied for you:

"At the University of Oregon, Richard Taylor is using fractals to reveal the secrets of another part of the body: the eye."

"RICHARD TAYLOR: What we want to do is see, "What is that eye doing, that allows it to absorb so much visual information?" And so that's what led us into the eye trajectories. Under the monitor is a little infrared camera, which will actually monitor where the eye is looking. And it actually records that data, and so what we get out is a trajectory of where the eye has been looking. And so the computer will get out this graph, and it will look...you know...have all of these various little structures in it. And it's that pattern that we zoom in...we tell the computer to zoom in on and see the fractal dimension."

At any rate, it sounded intriguing to me, especially after perusing your references at the end of your article. I plan to later on look up some of those references on eye movement and read more.

The thought has of course occurred to me, that perhaps different kinds of video games may not all have the same beneficial effect on the recurrance or intensity of PTSD flashbacks, due perhaps to the type of eye movements made in response to the specific structure of whatever game is being played. Different tasks in a game may possibly mean different types of eye movements. Or,

perhaps the eye movements are the same. Either way, it could lead you into further understanding of how sensory cognition works in your area of study. I hope some of the information I have presented to you above, might help you further your research in some way.

I also want to comment on what video games seem to help me and why others seem to frustrate me.

Most of the following games are for the Nintendo DS Lite & the DSi XL, the original Game Boy, and the Game Boy Advance SP, except where noted. I also have some computer games which I haven't talked about. I play the handheld games the most.

‘Scrabble’ (I REALLY LOVE this game!! I can't however, listen to the TV or audio book and play it and expect to remember what I'm listening to at the same time because it requires too much concentration!! It's addictive too.)

‘Book Worm’ (I also like this game too. It's easy and quick to play and I can listen to other things at the same time.)

‘Mahjong’ (love Mahjong games of all types!!)

‘Mahjong Journey: Quest for Tikal’

‘Mahjongg Mysteries: Ancient Egypt’

‘Wordjong’

‘Arkanoid’ (involves breaking tiles with a ball, very repetitive)

‘Bejeweled Twist’ (extremely addictive!!)

‘7 Wonders II’ (this game and the following 4 games involve destroying all the gems in different arrangements and collecting different tokens to build a society. Games of this type I usually play until I get through ALL 100 levels!!)

‘7 Wonders of the Ancient World’

‘Jewel Master: Cradle of Athena’

‘Jewel Master: Egypt’

‘Jewels of the Tropical Lost Island’

‘Luxor: Pharaoh's Challenge’ (Arcade style game, exploding an unending moving chain of balls. Loved this game!!)

‘Solitaire Overload’ (Over a hundred different games of Solitaire!! One of my favorite games to play!! Extremely addictive and repetitious.)
‘Space Invaders Extreme’ (Fun classic arcade game.)
‘Touchmaster 1, 2, & 3’ (These three games and the Zenses games have a variety of different puzzle and/or strategy games to solve. None are very complicated and have simple rules. However, they aren't always easy!!)
‘Zenses: Ocean Edition’
‘Zenses: Rainforest Edition’
‘Call of Duty: Modern Warfare’ (I like first person shooter games but find ones like this so complicated to learn, I get frustrated)
‘Doom & Doom II’ (these games, and the Nukem games are all first person shooter games and are fun, but you have to solve and find objects to help you through the different levels, and I get impatient when I can't solve something fairly soon.)
‘Duke Nukem’
‘Duke Nukem Trilogy: Critical Mass, Chain Reaction, & Proving Grounds’
‘Jungle Strike’ (these two games are the same in style in that you fly a helicopter and shoot at various targets to destroy them)
‘Desert Strike’
‘Army Men’ (got pretty far with this game. It grew on me.)
‘Super Battle Tank’ (this game for the Super Nintendo. Both this game and the next game I enjoy because they are arcade style, don't require a lot of thinking, just reacting. Plus you get to blow up things!!)
‘Operation Armored Liberty’
‘BattleTanx’ (a bit involved arcade style)
‘Karnaaj’ (Racing game but with bomb and points you can collect to destroy your enemy and repair your car. The only racing game that I finished ALL the levels!!)

