INFORMATION UPDATING AND AUTOBIOGRAPHICAL MEMORY IN POSTTRAUMATIC STRESS DISORDER



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ABSTRACT

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Cognitive theories suggest that information updating and autobiographical memory characteristics may play a role in the development and maintenance of PTSD symptoms (e.g., Ehlers & Clark, 2000). This thesis presents five studies that examine memory updating of negative and neutral associated memories, negative and positive appraisals about strangers, and disorganised trauma memories in posttraumatic stress disorder (PTSD). Study 1 demonstrated that low mood but not anxiety tended to be associated with difficulties with updating negative compared to neutral associative memories (Chapter 2). Study 2 found that relative to a sample of control participants, people with PTSD had difficulties with updating neutral compared to negative associative memories. Updating performance for neutral material was related to changes in memory characteristics with PTSD treatment (Chapter 3). Study 3 demonstrated that compared to controls, trauma survivors with PTSD showed more change in negative appraisals about strangers with negative information, compared to change in positive appraisals with positive information. Interpersonal distressing events in both groups tended to be associated with difficulties in updating appraisals about strangers (Chapter 4). Study 4 demonstrated that compared to controls, trauma survivors with PTSD reported poorer memory recall and more memory disjointedness of their traumatic event, but not of a negative control event. Poor recall and memory disjointedness improved with PTSD treatment (Chapter 5). Study 5 demonstrated that in healthy participants, exposure to a trauma film led to more disjointed memories of the film compared to exposure to a neutral film. Memory disjointedness partly mediated the relationship between peri-traumatic cognitive processing and re-experiencing symptoms after trauma film exposure (Chapter 6). The findings provide support for the cognitive model of PTSD (Ehlers & Clark, 2000), and suggest that difficulties in updating neutral information, the development of negative appraisals, and poor memory recall and memory disjointedness of trauma memories may contribute to the maintenance of PTSD symptoms.

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INTRODUCTION AND LITERATURE REVIEW

Introduction

Trauma survivors with posttraumatic stress disorder (PTSD) re-experience parts of their traumatic event as if it was happening again (Ehlers, Hackmann, & Michael, 2004). In these moments, they seem to have difficulties accessing information that would update the impressions and expectations they had during the trauma (e.g., 'I am going to die'). They also often struggle to intentionally recall certain aspects of the trauma (American Psychiatric Association [APA], 2013). Furthermore, trauma survivors with PTSD often have strong negative beliefs about the world and others, feel easily startled and struggle to regain a feeling of safety after their traumatic experience (APA, 2013). Cognitive theories (e.g., Brewin, Dalgleish, & Joseph, 1996; Brewin, Gregory, Lipton, & Burgess, 2010; Ehlers & Clark, 2000; Foa, Tekette, & Rothbaum, 1989) suggest that the memory of the trauma is poorly elaborated. Ehlers and Clark (2000) further suggest that problems integrating parts of the trauma memory into its autobiographical context may prevent initial appraisals during trauma (e.g., 'I am going to die') from being updated with the actual outcome (e.g., 'I did not die'). They further suggest that this contributes to a sense of current threat when the memories are triggered, and to the development of excessively negative beliefs that are thought to be the second source of current threat in PTSD.

Although updating the trauma memory and changing dysfunctional negative appraisals are important procedures in trauma-focused Cognitive Therapy for PTSD (CT-PTSD; Ehlers, Clark, Hackmann, McManus, & Fennell, 2005; Ehlers & Clark, 2000), little is known in the literature about how non-trauma memories are updated, and how negative appraisals about strangers are developed and maintained in PTSD. Low mood, hypervigilance and memory biases towards negative information in the aftermath of the trauma may contribute to the development and maintenance of negative appraisals about the world and others, and prevent memories of negative experiences from being updated with new information. Similarly, even though cognitive theories of PTSD suggest that the nature of the trauma memory plays an important role in the development and maintenance of PTSD symptoms (e.g., Brewin et al., 2010; Ehlers & Clark, 2000), the quality of trauma memories is still poorly understood. It remains unclear which aspects of memory disorganisation are specific to trauma memories in PTSD, and which cognitive processes before and during a trauma may lead to poorly-elaborated trauma memories. Further, it is not yet understood how these cognitive processes and the quality of the trauma memory relate to the development of PTSD re-experiencing symptoms.

This thesis examines information updating and autobiographical memory characteristics in PTSD, and their relationship to PTSD treatment. It aims to contribute to a better understanding of the development and maintenance of negative appraisals, disorganised trauma memories, and re-experiencing symptoms in PTSD. It further aims to contribute to understanding processes that may play a role in recovery from PTSD with treatment, and why most, but not all, PTSD patients recover with CT-PTSD. This project focuses on four cognitive processes that may play a role in the development and maintenance of PTSD symptoms: updating memories of negative and neutral material; development and maintenance of negative appraisals about strangers; trauma memory

disorganisation; and peri-traumatic cognitive processing. This introductory chapter will firstly give an overview of PTSD, different aspects of memory, and of Ehlers and Clark's (2000) cognitive model of PTSD. It will then review the cognitive processes that are relevant for this thesis. It will review the phenomena of hypervigilance and memory biases in PTSD, and give an overview on the current literature on memory updating and appraisals. Finally, it will focus on the characteristics of the trauma memory in PTSD, and describe the literature on peri-traumatic cognitive processing and its relationship to memory characteristics and re-experiencing symptoms.

Posttraumatic Stress Disorder (PTSD)

After experiencing a traumatic event such as a sexual assault or road traffic accident, some people develop a psychiatric condition called posttraumatic stress disorder (PTSD)[1].

Definition of Trauma

A traumatic experience is defined under Criterion A of the diagnostic criteria for PTSD in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; APA, 2013). A trauma is defined as an experience that involves exposure to actual or threatened death, a serious injury, or sexual violence (APA, 2013). According to the DSM-5, an event counts as a trauma when a person was exposed to it directly, witnessed it in person, or learned about a close relative or friend who was exposed to such an event. Learning about the actual or threatened death of someone close can only be classified

[1] Note that PTSD is not the only psychiatric disorder that people may develop after a traumatic experience. For example, studies found that major depressive disorder, anxiety disorders, and substance misuse are also common following a trauma (e.g., Ehring, Ehlers, & Glucksman, 2008; Fullerton, Ursano, & Wang, 2004; Mayou, Bryant, & Ehlers, 2001; Shalev et al., 1998).

as a trauma if it was violent or accidental. Finally, the indirect exposure to aversive details of an event can be classified as a trauma in case of repeated or extreme exposure, for example exposure during professional duties (e.g., first responders). In previous versions of the DSM, the trauma criterion also involved the presence of subjective responses towards the event, such as fear, helplessness and horror (DSM-IV; APA, 1994). These subjective responses are no longer included in the newest version of the DSM. This thesis will refer to the trauma definition of DSM-5, unless otherwise specified.

Definition of PTSD

In the DSM-5 (APA, 2013), PTSD is classified under 'trauma and stressor-related disorders'. In addition to the exposure to a traumatic event (Criterion A), trauma survivors need to have symptoms of four other diagnostic criteria to qualify for a diagnosis of PTSD. Firstly, a trauma survivor needs to have at least one re-experiencing symptom, such as involuntary recollections of the trauma, strong physical reactions to trauma reminders, or nightmares (Criterion B). Secondly, a trauma survivor needs to show efforts to avoid trauma-related cues. Potential trauma-related cues may be internal, such as thoughts, or external, such as certain places that remind them of what happened (Criterion C). Thirdly, a trauma survivor needs to show changes in mood and cognitions, such as excessive negative beliefs about the world and others, or distorted self-blame (Criterion D). Fourthly, a trauma survivor should show changes in their arousal and reactivity, such as irritability, hypervigilance or exaggerated startle responses (Criterion E). PTSD can be diagnosed when the symptoms persist for more than a month, and are associated with significant distress or functional impairment. Table 1.1 displays the full diagnostic criteria of PTSD according to DSM-5.