‘Super RC Pro-Am’ (older game in the style of Karnaaj and I love it!! Except you can't save where you leave off and have to start at the beginning all over again.)
‘Advance Wars’ (complicated strategy)
‘Tetris’ (almost all permutations of the original Tetris game that follow are enjoyable for the same reasons, repetition and simplicity.)
‘Tetris Blast’
‘Tetris Attack’
‘WordTris’
‘Tetris Plus’
‘Tetris 2’ (for Super Nintendo. VERY repetitious but lot's of fun because you get to blow up blocks and towards the end you have to think and move fast!!
‘Tesserae’ (strategy game, very simple rules, repetitious but fun. Similar to board games like checkers or Reversi)
‘Kirby's Pinball Land’ (I love this pinball game!)
‘Dream Pinball’ (Regular pinball games)
‘Kirby's Block Ball’ (This is FUN!! One of the few Kirby games I liked!!)
‘BreakThru’ (the game I discovered that helped me because of it's repetive nature of breaking down walls and blowing up obstacles)
‘Ms Pacman’ (classic arcade game)
‘Learn Chess’ (Don't like chess. Again too damned complicated!! You have to think too far ahead all the time. I like simple and visual strategy games. Actually, I'd probably be really good at chess because I have a mind that can see far ahead, but it's too much work and not enough fun!!)
I hated all ‘Zelda’ games, all ‘Donkey Kong’ games, almost all ‘Super Mario’ games, and most ‘Kirby’ games. Didn't like ‘Star Wars’ games. Didn't like them because they were too complicated to learn and you had to figure things out and search for items to use to get ahead. Don't like most fighting games because you have to

learn all the button combos to make the fighters do certain things. Gets too complicated.

I don't like role playing games, narrative games, sim games, sports games unless they are on the Wii and I can actually play them with my body.

I don't like the ‘Brain Age’ games, especially the math stuff. I don't like games like ‘Sudoku’ or games like ‘Picross.’ I don't like word jumble games or crossword puzzle games. They frustrate me terribly.

The one thing I do enjoy that isn't on a video game yet in a form I like are jigsaw puzzles. I love very colorful puzzles with lots of contrast. Color has ALWAYS excited me, even as an infant. I used to collect stamps, back when I had money, because I loved the color and designs of them. Another thing I like is building something or repairing things. I built my own radio controlled racing car a few years ago. It's worth about $500 and I did it ALL on my own, teaching myself. As a child I loved building with Lego and as an adult, I liked building with Knex. I love electronic gadgets and I like building them, like in kits too. I also love photography and subscribe to WebShots where I download photos by professionals and non-professional photographers to use as my screensaver and my wallpaper for my computer. I'm a very visual person and when I write poetry, I use images to create emotions in my readers and express the state of my inner self. I like Walt Whitman's poems the best, then Emily Dickenson, and Robert Frost.

I hope what I've written about the games can help you to know about other games that are similar to Tetris that you might also find useful in your research. I've spent several hours on this email in hopes that some of my ideas and comments will help you in your future research. I also wrote somethings about myself above, about my interests and how visual I am, hoping this will help also.

CORRESPONDENCE 3 [2/2 EMAILS]

I read about your experiments with the game Tetris in reducing the effects of flashbacks following traumatic events in "Time" magazine on the CNN website. It was of interest to me because I have found playing video games to be quite therapeutic for me in coping with my own mental illness. While your experiment addresses a somewhat different reason for the use of video games, I thought you might be interested in why I found the games to be helpful to me

I first realized the power of a game to help me when I was hospitalized during a difficult episode of my mental illness. I had my Game Boy with me and on an outing, I had purchased a game that involved destroying a wall by doing away with groups of identical bricks. There were bombs to help remove impediments to destroying the walls, etc. It was a very simple and repetitive game, yet quite absorbing.

I had gotten upset at one of the staff, and it was my usual behavior to try to get their approval instead of standing up for myself. I was quite disturbed, but I wanted to somehow get my emotions under control so that I could think more clearly and objectively. I wanted to be able to go to the staff member later and work the problem out in a calm, assertive, and adult manner. I went to my room and played this game for an hour. At the end of the hour, I was quite surprised to find that I was much more calm, in control of my feelings, and able to think logically and clearly with much less anxiety and the need for approval. This began a realization that these games for me, were not a waste of time, but a very beneficial way to handle anxiety and circular or obsessive thinking.

I had discovered a few years earlier a book on "The Psychology of Consciousness," by Robert E. Ornstein, that explained to me that a person can hold only one train of thought or concept in the forefront of your consciousness at a time. I had experimented with

this concept when I injured my knee and had to spend two weeks in bed coping with continuous and unmitigated physical pain. I learned to use music, radio programs, and audio books to distract my conscious thinking from my physical pain and thus helped me cope successfully with two weeks solid bed rest and recuperation!! Other books, like "Maps of the Mind," on concepts of the mind, by Charles Hampden-Turner and "The Observing Self," by Arthur J. Deikman, helped me to better understand and learn how to compartmentalize my thoughts and emotions, making them more manageable and giving me more control over the processes of my own mind.