Table 1.1

Diagnostic criteria of PTSD according to the DSM-5 (APA, 2013)

Epidemiology

Many people experience a traumatic event at some point in their lives. A recent survey on adult mental health in the England, United Kingdom (Adult Psychiatric Morbidity Survey; McManus, Bebbington, Jenkins, & Brugha, 2016) suggests that about one third (31.4%) of adults in England have been exposed to a traumatic event at some point in their lives[2]. About four out of 100 people (4.4%) qualified for a PTSD diagnosis for their symptoms in the past month (current PTSD). Of these, about half were receiving treatment for their mental health difficulties, which was mostly medication (about 40%) or psychological therapy (about 25%). Large epidemiological studies that were conducted in the United States found even higher prevalence rates of trauma exposure and PTSD. At the time of assessment, up to 90% of people in a community sample had experienced a traumatic event at some point in their life (lifetime

[2] Studies that were conducted in Germany and Switzerland found 20 to 28% of the people had experienced a traumatic event according to DSM-IV (Hepp et al., 2006; Perkonigg, Kessler, Storz, & Wittchen, 2000).

prevalence of trauma; Breslau et al., 1998; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995; Kilpatrick et al., 2013; Norris, 1992), and about 8% of the community sample had developed PTSD at some point in their lives (lifetime prevalence of PTSD; Breslau et al., 1998; Kessler et al., 1995; Kilpatrick et al., 2013). Women showed higher lifetime prevalence rates of PTSD than men (13% vs. 6%; e.g., Kilpatrick et al., 2013). Sexual violence and combat exposure were the two traumatic experiences that were most likely to result in PTSD (Kessler et al., 1995). To date, most studies examined trauma and PTSD prevalence rates according to the criteria of DSM-IV. A recent study by Kilpatrick and colleagues (2013) compared PTSD prevalence rates according to DSM-IV and DSM-5 criteria. They found similar but slightly lower prevalence rates for both, traumatic experiences and PTSD according to DSM-5 compared to DSM-IV. According to the authors, lower PTSD prevalence rates in DSM-5 could mainly be explained with (1) changes in the Criterion A (exclusion of non-violent deaths) and (2) the necessity of showing at least one symptom of active avoidance.

Memory

PTSD is associated with specific characteristics of the trauma memory, such as intrusive re-experiencing symptoms and difficulties in the voluntary recall of the trauma (APA, 2013). A better understanding of memory functioning in PTSD may therefore help to better understand the factors that contribute to the development and the maintenance of PTSD symptomatology. While a detailed review on the principles of memory would exceed the scope of this thesis, the following section will give a brief overview of the terms and theories relevant for the series of studies presented in this thesis.

Autobiographical Memory

Autobiographical memories are memories for facts and events that concern the self, and are crucial for experiencing the self as a stable individual in the context of time and place (Conway & Pleydell-Pearce, 2000; K. Nelson & Fivush, 2004). The cognitive model of PTSD (Ehlers & Clark, 2000) builds on the model of autobiographical memory by Conway and Pleydell-Pearce (2000). This section will therefore focus on this specific model and only those aspects relevant for this thesis will be reviewed. Conway and Pleydell-Pierce (2000) suggested that all autobiographical memories are event representations within a self-memory system (SMS). This SMS contains an autobiographical knowledge base with all information about the past, including the context of time and the relationship with the self for each event. They further suggested that the autobiographical knowledge base is organised hierarchically and contains information with different levels of specificity, namely lifetime periods (e.g., when at university), general events (e.g., trip to Paris), and event-specific knowledge that contains details of the event (e.g., which music was playing). The structures at higher-order levels (e.g., when at university) can provide the context for the information at the lower levels (e.g., trip to Paris). This allows an individual to organise new experiences and memories in time and space. Event-specific knowledge on the lowest level contains the details and sensory information from the events, and contributes to the vividness of the recollections of event memories. This aspect is particularly relevant for PTSD, as trauma survivors with PTSD often re-experience sensory information from the trauma (e.g., Hackmann, Ehlers, Speckens, & Clark, 2004).

Overgeneral Memory Recall

Retrieval of specific memories is thought to help maintain the sense of self (Conway & Pleydell-Pierce, 2000). Williams and Broadbent (1986) were the first to

investigate memory specificity in individuals. They presented suicidal patients and control participants with positive and negative cue words and asked them to retrieve a memory that came into their mind in response to the cue word (Autobiographical Memory Test; AMT; Williams & Broadbent, 1986). They found that the suicidal patients had difficulties in retrieving specific memories (e.g., at my friend's birthday party last week), and instead often recalled memories that comprised a category of events (e.g., I used to go for a walk with the dog). Healthy participants retrieved specific events in response to most cue words (80%). Since then, it has been shown that people with depression or anxiety disorders often show difficulties in retrieving specific memories (overgeneral memory bias; e.g., Williams et al., 2007). This phenomenon will be discussed in more detail in the section on memory biases in PTSD.

Episodic Memory

Episodic memory comprises information about episodes and events, their temporal information, as well as their temporal-spatial relationship with other events (Tulving, 1985, 2002). An episode or event involves the interaction of different sets of entities, such as individuals or objects, that occur in the context of time and space. During episodic memory encoding, the entities are bound together with spatial and temporal context information (e.g., Nadel, Hupbach, Gomez, & Newman-Smith, 2012). Episodes and their context information are preserved by a series of processes that are commonly referred to as memory consolidation (Alberini, Bambah-Mukku, & Chen, 2012; Davis & Squire, 1984; McGaugh, 2000). Trauma memories often seem to lack this temporal and context information that is thought to be specific for episodic memories (e.g., Hackmann et al., 2004).

Associative Memory

Associative memory refers to a form of memory that binds several entities together. For example, associative memories can provide context information for a single object (e.g., the object's location or colour), or bind two separate objects together. It can either contain intrinsic information about an object, such as its colour or location, or extrinsic details, such as another object (e.g., Mather & Sutherland, 2011). It can be tested with paired recognition tests, in which participants are shown pairs of objects, and in a subsequent recognition phase, asked to either give confidence or yes/no ratings for whether they have encountered that pair before. Alternatively, participants can be presented with one pair of the association, and participants are asked to recollect their intrinsic details (e.g., their location), or the matching object (e.g., another picture). Encoding associations between objects or intrinsic details correctly can provide relevant context information during episodic memory encoding. It was found that emotions influence how well associative memories are encoded and remembered (e.g., Mather & Sutherland, 2011). This may be particularly relevant for trauma memory encoding, as traumatic experiences are highly stressful, and trauma survivors with PTSD show strong hyperarousal in the aftermath of a trauma. A better understanding of the effect of emotions on associative memory may help to explain the memory phenomenology in PTSD.

Memory and Information Updating in PTSD

Intrusive re-experiencing of traumatic memories is one of the core symptoms of PTSD (DSM-5; American Psychological Association, 2013). At the same time, trauma survivors with PTSD have problems intentionally recalling aspects or details of the trauma. Cognitive models aim to consider how these characteristics can explain the

development and maintenance of PTSD (e.g., Ehlers & Clark, 2000).

Re-Experiencing in PTSD

Clinical observations show that intrusive memories are often short sensory impressions from the trauma. They mostly occur in the form of images, and may also comprise strong physical reactions, emotions or thoughts (e.g., Hackmann et al., 2004). The memories of the trauma usually pop into mind involuntarily and unexpectedly, and often lack contextual information (e.g., what happened before and afterwards). Therefore, when re-experiencing parts of the trauma, PTSD patients often relive the fear and horror of the trauma as if it was happening again. In these moments, they seem to be unable to access other information, often from after the trauma, that puts these moments into perspective (e.g., the fact that they survived and are safe now). This can be illustrated by the example of a survivor of a road traffic accident who kept having intrusive memories of the flashlights of the car coming towards him right before the accident. In these situations, he did not seem to be aware that this was a memory of the past and that the accident was over and he survived (Ehlers et al., 2004). Another example is a woman whose daughter died during a fire. At the time of the fire, she thought that her daughter was burning alive in the house. It later turned out that her body was unburnt and that she had instead died by being overcome by fumes. However, the patient kept re-experiencing an image of the burning curtains and the horror of the thought that her daughter was burning alive. She did not connect her impressions from during the trauma with the knowledge she acquired afterwards (Ehlers et al., 2004).

Ehlers and Clark's Cognitive Model of PTSD

Cognitive models aim to account for the phenomenology of re-experiencing symptoms in PTSD (e.g., Brewin et al., 1996, 2010; Ehlers et al., 2005; Foa et al., 1989).

The following section will mainly focus on Ehlers and Clark's (2000) cognitive model of PTSD, as it is most relevant for this thesis. Ehlers and Clark (2000) suggested that the nature of the trauma memory and excessive negative appraisals of the trauma or its sequelae can explain why PTSD symptoms sometimes persist in trauma survivors. They suggested that they are the two sources of a sense of current threat, which is seen as a central factor in maintaining PTSD symptoms. For example, trauma survivors often do not feel safe after their traumatic experience, even though there is often no longer an objective danger. This sense of current threat is thought to lead to dysfunctional coping strategies, such as avoidance or hypervigilance towards threat cues, that in turn may maintain PTSD symptoms. Figure 1.1 displays Ehlers and Clark's (2000) cognitive model. The following section will focus on two core aspects of the model that are most relevant for this thesis, namely the nature of the trauma memory and excessively negative appraisals.

Figure 1.1. Ehlers and Clark's (2000) cognitive model of PTSD.

Nature of the Trauma Memory. It was suggested that trauma memories are poorly elaborated, meaning they do not contain all the relevant information about what happened during the trauma. It was further suggested that the memory lacks integration into its autobiographical memory context so that it is not linked to the information about what happened before and afterwards (e.g., Brewin et al., 1996, 2010; Ehlers & Clark, 2000; Foa et al., 1989; Siegel, 1995). This context information (often obtained after the trauma) may contradict the expectations that people had during these moments. As it is not properly linked, it was suggested that the worst moments of the trauma are prevented from being updated with this information and excessively negative meanings of trauma are maintained (e.g., Ehlers & Clark, 2000). At the same time, the poor elaboration and integration of the trauma memories may lead to the easy triggering of re-experiencing symptoms by matching cues that contribute to maintaining a sense of current threat. This means that re-experiencing symptoms are often triggered by stimuli that physically resemble those that were present during the trauma (e.g. have a similar colour or shape), rather than having a meaningful connection to the trauma (e.g., a knife). This, in turn, can result in the impression that the re-experiencing symptoms are coming out of the blue, and may lead to excessive avoidance behaviours (e.g., Ehlers et al., 2002).

Excessively Negative Appraisals. Ehlers and Clark (2000) suggested that excessively negative appraisals (e.g., 'It is my fault' or 'The world is a dangerous place') are another source of a sense of current threat in PTSD. They imply threatening negative consequences for the future, either externally (about the world and other people), or internally (about the view of the self). According to Ehlers and Clark (2000), the negative appraisals also motivate behaviours that maintain the sense of current threat. For example, the appraisal 'The world is a dangerous place' may lead to avoidance of

places and people associated with the trauma, preventing disconfirmation of the belief. It may also lead to hypervigilance to potential dangers and negative experiences after the trauma, i.e., information that confirms the negative belief. Avoidance of attending to the trauma memory prevents full processing of the memory and the information it contains, and limits the elaboration and integration of the trauma memory with other information in autobiographical memory.

Cognitive Therapy for PTSD

Trauma-focused CT-PTSD has been shown to be an effective treatment for PTSD (Ehlers et al., 2003, 2014, 2005). It has been found to be superior for alleviating PTSD symptoms, general anxiety, and disability, compared to another credible psychological treatment for PTSD, such as emotion-focused supportive therapy (Ehlers et al., 2014), and has shown effectiveness in community and routine clinical settings (Duffy, Gillespie, & Clark, 2007; Ehlers et al., 2013; Gillespie, Duffy, Hackmann, & Clark, 2002). One of its core procedures is to update the worst moments of the trauma with new information to change the negative appraisals made at the time, and thereby reduce their threatening meanings for the present. The worst moments of the trauma and their meanings are identified (e.g., 'It is my fault'). Then, the memory is elaborated and missing details (e.g., 'I could not have fought back because I was threatened with a knife'), post-trauma information (e.g., 'I am safe now'), or the results from cognitive restructuring (e.g., 'It is not my fault as there was nothing I could do'), are integrated into the memory of the worst moments of the trauma. It has been found that CT-PTSD leads to a change in the quality of re-experiencing symptoms and reduces the feeling that the trauma is happening again (lack of time perspective) in intrusive memories (Ehlers et al., 2004; Speckens, Ehlers, Hackmann, & Clark, 2006). This shows that trauma-focused treatments affect memory characteristics of unwanted trauma

memories. It has not been investigated which aspects of disorganisation in voluntary trauma memory recall are affected by successful treatment of PTSD. To the author's knowledge, only one study has directly investigated the effect of trauma-focused cognitive behavioural therapy (CBT) on changes in non-trauma autobiographical memory retrieval in PTSD. In this study, Sutherland and Bryant (2007) examined changes in memory specificity in PTSD patients before and after CBT using the AMT (Williams & Broadbent, 1986; see section on overgeneral memory recall for further information about the AMT). Participants were asked to recall specific memories in response to five positive and negative cue words. They found that PTSD patients showed improvements in specific memory recall for positive cue words, and less retrieval of categorical memories in response to positive cue words after CBT. They concluded that CBT helped the PTSD patients accessing specific memories about positive experiences.

Hypervigilance and Memory Biases in PTSD

As described above, the cognitive model of PTSD (Ehlers & Clark, 2000) suggests that a sense of current threat is central for the maintenance of PTSD symptoms. It is possible that high levels of arousal and hypervigilance towards potential threat cues may affect memory performance. As PTSD has high comorbidity with depression, the effect of low mood on attention and memory will also be reviewed.

Emotion and Memory

A trauma is a highly stressful experience, and people with PTSD have high levels of arousal in its aftermath (APA, 2013). In order to understand memory processes in PTSD, it is necessary to gain a basic understanding of how stress influences memory. A detailed review of all findings on the relationship between emotions and memory

exceeds the scope of this thesis. Therefore, this section will give a brief overview on the literature examining the influence of emotion on memory, before exploring how emotion may influence attention and memory processes in PTSD. Many studies have illustrated that memories for negative stimuli and events are influenced by the emotional reactions that they evoke, such as fear or sadness. For example, Easterbrook (1959) suggested that stress leads to a narrowing of the focus of attention. In line with this, it was found that in highly stressful situations, people remembered central details of an event better than peripheral details (for reviews, see Christianson, 1992; Laney, Campbell, Heuer, & Reisberg, 2004; Levine & Edelstein, 2009). When emotionally-arousing objects (e.g., a snake) were placed in neutral scenes (e.g., a desert), participants remembered the central objects better than the surroundings (e.g., Kensinger, Garoff-Eaton, & Schacter, 2007). It seems to be clear that emotion influences memory for events, but it is not well understood which parts of the event are remembered better or worse, and under which conditions emotion leads to memory enhancements or impairments (for reviews, see Kensinger, 2009; Mather & Sutherland, 2011). A large amount of studies examined the effects of emotion on context memory and memory associations in the laboratory. Findings from these studies suggest that memory may be enhanced for intrinsic details, such as colour or location, of emotional items compared to neutral items, and may lead to impairments in memory for neutral context information, such as other objects, that is not directly part of the emotional item (e.g., D'Argembeau & Van der Linden, 2004; Doerksen & Shimamura, 2001; MacKay & Ahmetzanov, 2005; Mather, Gorlick, & Nesmith, 2009; Nashiro & Mather, 2011). This may be relevant during a traumatic experience, as features, such as location, may provide relevant context information that may later help to integrate the memory into time and space. It is, however, not well understood how emotions during trauma

influence memory, and how people with PTSD remember context information. The following section will discuss the literature that examines the role of emotions in memory and PTSD.

Hypervigilance in PTSD

A number of studies have demonstrated that trauma survivors with PTSD show a processing bias towards trauma-related words (for a review, see Buckley, Holohan, Greif, Bedard, & Suvak, 2004). Several studies used a stroop colour-naming paradigm (Mogg, Mathews, & Weinman, 1989) to investigate attention biases towards trauma-related words. In this task, trauma survivors with and without PTSD are usually asked to name the colour of neutral words (e.g., input), positive words (e.g., love), PTSD words (e.g., bodybags), and sometimes words related to other disorders (e.g., germs). It was found that participants with PTSD took more time to name the colour of the PTSD-related words compared to other words (e.g., Dalgleish et al., 2003; Foa, Feske, Murdock, & Kozak, 1991; Kaspi, McNally, & Amir, 1995; McNally, English, & Lipke, 1993; McNally, Kaspi, Riemann, Bradley, & Zeitlin, 1990; Vrana, Roodman, & Beckham, 1995), indicating that the meaning of the word involuntarily attracted attention (stroop interference). A study by Vrana and colleagues (1995) found that participants showed better recall and recognition memory for the trauma-related words, indicating that the prolonged response times in the stroop tasks may indeed be related to an attention bias rather than the general avoidance of the stimuli, which would be associated with poorer memory for these stimuli. Other studies used dot-probe tasks (Mogg et al., 1989) to examine attention biases in PTSD. In this task, target stimuli are presented in the same location as one of two words that were previously presented on the screen. Participants are asked to respond to the target stimuli. Attention biases are associated with faster response times towards the target stimuli when they appear in the

location of the trauma-related word. Using this paradigm, studies found that PTSD was associated with an attention bias towards trauma-related words (e.g., Dalgleish et al., 2003). Several studies also found that the attention bias in PTSD is related to difficulties disengaging from trauma-related stimuli, rather than enhanced detection of potential threat cues (Pineles, Shipherd, Mostoufi, Abramovitz, & Yovel, 2009; Pineles, Shipherd, Welch, & Yovel, 2007). These studies suggest that trauma survivors with PTSD show attention biases towards threat-related stimuli. Recent studies further used eye tracking tasks to examine attention biases in PTSD of visual material. They found that trauma survivors with PTSD showed an attention bias towards visual trauma-related stimuli (Kimble, Fleming, Bandy, Kim, & Zambettti, 2010; Thomas, Goegan, Newman, Arndt, & Sears, 2013), and also negative material in general (e.g., Kimble, Fleming, Bandy, & Zambettti, 2010). However, attention biases may not necessarily be reflected in memory. The next section will therefore discuss memory biases in PTSD.