You see, <REMOVAL OF IDENTIFYING TEXT>, I have been dealing with a serious mental illness, of which my father also suffered. I have had a variety of diagnoses over the years, but the latest, and the one that seems to fit the best, is schizo-affective disorder. Primarily this is exhibited in circular or obsessive thinking, paranoid thinking, racing thoughts, intrusive thinking, anxiety, severe depression, sleep disorder, etc.

In spite of my illness, I managed to get an undergraduate degree and a graduate degree in library and information science. I have an extensive science background from my undergraduate education which has helped me better understand my illness and the medications and therapies that would help me. I am a single lady, 58 years old, never married, no siblings, and no children.

I worked full time for 30 years, at a variety of different jobs, some professional and some non-professional, and at the same time took care of my elderly father until his death at 95 and a half. After his death, I went on disability. I was simply tired of coping with my illness, working full time all those years, AND taking care of an elderly parent. Finally, I am able to enjoy being alive, without all the stress. It took at least 20 years before the right combination of medication was found to alleviate my symptoms to where I was no longer tormented by them day and

night, incessantly for years. I still have symptoms, but not nearly as severe.

I continue to find that the video games do help me cope with whatever stress or anxiety that comes into my life on a daily basis. I also use books in print or audio format, listening to music, or to news radio, or watching TV, to distract my mind from obsessive thinking. Sometimes I play video games, while watching TV, listening to books, or the radio!! It is so very true, that you can only hold one main task in the forefront of your consciousness at one time!! I am so very glad I discovered all this those many years ago!!

Using these coping mechanisms has helped me learn the discipline of how to compartmentalize or put to one side, things that formerly I would have obsessed over ad nauseum, until I drove myself nuts!! I can put a concern or worry out of my mind, to deal with it at the appropriate time, and not allow it to rule and ruin my life. I have learned to, as the Serenity Prayer says, "God grant me the serenity to accept the things I cannot change; courage to change the things I can; and the wisdom to know the difference."

Well, that's my story. I'm not entirely sure what you can make of it, or whether it is entirely applicable to your research with PTSD and Tetris. However, I thought my experience might give you some ideas for future research or clues as to how video games could be used as an adjunct to cognitive therapy. It's been interesting to me to see the process I went through in discovering ways of coping with the symptoms of my illness. I am so glad I discovered how beneficial the games could be to me, in helping me have a more controllable thought life.

Your study was quite interesting and I wish you future success in your endeavors.

CORRESPONDENCE 4 [1 email]

I am writing to you about your study published in PLoS ONE regarding the role of Tetris as a "cognitive vaccine against traumatic flashbacks". I read about your study in a brief article in the Los Angeles Times by William Weir, and then found and read your complete published study on PLoS ONE.

I was drawn to your study and to this subject, because about 10 years ago I discovered Tetris (from my young son, who was an avid video game player) and began to use his hand held Nintendo player to play Tetris for at least an hour before I went to bed each night. I did this for about four years. At the time, I had no idea why I felt compelled to keep playing this game each night before bed, but I did know that it calmed me down and allowed me to eventually fall asleep.

At the time I began using Tetris to help calm me down, I was in a very high stress job, that eventually made me very sick. Happily and thankfully, I am no longer in that job. Since that time, I have been officially diagnosed with PTSD and am currently in treatment with a Clinical Psychologist here in <REMOVAL OF IDENTIFYING TEXT>. She continues to help me find ways to cope with the pain, stress, anxiety and fear that has been present in my life since childhood, when I suffered severe sexual abuse <REMOVAL OF IDENTIFYING TEXT>.

I just thought you might like to know that your study has special significance for me, in that it validated (and explained) my own intuitive use of Tetris in the way your study found to be valid for relieving symptoms associated with PTSD. I wouldn't be surprised if there are others out there, too, who, like me, have quite by accident found a mechanism, which you have validated in your study, as working to help ease some of the pain associated with repeated trauma.

Thank you for your work in this significant, and very important area of need.

CORRESPONDENCE 5 [1 EMAIL]

I don't know whether you've looked at this as well, but your recent article in PLoS One made me wonder if playing a game like Tetris would also be beneficial for those already suffering from PTSD. Tetris was one of the few computer games widely available after the 1991 Gulf War. I came home from that war and soon found myself in the grip of PTSD and PTSD-caused depression. It was awful. Interestingly enough, I played a lot of Tetris from late 1991 through 1995. I found it soothing. It didn't eliminate my mental health issues, but it didn't make them any worse, and it felt hypnotic and calming to play.

CORRESPONDENCE 6 [1 EMAIL]

I recently heard about your work, whilst listening to All in the Mind on Radio 4, regarding using the computer game Tetris to reduce flashbacks after a traumatic event.
I am dyslexic which was only officially recognised 2 years ago. So <REMOVAL OF IDENTIFYING TEXT> I am still trying to understand how my brain works even at the day to day level! I think and remember visually and I find it sometimes very hard to switch off / relax my brain activity. Hearing about your research coincided with me rediscovering Tetris and finding it useful to help me relax and slow down my brain. Would this have any connection to the research you are doing?

CORRESPONDENCE 7 [1/2 EMAILS]

I don't known if what I had was PTSD or some psychotic depression or just a natural reaction to a German phd program. It was not properly diagnosed and treated. But there was a long period (months) of recovery after the initial crisis, when my brain was constantly very active. I would lie on the sofa and play these

games on a laptop. Before that I used to read a lot (mostly non fiction) but at this time I did not want to read or watch movies (except psychology books because I wasn't going to let some shrink tell me what's what). I think it is the lack of narrative you mentioned - Nothing for the hyperactive brain to react to. But gazing at the ceiling did not seem as relaxing. So maybe it's the distraction from your own thoughts, or maybe the games actually do something to the brain like the left-right alternations of EMDR?

CORRESPONDENCE 7 [2/2 EMAILS]

Your findings on Tetris and PTSD and interesting - I spent many hours a few years ago playing Puzzle Inlay (a two-dimensional tetris) while having such issues. The game was very relaxing. You should definitely pursue this. Good luck!

CORRESPONDENCE 8 [1 EMAIL]

I read this article on physorg about your work with tetris and PTSD. Interesting research.
If this interests you at all, I can tell you that playing "tetris attack" on the super nintendo (later becoming pokemon puzzle league on the N64) is what I use to effectively "benchmark" my current brainstate, including cognitive performance, mental reaction and latency, etc, as well as clear my mind. Your research reminded me of this.
What may also interest you is that when playing this very fast paced action puzzle game, my performance gets markedly better when I'm simultaneously having a conversation with my wife. Abilities to see patterns become faster and deeper. Conversation flows normally as if I'm not even playing even in the tensest situations. If she walks away, that performance boost is lost. This is repeatable. Maybe this is some normal cognitive property you are well aware of already.

CORRESPONDENCE 9 [1 EMAIL]

<REMOVAL OF IDENTIFYING TEXT> also suffer from PTSD symptoms. I have know for some time that the computer game “marbles” www.netives.com is quite effective at reducing/blocking my symptoms (and actually it is a game akin to tetris.) Experientially it feels like what I imagine a morphine drip would feel like for someone with a physical pain.

Further, it is an activity that I can do, with great concentration, for hours upon hours, while there is very little else I can focus on for even limited periods of time.

While I accidently found how effective this computer game was for my symptoms, it is quite validating to see that there is actually research being conducted.

Appendix 7.4. Public Communication (News) Coverage in Response to Previous Research that had used Tetris Game Play to Reduce Flashbacks to Analogue Trauma (Holmes et al., 2010)

Tetris relieves post-traumatic stress

The Daily Telegraph, p.2, Unattributed (UK), 07/01/2009

http://www.telegraph.co.uk/scienceandtechnology/science/sciencenews/4142908/Playing-the-video-game-Tetris-could-reduce-trauma-claim-Oxford-University.html

Tetris 'helps to reduce trauma'

BBC News Online, 07/01/2009

http://news.bbc.co.uk/1/hi/health/7813637.stm

Playing 'Tetris' computer game can help reduce trauma

Daily Mail online, Unattributed, 07/01/2009

http://www.dailymail.co.uk/sciencetech/article-1107631/Playing-Tetris-game-help-reduce-trauma.html

Broadcast: Sky News Radio, 07/01/2009

Dr Emily Holmes is interviewed about research into how, in an experiment, Tetris reduced flashbacks after volunteers were shown traumatic images.

Traumatised? Console yourself with Tetris

The Daily Telegraph, p.21, Robert Colvile (UK), 08/01/2009

Tetris: an excellent treatment for post-traumatic stress disorder?