Memory Biases in PTSD

Difficulties with the trauma memory are a core symptom of PTSD (APA, 2013). However, the question of whether trauma survivors with PTSD have general difficulties in memory is more controversial. To date, it remains unclear in what way alterations in memory are related to PTSD symptomatology. Studies showed that people with PTSD had more difficulties with verbal memory of neutral material, compared to trauma survivors without PTSD and non-traumatised controls (Brewin, Kleiner, Vasterling, & Field, 2007; Johnsen & Asbjørnsen, 2008). Brewin (2011) described that the effects are small to moderate, and stable for immediate and delayed recall of verbal material. He further argued that it is difficult to determine whether difficulties in memory may have preceded the trauma, as lower intelligence, amongst others, was found to be a risk factor for PTSD (Andrews, Brewin, Rose, & Kirk, 2000). Furthermore, it was found that

trauma survivors with PTSD were more likely to recall trauma-related compared to neutral material (Golier, Yehuda, Lupien, & Harvey, 2003; Paunovic, Lundh, & Öst, 2002; Vrana et al., 1995), demonstrating a retrieval advantage of trauma-related material. Similar to people with a diagnosis of major depression, trauma survivors with PTSD also have difficulties in recalling specific memories (overgeneral memory bias; Moore & Zoellner, 2007; Williams et al., 2007). Overgeneral memory bias has been found to predict the development of PTSD in firefighters (Bryant, Sutherland, & Guthrie, 2007; Hauer, Wessel, Engelhard, Peeters, & Dalgleish, 2009; Kleim & Ehlers, 2008), and was found to decrease after successful treatment (Sutherland & Bryant, 2007).

Influence of Low Mood on Attention and Memory

Attention and memory biases towards negative material are also common in people with mood disorders and are thought to play an important role in the development and maintenance of depressive symptoms (Abramson, Alloy, Hankin, & Haeffel, 2002; e.g., Abramson & Seligman, 1978; Beck, 1967; Bohon, Stice, Burton, & Fudell, 2008; Hankin, 2008; Meites, Deveney, Steele, & Holmes, 2008). Many studies have shown that people with depression are more sensitive to negative stimuli and are more likely to neglect positive stimuli (e.g., Gotlib, Krasnoperova, & Yue, 2004). Studies also showed an explicit memory bias for recalling negative information compared to neutral information (e.g., Mathews & MacLeod, 2005; Matt, Vázquez, & Campbell, 1992; Williams et al., 2007). For example, Matt and colleagues (1992) found in a meta-analysis that depressed participants were more likely to recall negative compared to neutral information, whereas non-depressed participants showed better recall for positive compared to negative information in the majority of the examined studies.

Updating Emotional Non-Trauma Memories

In everyday life, it is not only important to remember new information but also to adapt previously encountered information when the environment changes. Memory flexibility and the ability to update memories is an adaptive process and necessary to keep memories relevant and up to date (e.g., Lee, 2009; Sakaki, Gorlick, & Mather, 2011). After a traumatic experience, memory flexibility may help the incorporation of new information (e.g., 'I did not die', 'I am safe now'), to adjust initial trauma appraisals or appraise situations following the trauma adaptively. This may contribute to regaining a sense of safety. For example, a trauma survivor who was assaulted in a car park may need to update their learned association between the location of the trauma and the traumatic experience, in order to remember that this particular or other similar places are not dangerous anymore. In the following section, different lines of research will be reviewed that can provide an insight into memory flexibility in PTSD.

Updating the Value of the Same Stimulus

Several studies have investigated the phenomenon of updating the affective values of learned associations (e.g., previously negative stimuli that are not negative anymore) in trauma survivors with PTSD. Most of these studies have used extinction learning paradigms. In these paradigms, participants learn that a stimulus that has previously been paired with a negative stimulus (e.g., an electric shock) does not predict a negative stimulus anymore.

In typical fear conditioning studies, participants firstly learn a fear response towards a new stimulus. In these studies, participants repeatedly learn that a conditioned stimulus or context (CS; e.g., noise) is associated with an unconditioned stimulus (UCS; e.g., mild electric shock). The UCS (e.g., mild electric shock) initially evokes a fear response (UCR), whilst the CS initially does not lead to a fear response. The learned

association between CS and UCS, however, results in a conditioned response (CR; fear response) towards the previously non-threatening CS (e.g., noise). As a next step, it is examined how easily participants forget the learned association between the CS and UCS (extinction learning). The CS is presented without the shock (CS-noUCS), which should usually lead to a decrease in the fear response as the participant learns the new association (the CS is no longer associated with the UCS). Several studies found that trauma survivors with PTSD showed heightened conditioned responses during extinction learning, indicating that they had more difficulties updating their learned associations of emotional memories for fear-provoking stimuli once they were not relevant anymore (e.g., Blechert, Michael, Vriends, Margraf, & Wilhelm, 2007; Lissek, Powers, McClure, & Phelps, 2005; Orr, Metzger, Lasko, & Macklin, 2000). It was suggested that this could mean that people with PTSD might have difficulties learning that previously-threatening cues no longer predict danger, or that they initially showed stronger conditioned fear responses that were more difficult to extinguish (Norrholm, Jovanovic, Olin, & Sands, 2011). Furthermore, it was found that individual differences in extinction learning predicted the development of PTSD symptoms (e.g., Guthrie & Bryant, 2006; Lommen, Engelhard, & Sijbrandij, 2013). These studies give an important insight into emotional memory updating in trauma survivors with PTSD, and suggest that individual differences in updating fear associations may be important in PTSD. It might, however, not always be possible to change the affective value of certain stimuli in the context of trauma. For example, a rape victim would usually not change their appraisal that the perpetrator is dangerous in the aftermath of the trauma, nor would their fear necessarily extinguish upon meeting the perpetrator again. It is therefore necessary to better understand how memory can be updated when the value of the information does not change.

Memory Reconsolidation

As described earlier, CT-PTSD (Ehlers et al., 2005; Ehlers & Clark, 2000) aims to identify relevant information that generates a new perspective on the appraisals of the trauma and integrate it into the trauma memory to update the appraisals and reduce the sense of current threat. For example, a rape victim might now know that the perpetrator was sentenced and went to prison. Integrating the information about the perpetrator's new location would be important to change the feeling of current threat that the victim may have, even though it would not change how they feel about the perpetrator himself. To the author's knowledge no study has investigated directly how PTSD patients integrate such new information, and whether there are differences in the kind of information that they integrate (e.g., negative or neutral information). Only a few studies have investigated the ability to update remembered information in healthy samples.

As discussed previously, memories are usually stable over time once they have been transferred into long-term memory through a memory process called memory consolidation (Alberini et al., 2012; Davis & Squire, 1984; McGaugh, 2000). A growing number of studies showed that consolidated memories can be updated through reactivation of the original memory, a process termed memory reconsolidation (e.g., Alberini & LeDoux, 2013; Hupbach, Gomez, Hardt, & Nadel, 2007; Jacques & Schacter, 2013; Nader & Einarsson, 2010). These studies on memory reconsolidation can provide initial evidence on people's ability to integrate new information into an existing memory (memory updating). Most studies found that the exposure to new information, at the time of reactivation, interfered with previously learned information. For example, in a typical study, participants learn a list of items (usually words) in the first session (Day 1). A second list of different items is learned on a subsequent day (usually two days later; Day 2), which is presented after a reminder from List 1. The

reminder consists of a brief reactivation of the previous learning experience. Participants are asked to recall the procedure of the task on Day 1, without recalling specific items of List 1. Participants are then asked to recall the items from List 1 on a subsequent day (usually five days later). If items from List 2 intrude into the recall of List 1, this is interpreted as indirect evidence that the later learned information (List 2) has been integrated in the initial memory (List 1) (Hupbach et al., 2007; Schwabe & Wolf, 2009).