Guardian online, Charles Arthur, 07/01/2009

http://www.guardian.co.uk/technology/blog/2009/jan/07/tetris-trauma-cure

Playing Tetris: prescription for traumatic memories?

Los Angeles Times online, Melissa Healy, 07/01/2009

http://latimesblogs.latimes.com/booster_shots/2009/01/playing-tetris.html

Using Tetris to treat trauma

New Scientist, Ewen Callaway, 07/01/2009

http://www.newscientist.com/blogs/shortsharpscience/2009/01/using-tetris-to-treat-trauma.html

Tetris can wipe out your traumas

Cnet News, 06/01/2009

http://news.cnet.com/8301-17852_3-10133993-71.html

Play Tetris to delete bad memories

Asian Age (Main), p.20, Unattributed (UK), 08/01/2009

'Playing Tetris can wipe out bad memories'

Times of India (Mumbai), p.17, Unattributed (India), 08/01/2009

Appendix 7.4. Public Communication (News) Coverage in Response to Previous Research that had used Tetris Game Play to Reduce Flashbacks to Analogue Trauma (Holmes et al., 2010)

Playing Tetris 'can reduce trauma'

Straits Times, p.19, Unattributed (Singapore), 08/01/2009

Computer puzzle may ease stress

Oman Daily Observer, p.4, Unattributed (Oman), 09/01/2009

Tetris gets the drop on stress

The Gazette (Montreal), p.10, Unattributed (Canada), 09/01/2009

'Tetris' game may ease posttraumatic stress

The Japan Times, p.6, Unattributed (Japan), 10/01/2009

Tetris could block flashbacks

Computeractive, p.12, Unattributed (UK), 22/01/2009

Tetris prevents mental anguish

Men's Health -Main-, 01/07/2009, p.33, Unattributed

What are the benefits of Tetris?

BBC News Online (Magazine), 03/09/2009, Mark Yates

http://news.bbc.co.uk/1/hi/magazine/8233850.stm

The 9th Annual Year in Ideas: Treating P.T.S.D. With Tetris

New York Times, 14/12/2009, Clive Thompson

http://www.nytimes.com/projects/magazine/ideas/2009/?hp#social_science-13

The player

The Guardian -G2-, 28/01/2010, p.17, Naomi Alderman

http://www.guardian.co.uk/technology/2010/jan/28/the-player-games-relax-you

Radio: Today

BBC Radio 4, 25/03/2010, 7.14am

http://news.bbc.co.uk/today/hi/today/newsid_8586000/8586459.stm

Tetris, trauma and the brain

BBC News, Today programme online pages, Tom Feilden, 25/03/2010

http://news.bbc.co.uk/today/hi/today/newsid_8587000/8587211.stm

Tetris may help erase memories of trauma

The Daily Telegraph, 26/03/2010, p.15, Unattributed

http://www.telegraph.co.uk/science/science-news/7521136/Tetris-could-reduce-long-term-stress-after-major-trauma.html

Appendix 7.4. Public Communication (News) Coverage in Response to Previous Research that had used Tetris Game Play to Reduce Flashbacks to Analogue Trauma (Holmes et al., 2010)

Neuroscientists explore erasing bad memories

BBC News, World Service online pages, 26/03/2010

http://www.bbc.co.uk/worldservice/news/2010/03/100325_erasing_memories_hs.shtml

Traumatised? Tetris could help relieve impact of traumatic memories, say scientists

Broadband Genie, 25/03/2010

http://www.broadbandgenie.co.uk/news/20100325-tetris-could-help-ease-trauma-say-scientists

Radio: Bill Heine

BBC Radio Oxford, Bill Heine, 25/03/2010, 4.32pm

Radio: Anna Cookson

BBC Radio Oxford, 25/03/2010, 6.12am

Radio: Ray Clark

BBC Radio Essex, 25/03/2010, 6.21am

Radio: Andrew Edwards and Georgey Spanswick

BBC Radio Leeds, 25/03/2010, 6.40am

Radio: Matthew Gudgin

BBC Radio Norfolk, 25/03/2010, 6.42am

Radio: Steve Le Fevre

BBC Radio Bristol, 25/03/2010, 6.49am

Radio: The Islands at One

BBC Radio Guernsey, 25/03/2010, 1.27pm

The science of fear

BBC Focus, p. 26, Daniel Bennett, 01/07/10

When it comes to traumatic flashbacks, Tetris blocks

New Scientist Online, Duncan Graham-Rowe & Debora MacKenzie, 10/11/2010

http://www.newscientist.com/article/dn19710-when-it-comes-to-traumatic-flashbacks-tetris-blocks.html

Playing computer game Tetris can reduce trauma flashbacks

The Daily Telegraph, p. 20, Unattributed, 11/11/10

TETRIS TRAUMA: If you have [...]