One study also investigated the effects of stress on memory reconsolidation after episodic memory updating. The same paradigm was used, but a psychosocial stressor task was performed after participants had learned List 1 on Day 1, and List 2 on Day 2 (two days later), after having been asked to recall the learning procedure of Day 1. For stress induction, the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993) was used. In this task, participants are asked to prepare a speech and give it in front of two judges that evaluate their performance. It was found that the psychosocial stress induction after List 2 learning resulted in fewer intrusions of List 2 items into List 1 memory recall at follow-up (Dongaonkar, Hupbach, Gomez, & Nadel, 2013). This finding suggests that stress may impair the reconsolidation process and is particularly interesting when considering the impact of a trauma, which by nature evokes a high level of stress. Trauma survivors with PTSD also show a continuing high arousal in the aftermath of the trauma (APA, 2013), which may diminish their ability to integrate new or post-trauma information into the original trauma memory trace, and thereby impair memory updating.

Adding New Information to an Existing Memory

Findings from behavioural studies further suggest that adding new information to existing emotional memories is more difficult than adding information to neutral memories. For example, in a study by Mather and Knight (2008), participants learned

that neutral faces predicted either negative or neutral pictures. Afterwards, participants were asked to learn intrinsic information (location) about the neutral faces that were presented together with new neutral and negative faces. Although participants were better at remembering the location of the 'new negative' compared to the 'new neutral' faces, they had more difficulties remembering the location of neutral faces that had been associated with negative pictures compared to neutral pictures in the previous learning trial. The authors concluded that even if the affective value of the memories does not need to be updated, previously-learned negative information interferes more with new learning compared to previously-learned neutral information (e.g., Mather & Knight, 2008; Novak & Mather, 2009). It was suggested that emotional stimuli are associated with higher arousal, which may lead to strong binding of the initial association between the emotional item and their context. This, in turn, may impair the binding of new information to the existing memory (e.g., Novak & Mather, 2009).

Proactive Interference

Another line of literature can shed light on how neutral information is integrated into memory in PTSD. In studies of proactive memory interference, it is usually investigated whether previously learned information interferes with new learning in short term memory (e.g., Wickens, Born, & Allen, 1963). Studies investigating interference from previously-learned material in trauma survivors with PTSD used the Auditory Verbal Learning Test (AVLT; Rey, 1964). In this task, participants complete five learning trials for List 1, and then learn a second list. The difference in the number of words learned from List 1 (first trial) and List 2 is calculated and counted as proactive interference when performance for List 2 items is impaired compared to the initial performance for List 1 items, as these were learned before any potentially interfering material was encoded. It was found that veterans with PTSD showed more proactive

interference from previous learning compared to veterans without PTSD (Uddo, Vasterling, Brailey, & Sutker, 1993; Yehuda & McFarlane, 1995). These two studies looked at the learning and updating of neutral material in trauma survivors with PTSD. However, the valence of stimuli, and arousal at the time of learning (as a result of the stimulus valence, baseline arousal from PTSD, or both), may play an important role in the ability to update memories in PTSD. Recent studies on memory interference of arousing and non-arousing material provide some evidence that negative memories seem to be subject to greater memory interference compared to neutral ones. For example, in a study by Novak and Mather (2009), healthy college students were asked to learn picture locations of negative and neutral pictures and were tested on their location memory of each picture afterwards. After four learning and test trials, half of the pictures changed location and participants were asked to remember the new picture locations. When participants were asked to indicate the newly-learned picture locations after having completed some filler tasks, participants made more errors for negative compared to neutral picture locations. The authors suggested that emotional stimuli, such as the negative pictures, have stronger feature binding between picture and location when they are initially learned and are therefore more difficult to update.

Negative Appraisals in PTSD

The previous section reviewed the literature on updating non-trauma memories. Negative affect and appraisals are common in psychiatric disorders such as major depressive disorder (MDD) or PTSD. The following section will review the effect of trauma on appraisals, and the literature on how appraisals are developed and updated in general, and in PTSD particularly. As people with PTSD show low mood as well as

hyperarousal, literature for MDD and PTSD will be reviewed. Evidence from different lines of research on healthy participants will be discussed.

Development of Negative Appraisals

It has been long known that cognitive appraisals shape emotions (e.g., Oatley & Johnson-Laird, 1987; Smith, Haynes, Lazarus, & Pope, 1993) and influence how events are remembered (e.g., Levine, 1997; Levine, Prohaska, Burgess, Rice, & Laulhere, 2001). It was found that negative information has a greater effect on evaluations than positive information (negativity bias; e.g., Amabile & Glazebrook, 1982; Ito, Larsen, Smith, & Cacioppo, 1998). The experience of a traumatic event can shatter the fundamental assumptions that people have about themselves and the world (e.g., Janoff-Bulman & Frieze, 1983). Studies on cognitions in trauma survivors suggest that the experience of a trauma requires an adaptation of automatic cognitive schemas and heuristics to integrate the traumatic experience into their own view of the self and the world (e.g., Janoff-Bulman, 1989). Epidemiological studies show that interpersonal traumatic events, such as assault or rape, are more likely to lead to persistent PTSD symptomatology compared to other traumatic experiences, such as natural disasters or road traffic accidents (e.g., Breslau et al., 1998). This may suggest that the experience of interpersonal violence may make people particularly vulnerable to negative cognitions, such as overgeneralised perception of danger and mistrust in other people, and may therefore require more efforts to adapt fundamental assumptions about the world and others.

Maintenance of Negative Appraisals

Dysfunctional coping strategies, such as selective attention towards negative information or avoidance of people and places associated with the trauma, are thought

to contribute to the maintenance of negative judgements and beliefs about others and the world (e.g., Ehlers & Clark, 2000). Trauma survivors with PTSD were found to have an attention bias towards trauma-related material (e.g., Kimble, Fleming, Bandy, Kim, et al., 2010; Thomas et al., 2013), which may contribute to maintaining a sense of current threat, and negative appraisals about others. Appraisals can be updated through a cognitive process that is often called reappraisal. Cognitive reappraisal involves a cognitive change of appraisals in a way that helps to change negative appraisals by reducing the emotional impact of a situation (e.g., Gross & John, 2003). Several studies on emotional regulation in PTSD found that trauma survivors with PTSD underutilised reappraisal strategies (Eftekhari, Zoellner, & Vigil, 2009; Ehlers & Clark, 2000; Ehring & Quack, 2010; Moore, Zoellner, & Mollenholt, 2008). These studies assessed reappraisal using self-report measures to examine how much reappraisal was used as an emotion regulation strategy. However, accurate appraisals depend on the information that is available. To successfully update appraisals with new relevant information, it needs to be linked with previous information that led to the initial appraisals. Hypervigilance, anxiety and low mood may influence how information is linked and appraisals are updated. The following sections will give an overview of the research to date.

Working Memory Updating

Updating expectations and impressions from the trauma is necessary to overcome the sense of current threat in people with PTSD (e.g., 'I survived', 'I am safe now'). In the aftermath of the trauma, it is necessary to update appraisals when the environment changes, so that overgeneralised appraisals about the world and others can be disconfirmed. Adapting initial expectations and appraisals may help to gain back a sense of safety (e.g., 'Some people can be trusted'). Little is known about how people

with PTSD develop negative appraisals in the aftermath of the trauma, and how they adapt their initial impressions when new information becomes available.

Even though studies have not directly investigated impression updating in MDD and PTSD, research on working memory updating may help to better understand this process. The working memory holds all information that is currently conscious and available for cognitive reasoning (e.g., Baddeley, 2003). Working memory updating is seen as one of the central processes that keep the working memory content relevant, for example substituting outdated information with new relevant information (e.g., Morris & Jones, 1990). Most studies have shown that people with MDD have difficulties updating information in working memory (working memory updating; Harvey, Bastard, Pochon, & Levy, 2004; Joormann & Gotlib, 2008). In particular, people with MDD struggled to disengage from mood-congruent sad material, whilst finding it easier to disengage from happy information, compared to healthy control participants (Levens & Gotlib, 2010). This suggests that increased attention to mood-congruent (in this case sad) information may be associated with problems integrating mood-incongruent (in this case happy) information (Joormann & Gotlib, 2010). Only a few studies have investigated working memory updating in trauma survivors with PTSD. Most of these studies did not find differences in behavioural measures for working memory updating (e.g., Clark, McFarlane, Morris, & Weber, 2003; Weber, Clark, McFarlane, & Moores, 2005). However, studies found abnormal patterns of neural activation, such as abnormal frontal and parietal activity (e.g., Moores, Clark, McFarlane, & Brown, 2008; Weber et al., 2005). This suggests that there may be differences in brain activity during working memory updating, but that these may not result in difficulties disengaging from negative

material in working memory. However, the sample sizes of these studies may not have been big enough to detect behavioural differences[3].

Updating Initial Impressions of People

Another line of research that may help examine the role of appraisal updating in PTSD is research investigating person impression updating. Some studies investigated the effect of incongruent information on appraisals in healthy samples. In these studies, participants were presented with faces of people that were paired with negative or positive behaviours (e.g., 'Anna spat at someone'). Participants were then asked to rate their impressions of each person. Participants saw each person's face five times with a different behaviour each time, starting with neutral information (introduction of the person; 'This is X'). For half of the faces, participants received congruent negative or positive information consistently throughout the five trials (e.g., one neutral, four positive behaviours). For the other half of the faces, participants received incongruent information after three trials (e.g., one neutral, two positive, two negative behaviours). Studies found that participants had more difficulties updating incongruent person impressions from negative towards positive, than from positive towards negative valence (Mende-Siedlecki, Baron, & Todorov, 2013; Mende-Siedlecki, Cai, & Todorov, 2013). As reviewed in previous sections, trauma survivors with PTSD show hypervigilance towards threat, low mood and strong negative beliefs about the world and others (APA, 2013). This is likely to influence subsequent appraisals after the

[3] Note that the findings refer to behavioural outcome measures that were assessed as part of neuroscientific studies, but were not the primary outcome measures of these studies. The study by Moore and colleagues (2008) assessed 13 PTSD patients and 12 non-traumatised control participants. The study by Weber and colleagues (2005) examined ten PTSD patients and ten control participants (not specified whether traumatised or non-traumatised controls).

trauma and may affect ability to reappraise initial impressions, including those of other people. To the author's knowledge, no study to date has examined how trauma survivors with PTSD update initial person impressions.

Trauma Memory Disorganisation in PTSD

The previous sections reviewed memory and appraisal updating with regard to non-trauma memories. The most evident memory disturbance in PTSD is related to the memories of the trauma itself. As discussed above, cognitive theories assume that poor elaboration of the trauma memories and their poor integration into the autobiographical memory base play an important role in the development of PTSD re-experiencing symptoms (e.g., Ehlers & Clark, 2000; Brewin, 2010). In the following section, relevant aspects of memory disorganisation will be discussed, and the current literature on memory disorganisation will be reviewed.

Aspects of Memory Disorganisation

The concept of disorganisation of the trauma memory has long been discussed in the PTSD literature. It was suggested, for example, that the trauma memory in people with PTSD is fragmented (van der Kolk & Fisler, 1995), disorganised (e.g., Halligan, Michael, Clark, & Ehlers, 2003), and disjointed from the rest of the autobiographical memory context (e.g., Ehlers et al., 2004). However, the exact use of these terms differs widely throughout the PTSD memory literature, and the concepts are not used consistently with regards to either intentional recall of the trauma memory, or intrusive involuntary trauma memories. For example, Ehlers and colleagues (2004) argued that the idea of fragmented trauma memories was developed by van der Kolk and Fisler (1995) to explain the characteristics of involuntary trauma memories in PTSD, as these memories often occur as short sensory impressions that are not linked to the rest of the

trauma. They further argued that most studies investigate the question of disorganised memories by examining difficulties with the intentional recall of the traumatic event, such as difficulties remembering the order in which the event happened. Consequently, different studies that examined trauma memory disorganisation used the terms memory disorganisation (Halligan, Michael, Clark, & Ehlers, 2003), coherence of the overall trauma narrative (e.g., Rubin, 2011), or memory distortion (e.g., Segovia, Strange, & Takarangi, 2016). In this thesis, the term 'memory disorganisation' will be used with regard to difficulties in the intentional recall of trauma memories.

Memory Disorganisation in PTSD

A variety of studies have investigated memory disorganisation in PTSD with subjective (self-report) and objective (independent ratings of trauma narratives). Several studies investigated memory disorganisation in people with and without PTSD using subjective self-report measures. Most of these studies showed that trauma survivors with PTSD reported more disorganised trauma memories compared to trauma survivors without PTSD (e.g., Halligan et al., 2003; Jelinek, Randjbar, Seifert, Kellner, & Moritz, 2009). Other studies used objective ratings of written trauma narratives, in which independent raters or computer software programs rated the overall trauma narrative for consistency and coherence. They generally showed that trauma survivors with PTSD (e.g., Hagenaars, Minnen, & Hoogduin, 2009; Halligan et al., 2003, Study 1; Jelinek et al., 2009; Jones, Harvey, & Brewin, 2007) had more disorganised trauma memories compared to participants without PTSD (for negative results, see O'Kearney, Hunt, & Wallace, 2011; Rubin, Boals, & Berntsen, 2008). It is less clear whether memory disorganisation is specific to trauma memories, or whether people with PTSD also have disorganised non-trauma memories, suggesting a general impairment in autobiographical memory. Several studies compared characteristics of trauma memories

to those of negative control events. They found that memory disorganisation in self-report measures (Halligan et al., 2003) and objectively rated trauma narratives (Jelinek et al., 2009) was specific to trauma memories in PTSD. However, other studies did not find this effect in self-report measures (Jelinek et al., 2009; Megías, Ryan, & Vaquero, 2007; Rubin et al., 2008) and objective ratings of trauma narratives (Rubin, 2011).

Findings from Trauma Film Studies

Memory disorganisation can also be studied in the laboratory. In these studies, aversive film material is used in order to model trauma in the laboratory. This allows experimental control over the traumatic stimulus and enables the investigation on how risk factors and cognitive processes are related to the development of PTSD-like symptoms. Studies have shown that the qualities of intrusions that are induced by trauma films resemble those reported by trauma survivors with PTSD (Holmes, Holloway, Brewin, & Hennessy, 2004; Laposa & Alden, 2006). Several studies found that after trauma film exposure, memory disorganisation was related to the development of re-experiencing symptoms (e.g., Halligan, Clark, & Ehlers, 2002, Study 2). To the author's knowledge, only one study has used the trauma film paradigm to directly manipulate memory disorganisation during encoding (Segovia et al., 2016). The study manipulated the order in which the film scenes were shown. Participants were exposed to a trauma film and either saw the film scenes in the correct order, or in a mixed order. However, there was no relationship between the encoding of the correct or mixed order of the film scenes and the development of re-experiencing symptoms (Segovia et al., 2016). However, this study manipulated the encoding of the temporal order of the overall trauma narrative, and did not investigate which particular aspects of the trauma film may be relevant to update negative appraisals from the film. In the following, evidence

on difficulties in the voluntary recall of the trauma memory and disjointedness of the worst moments of the trauma in PTSD will be reviewed.

Poor Memory Recall of the Trauma

Clinical observations show that trauma survivors with PTSD remember the gist of what happened in the trauma well, but struggle to access some details about the trauma, or are confused about the temporal order in which the event happened (Ehlers et al., 2004). It is less clear whether these characteristics are different compared to memories of other emotional events. For example, it was argued that autobiographical memory encoding never comprises all details of an event, and that it is a normal process that memory recall is not complete but needs to be reconstructed (e.g., McNally et al., 1993). A study by Porter and Bird (2001) investigated whether trauma memories contained more or fewer details compared to positive events in undergraduates. They found that the trauma narratives consisted of more details compared to the positive narratives. However, confusion about the temporal order, or a lack of recall of detail may not necessarily be central for the development of PTSD symptoms. It was argued that remembering details from the event or the order in which things happened are only relevant for the development of PTSD if they relate to the meaning that trauma survivors make of the trauma (Ehlers & Clark, 2000; Ehlers et al., 2004). This can be illustrated by the example of a rape victim who felt extremely guilty for not having fought back enough during the event. It turned out that she had been threatened with a knife but did not intentionally recall this particular aspect when thinking about the event (Ehlers et al., 2004). Hence, the lack of recalling the knife was the missing detail that contributed to the negative appraisals of the trauma, and having difficulties remembering other details from the rape may not have had an effect on her negative appraisals or PTSD symptoms. This suggests that trauma memory recall may play a role in the development

and maintenance of PTSD. However, it would also be important to better understand which parts of the trauma memory may be particularly relevant in the development and maintenance of PTSD symptoms.