Metro, p. 28, Unattributed, 11/11/10

Appendix 7.4. Public Communication (News) Coverage in Response to Previous Research that had used Tetris Game Play to Reduce Flashbacks to Analogue Trauma (Holmes et al., 2010)

Traumatized? Playing Tetris may reduce flashbacks

CNN, The Chart blog, Sarah Klein, 11/11/10

http://pagingdrgupta.blogs.cnn.com/2010/11/10/traumatized-playing-tetris-may-reduce-flashbacks/

Study: Playing Tetris to Prevent PTSD Flashbacks

Time Magazine, Healthland blog, Sora Song, 10/11/10

http://healthland.time.com/2010/11/10/study-playing-tetris-to-prevent-ptsd-flashbacks/

Why Does Playing Tetris Help Reduce Trauma?

ABC News, Ki Mae Heussner, 10/11/10

http://abcnews.go.com/Technology/playing-tetris-reduce-trauma-flashbacks/story?id=12099590

Tetris could prevent post-traumatic stress disorder flashbacks (but quiz games make them worse)

Discover Magazine, Not Exactly Rocket Science blog, Unattributed, 10/11/10

http://blogs.discovermagazine.com/notrocketscience/2010/11/10/tetris-could-prevent-post-traumatic-stress-disorder-flashbacks-but-quiz-games-make-them-worse/

Radio: Europe Today

BBC World Service, 15/11/10, 5.51pm

http://www.bbc.co.uk/iplayer/episode/p00bsmbk/Europe_Today_15_11_2010/

Radio: All in the Mind

BBC Radio 4, 23/11/2010, 9pm and BBC Radio 4, 24/11/2010, 4.30pm

http://www.bbc.co.uk/iplayer/episode/b00w200f/All_in_the_Mind_23_11_2010/

Radio: Fry's English Delight Winter Special: Word Games

BBC Radio4, 28/12/10, 09:21

Radio: Health Check

BBC Radio 4, 08/02/11, 1.53am

Tetris-PTSD Study Suggests Video Game Curbs Flashbacks, Other Symptoms

Huffington Post (US), 25/04/2012, Robin Nixon

http://www.huffingtonpost.com/2012/04/25/tetris-ptsd-study-flashbacks_n_1453465.html

Oxford Doctors Can Prevent Post-Traumatic Stress Disorder With… Tetris?

Gizmodo Australia, Katie Drummond, 02/05/12

http://www.gizmodo.com.au/2012/05/oxford-doctors-can-prevent-post-traumatic-stress-disorder-with-tetris/

Appendix 8.1. Presentation Given by the Forced Migration Trauma Service at the London Assembly (1/5)

Central and North West London NHS
NHS Foundation Trust

Meeting the Mental Health Needs of London's Refugee and Asylum Seekers

Dr. Brock Chisholm & Kerry Young
The Forced Migration Trauma Service

Wellbeing for life

THE SCALE OF THE PROBLEM

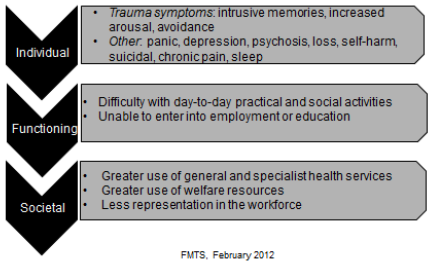
The Scale of the Problem

- Mental Health- PTSD etc. focus on PTSD
  –
- Practical problems
- Agency, social isolation and doing stuff
- How many with mh probs working/in education? At least can do our

FMTS, February 2012

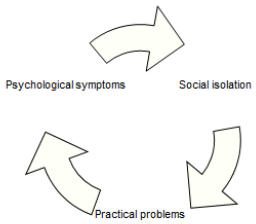
IMPACT

Levels of Impact



FMTS, February 2012

Impact



FMTS, February 2012

TREATMENT: HOW DO WE HELP WITH THIS?

How do we help with this?

- **Recent systematic review (Nickerson et al.,2011)**
- **Identifies two main approaches to treating mental health difficulties in refugees:**
  1. **DOMINANT: Multimodal i.e. practical, social, occupational, medical & general counselling**
  2. **LESS PREVALENT: Trauma-focused therapy i.e. Cognitive-Behavioural Therapy (CBT) or Narrative Exposure Therapy (NET)**

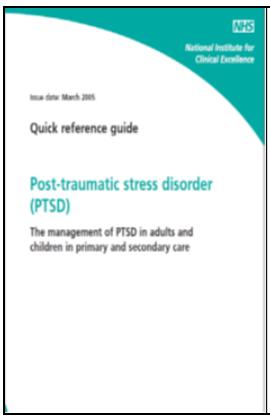
FMTS, February 2012

Appendix 8.1. Presentation Given by the Forced Migration Trauma Service at the London Assembly (3/5)

How do we help with this?

- **MULTIMODAL:**
  no evidence of significant changes in PTSD, anxiety or depression symptoms in studies reviewed for the dominant approach
- **TRAUMA-FOCUSED:**
  evidence of significant reductions in PTSD and depression symptoms
- **NB lack of large-scale studies**

FMTS, February 2012



NATIONAL INSTITUTE FOR CLINICAL EXCELLENCE (NICE)

Evidence-based treatment guidelines

" **Differences of culture or language should not be an obstacle to the provision of effective trauma-focused psychological intervention.**"

(paragraph 2.3.7.3. 4)

EVIDENCE-BASED THERAPIES

- NICE guidelines provide model of best practice
- Phased model of intervention

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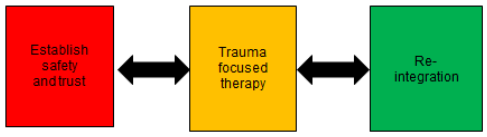
NICE Phased Model of Intervention



Phase One Phase Two Phase Three

FMTS, February 2012

THE FORCED MIGRATION TRAUMA SERVICE (FMTS)

Service offering evidence-based treatment for refugees and asylum seekers

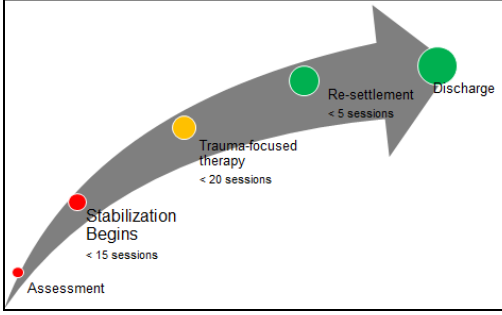
Offers unique stepped care service

Step 1: Stabilization and Support
Step 2: Trauma-focused therapy
Step 3: Re-settlement/re-integration

Patients continue to receive support throughout

FMTS, February 2012

Service-Patient Time-Line



What is Stabilization Phase?

Up to 15 goal-focused sessions with a Support Worker or Social Worker to help with:

- Housing
- Benefits and financial difficulties
- Asylum process
- Increasing community integration (e.g. learning English, socialising)
- Increasing meaningful activity (e.g. exercise, educational courses, voluntary work)
- Targeting and reducing health-related appointments

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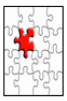
Appendix 8.1. Presentation Given by the Forced Migration Trauma Service at the London Assembly (3/5)

What is Stabilization Phase?

THEN (for some) 10 week Psycho-education courses will provide information about…

PTSD, depression and other common anxiety disorders



Evidence-based self-help interventions

- for sleep difficulties
- low activity levels
- somatic anxiety symptoms
- difficulties with problem solving

What is Trauma-focused Therapy Phase?

- Disturbing trauma memories are not fixed and untreatable
- Specialized treatment, involving detailed discussion of trauma, significantly reduces symptoms
- Up to 20 sessions of evidence-based therapy offered i.e. trauma-focused CBT or NET

FMTS, February 2012

What is Re-settlement Phase?

Up to 5 sessions over 6 months with Support Worker or Social Worker

Case Example – Mr A

- **41 years old**
- **Fled Iraq after 2 year's torture in prison**
- **Speaks Arabic**
- **Suffering from severe PTSD and Depression**
- **Socially isolated, 'paranoid', avoids leaving the house**
- **Missed mandatory benefits appointments, benefits stopped, housing under threat**
- **Visiting GP weekly, complaining of headaches/severe body pain**

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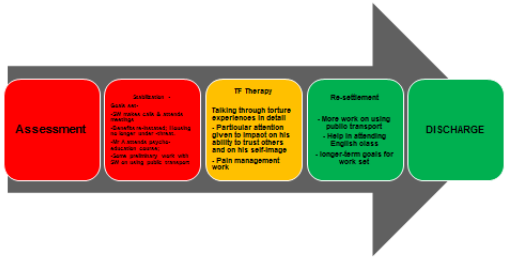
Case Example – Mr A



FMTS, February 2012

DOES IT WORK?