Disjointedness of the Worst Moments of the Trauma

Traumatic events can span a considerable amount of time, and not all parts are re-experienced. Thus, the disorganisation of trauma memories may mainly apply to the moments that are re-experienced. A study by Evans, Ehlers, Mezey and Clark (2007) rated the disorganisation of trauma narratives in perpetrators of violent crime with and without intrusive memories. Global disorganisation ratings of moments that were re-experienced were higher than disorganisation of other random segments of the trauma narrative. Similarly, a study by Jelinek et al. (2010) found differences in some but not all disorganisation measures for the worst moments compared to the rest of the trauma narrative. This suggests that the worst moments of the trauma may be more disorganised than the rest of the trauma memory. Ehlers and colleagues (2004) therefore suggested that disorganisation of the whole traumatic memory is less important for explaining PTSD than the disjointedness of the worst moments of the trauma (those that are later re-experienced) from other autobiographical memories. More precisely, they assume that these worst moments are poorly integrated into their context, such as what happened before or afterwards. This lack of connection to context information may account for the typical characteristics of involuntary trauma memories, such as a lack of time perspective ('nowness'), and may explain the difficulties of accessing post-trauma information whilst re-experiencing trauma memories (Ehlers et al., 2004). Kleim, Wallott and Ehlers (2008) investigated the disjointedness of trauma and non-trauma memories experimentally in assault survivors with and without PTSD. They asked participants to complete an autobiographical memory retrieval task while they were

listening to a narrative of the worst moments of their trauma and a negative control event. They found that trauma survivors with PTSD needed more time to retrieve other unrelated autobiographical information while listening to the trauma, compared to the non-trauma memory. Trauma survivors without PTSD did not show slower memory retrieval during the trauma script of the worst moments of their trauma. They concluded that the worst parts of the trauma were poorly connected to the autobiographical memory base so that, whilst listening to the worst parts of the trauma, people with PTSD had difficulties accessing other information from autobiographical memory. This suggests that disjointedness of the worst moment may be associated with PTSD, and may play an important role in the development and maintenance of PTSD symptoms.

Peri-Traumatic Cognitive Processing

In the previous section, it was discussed whether trauma memories are disorganised. Cognitive theories assume that cognitive processing styles, such as perceptual processing and dissociation, during the trauma (peri-traumatic cognitive processing) may contribute to the development of disorganised trauma memories. It was suggested that the high emotional impact of the trauma leads to increased perceptual (data-driven) processing and strong dissociation during the trauma, whilst at the same time leading to decreased conceptual processing (e.g., Ehlers & Clark, 2000). The following section will describe the cognitive processing styles that are thought to play a role during trauma, and provide an overview of the current literature on their relationship to the development of PTSD symptomatology and disorganised trauma memories.

Strong Perceptual Processing

Data-driven processing refers to a processing style that promotes the encoding of surface level information, such as colours and shapes. Conceptual processing focuses

on the meaning of the information and thereby places what is happening into context (e.g., Roediger, 1990). It was suggested that conceptual processing allows the formation of elaborated memories that can be retrieved in a controlled voluntary manner (Schacter, Alpert, & Savage, 1996). Surface-level encoding that focuses on perceptual features, on the other hand, is thought to lead to poorly elaborated memories that are easily retrieved by perceptually matching triggers (Roediger, 1990).

Strong State Dissociation

Dissociation can be described as a loss of the connection of a person with their own thoughts, memories, actions, or sense of self. It can involve depersonalisation, derealisation, altered bodily perceptions, distorted sense of time and numbing of emotions. Depersonalisation is described as a sense of being outside the body, or watching the scene or the own body from above. Derealisation involves a disconnection from the surroundings, in which a person may feel that things are not real. Whilst having these experiences, people are aware that this is unusual (APA, 2013). It has been suggested that strong peri-traumatic dissociation is associated with poor encoding during the trauma, and therefore may lead to disorganised trauma memories and re-experiencing symptoms (e.g., Brewin et al., 2010; Ehlers & Clark, 2000; van der Kolk & Fisler, 1995).

Peri-Traumatic Cognitive Processing and PTSD

Several prospective studies with trauma survivors found that peri-traumatic dissociation and data-driven processing predicted the development of PTSD symptoms after a traumatic experience (e.g., Breh & Seidler, 2007; Halligan et al., 2003; Murray, Ehlers, & Mayou, 2002; Ozer, Best, Lipsey, & Weiss, 2003). It was also found that peri-traumatic dissociation and data-driven processing were associated with memory

disorganisation (Halligan et al., 2003; Murray et al., 2002). Several studies used trauma film paradigms to investigate peri-traumatic cognitive processing and its relationship to re-experiencing symptoms and memory disorganisation. There is some evidence that peri-traumatic cognitive processing after analogue trauma is related to disorganised trauma memories (e.g., Halligan et al., 2002) and re-experiencing symptoms (e.g., Holmes et al., 2004; Sachschal, Suendermann & Ehlers, in prep.). However, the findings of previous studies are inconclusive. Some studies manipulated the cognitive processing styles during trauma film encoding to investigate their relationship with PTSD symptoms. For example, Halligan et al. (2002) asked healthy participants to engage in data-driven processing and instructed them to become absorbed in the sounds and images. They found that data-driven processing was related to the development of intrusive memories after the trauma film, and to less coherent memories of the film. A study by Kindt, van den Hout, Arntz, and Drost (2008) did not find that data-driven processing was associated with more intrusions after an analogue trauma film compared to neutral encoding styles. Instead, they found that engaging into conceptual processing reduced the development of intrusions. Several studies also aimed to manipulate state dissociation during the trauma film. For example, several studies used dual tasks or hypnosis to experimentally induce dissociation in participants (e.g., Hagenaars, van Minnen, Holmes, Brewin, & Hoogduin, 2008; Holmes, Oakley, & Stuart, 2006). They did not find that experimentally induced dissociation was related to more re-experiencing symptoms. Sachschal and colleagues (in prep.) measured self-reported peri-traumatic cognitive processing in two trauma film studies and found that peri-traumatic data-driven processing and state dissociation were related to the development of intrusive memories after an analogue trauma film. Some studies also found that peri-trauamtic state dissociation was related to subjective self-reported memory

fragmentation, but not to objectively-assessed memory coherence (Kindt & Van Den Hout, 2003; Kindt, Van Den Hout, & Buck, 2005). To sum up, the studies came to inconclusive results, depending on whether cognitive processing was manipulated during the trauma film (e.g., Holmes et al., 2006), or whether it was assessed with self-report measures directly after the trauma film exposure (e.g., Sachschal et al., in prep.). Furthermore, it was found that cognitive processing was associated with self-reported memory fragmentation, but not with objective coherence ratings of the trauma narrative. It was suggested that cognitive processing and memory fragmentation may be related to perceived fragmentation rather than actual memory characteristics (e.g., Kindt & Van Den Hout, 2003). More research is needed to better understand whether the manipulation of cognitive processing during a trauma film can successfully model cognitive processing during trauma, and whether self-report measures of cognitive processing administered after trauma film exposure can properly assess subjective impressions of cognitive processes during the trauma.

Summary and Aims of the Thesis

This chapter reviewed the relevant literature on memory updating, appraisals, the quality of trauma memories in PTSD, and peri-traumatic cognitive processes that are thought to contribute to memory characteristics in PTSD. To date, little is known about how symptoms associated with PTSD, such as low mood or hyperarousal, may influence associative memory updating and appraisals about strangers. It also remains unclear whether the quality of trauma memories in PTSD differs in memory qualities from other negative memories, as well as which cognitive processes contribute to the development of disorganised trauma memories, and how the qualities of trauma memories change with PTSD treatment and after recovery.

The studies described in this thesis use experimental paradigms that were derived from basic memory and neuroscience literature, as well as self-report measures to investigate information updating and autobiographical memory in PTSD. This thesis examines (1) differences in associative memory updating for negative versus neutral material in people with anxiety, low mood, and PTSD, and the effect of negative and positive information on appraisals about strangers in PTSD, (2) qualities of trauma memories in PTSD, in particular, different aspects of memory disorganisation, (3) the role of memory processes in PTSD recovery after cognitive therapy for PTSD (4) the role of pre-trauma and peri-traumatic cognitive processes in the development of memory disorganisation and re-experiencing symptoms after trauma exposure.