Appendix 8.1. Presentation Given by the Forced Migration Trauma Service at the London Assembly (4/5)

Treatment Effectiveness

Limited resources in NHS

Need to ask the questions:

1. Does it work?
2. Is it better than other available treatments: outcomes & cost?

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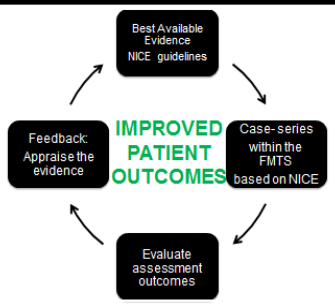
EVIDENCE-BASED PRACTICE



Measuring Effectiveness Using Evidence: Assessment Measures

Individual	***Trauma symptoms*:** CAPS (structured interview), IES-R ***Other symptoms*:** Depression (PHQ-9), Anxiety (GAD-7)
Impaired Functioning	***Impaired functioning***: Questionnaires examining; levels of day-to-day activity, pre-occupation with social/practical problems, trust, self-efficacy & phobic avoidance
Impact on Society	Questionnaires examining: GP / other specialist health care attendance levels & employment and education status

EVALUATION

- **3 year research plan, first phase outcome data available April 2012**
- **Characteristics FMTS Clients:**
  - **'extremely severe' PTSD**
  - **moderate depression**
  - **multiple trauma (7+ *types* trauma)**
  - **low levels activity**

PEDICTED OUTCOMES

- **PTSD < 66% remission at 6 mth follow-up**
- **PTSD <75% remission at one yr follow-up**
- **At one year:**
  - **75% learning English**
  - **50% in vocational training or voluntary/ paid work**
  - **65% reduction in health-related appts**

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What are the problems implementing this?

- 'Firefighting' practical problems at the expense of increasing activity.
- Huge demand, 'bottle neck' for trauma-focused therapy
- Current resources dictate we have to restrict the number of sessions we offer. Would more sessions have significantly positive outcomes?
  - E.g. Off medication, out of healthcare services and into work.

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Unanswered questions?

- When is the best time to provide psychological therapy for PTSD?
- What resources do we have in London? What works for whom and when? How do we know?
- Which problems are best addressing at what time?
  - PTSD or adjustment/loss?

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Multiple problems multiple difficulties

- Scattered approach to providing PTSD treatment. Complex trauma requires specialist knowledge and increased resources above standard CBT skills.
  - TSS closing, no other refugee/ AS specific team for PTSD in London.
  - No other PTSD specialist service that has support and social work in UK
- There are many agencies statutory and voluntary providing a range of resources. How can we best integrate and work together to produce the best outcome?

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Multiple problems multiple solutions

- A shared goal or vision between services
  - Which would include a shared understanding of what works.
- An economic analysis of how best to use and integrate help.
- More data collection.

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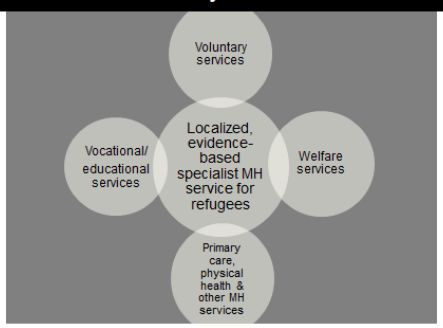
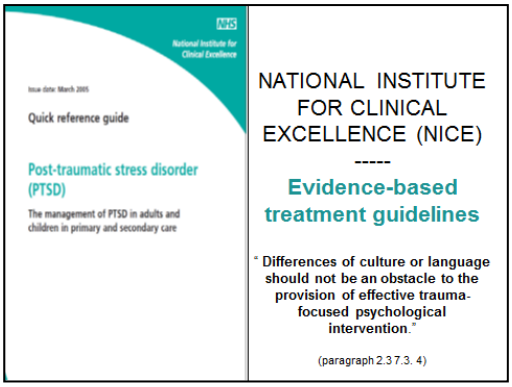
The Way Forward



End

- **NICE Guidelines:** Phased model of treatment
- **Possible to use evidence-based treatment with this group**
- **Need to evaluate what we do and review in light of results**



THANK YOU

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