A total of five studies address these aims. Study 1 used a location-updating paradigm to investigate how low mood and anxiety influence the way in which negative and neutral associative non-trauma memories are updated (Chapter 2). Study 2 applied the same paradigm in a study of trauma survivors with PTSD and control participants to investigate how trauma survivors with PTSD update negative and neutral memories, and how their ability to update these is related to changes in memory following PTSD treatment (Chapter 3). Study 3 used an updating task to examine how negative and positive information influences the development of initial impressions of people, and whether the ease with which such initial impressions are updated is influenced by PTSD and / or negative interpersonal experiences (Chapter 4). Study 4 uses self-report measures to examine qualities of memories for traumatic and negative non-traumatic control events in a sample of trauma survivors with and without PTSD, as well as non-traumatised controls. It further examined how the quality of memories changes with PTSD treatment (Chapter 5). Study 5 used a trauma film paradigm to examine the role of (1) memory updating performance before the trauma and (2) peri-traumatic cognitive

processing in the development of disjointed trauma memories and re-experiencing symptoms (Chapter 6).

Hypotheses and Theoretical Background

Ehlers and Clark's (2000) cognitive model of PTSD suggests that the nature of the trauma memory and excessive negative trauma appraisals contribute to a sense of current threat in trauma survivors with PTSD. This sense of current threat is thought to be central in the maintenance of PTSD symptoms, as it motivates dysfunctional coping strategies that maintain PTSD symptomatology, such as thought suppression, rumination, safety behaviours, avoidance and selective attention to threat (Ehlers & Clark, 2000).

The thesis aims to explore how low mood, anxiety, and PTSD may influence how negative and neutral associative non-trauma memories are updated. It also aims to examine how negative and positive information might affect the development of appraisals in trauma survivors with PTSD. Ehlers and Clark's (2000) cognitive model of PTSD suggests that PTSD is associated with difficulties in linking initial impressions during the trauma with new information that may change the negative meaning of the trauma. It has not been investigated experimentally how trauma survivors with PTSD update negative and neutral information, and how they develop and maintain appraisals about strangers in the aftermath of the trauma. Previous studies have found that healthy participants had difficulties updating negative compared to neutral associative memories (e.g., Novak & Mather, 2009), as well as difficulties updating initial negative person impressions with positive information (e.g., Mende-Siedlecki, Cai, & Todorov, 2013). People with major depressive disorder (MDD) were found to have difficulties disengaging from sad information in working memory, resulting in difficulties updating

working memory content with new information (Levens & Gotlib, 2010). Other studies found that people with PTSD showed attention biases towards visual trauma-related material (e.g., Kimble, Fleming, Bandy, Kim, et al., 2010; Thomas et al., 2013). It is conceivable that low mood in people with PTSD may lead to difficulties disengaging from initial negative compared to neutral information, and may be associated with stronger initial binding of negative material to its context. This would lead to more difficulties updating negative material, and to the development of more negative appraisals that are difficult to update. On the other hand, hyperarousal and selective attention to negative information in PTSD may be associated with increased attention to changes in negative material and thereby lead to better updating performance of negative compared to neutral material. The following research questions are examined:

(1) Does mood and anxiety influence how negative and neutral associative memories are updated (Study 1, Chapter 2)?
(2) How do trauma survivors with PTSD update negative and neutral associative memories (Study 2, Chapter 3)?
(3) How do trauma survivors with PTSD or interpersonal trauma appraise strangers, and update initial negative or positive information about them (Study 3, Chapter 4)?

Furthermore, the thesis aims to examine the quality of trauma memories. Cognitive models of PTSD suggest that the trauma memory is poorly elaborated and disorganised (e.g., Brewin et al., 2010; Ehlers & Clark, 2000). In line with this, trauma survivors with PTSD often have difficulties recalling details or the order of the traumatic event (‘poor memory recall’; Ehlers et al., 2004). However, studies that examined whether disorganised memories are specific to trauma memories in PTSD have come to

inconsistent conclusions. Whereas most studies found more disorganised trauma memories in those with PTSD, compared to traumatised controls without PTSD (e.g., Halligan et al., 2003), it is less clear whether memory disorganisation is specific to trauma memories (e.g., Jelinek et al., 2009). Ehlers et al. (2004) suggested that the worst moments of the trauma are not fully integrated into the rest of the autobiographical memory base ('disjointedness of the worst moments'). Some studies examined the worst moments of the trauma and found support for this hypothesis (Evans et al., 2007; Jelinek et al., 2010; Kleim et al., 2008). The following research questions are examined:

(4) Are trauma memories in PTSD more disorganised, and the worst moments of the trauma more disjointed compared to other non-traumatic negative memories, and compared to trauma memories in people without PTSD (Study 4, Chapter 5)?

(5) Does the exposure to an analogue trauma (upsetting film) lead to more disorganised film memories and more disjointedness of the worst moment of the film compared to exposure to a neutral film (Study 5, Chapter 6)?

This thesis further examines whether memory updating performance before PTSD treatment predicts treatment outcomes and whether the quality of trauma memories changes with PTSD treatment. Memory updating is a common procedure in trauma-focused CT-PTSD (Ehlers et al., 2005; Ehlers & Clark, 2000). To update the negative trauma appraisals, new (often post-trauma) information is integrated into the trauma memory to change the meaning of the trauma. Previous studies have found that trauma memory characteristics, such as the quality of 'here and now', change with PTSD treatment (Ehlers et al., 2004; Speckens et al., 2006), and cognitive theories suggest that PTSD symptoms are reduced by integrating disjointed trauma memories

into the autobiographical memory base (e.g., Ehlers & Clark, 2000). It can therefore be hypothesised that PTSD treatment leads to changes in the quality of the trauma memory. Furthermore, selective attention towards negative information, or difficulties integrating new information into memory before the start of treatment may influence changes in memory characteristics, and PTSD treatment outcomes. The following research questions are examined:

(6) Does the quality of trauma memories change with successful PTSD treatment (Study 4, Chapter 5)?

(7) Is associative memory updating performance before treatment related to PTSD treatment outcomes (Study 2, Chapter 3)?

Finally, this thesis examines whether memory updating performance before analogue trauma exposure, and peri-traumatic cognitive processing, were associated with the development of memory disorganisation and re-experiencing symptoms in healthy participants. Memory flexibility helps to keep the memory relevant and up to date (e.g., Lee, 2009). Research with healthy participants suggests that arousal leads to more difficulties updating negative compared to neutral material (e.g., Novak & Mather, 2009). As a traumatic experience is highly stressful, it is possible that pre-trauma memory flexibility may influence how well new information can be integrated during trauma. Furthermore, it has been shown that cognitive processes during peri-traumatic encoding of trauma films are related to memory disorganisation (e.g., Halligan et al., 2002) and PTSD symptoms (e.g., Sachschal et al., in prep.). Cognitive theories of PTSD assume that re-experiencing symptoms may result from poor integration of the worst moments of the trauma, rather than overall disorganisation of the trauma memory (e.g., Ehlers et al., 2004). Therefore, the following research questions are examined:

(8) Does the quality of trauma memories change with successful PTSD treatment (Study 4, Chapter 5)?

(9) Is associative memory updating performance before treatment related to PTSD treatment outcomes (Study 2, Chapter 6)?

2

INFLUENCE OF INDIVIDUAL DIFFERENCES IN MOOD AND ANXIETY ON MEMORY UPDATING

Introduction

Memory flexibility is important in order to keep memories relevant and up to date when the environment changes and new information becomes available (Schacter, Guerin, Jacques, & St Jacques, 2011). In everyday life, updating memory with new information may help to reappraise initial negative expectations (e.g., 'I will embarrass myself during this presentation') that did not come true (e.g., 'People liked my presentation') or update the outcome of negative interpreted experiences (e.g., 'They did not say hello because they do not like me') when things change for the better (e.g., 'They said hello next time'), or new information comes to light (e.g., 'They forgot their glasses and did not see me'). Difficulties updating initial negative information in memory might contribute to the maintenance of negative appraisals and interpretation biases in psychiatric disorders, such as mood and anxiety disorders. To date, no study has examined the influence of depression and anxiety on updating information in memory.

As discussed in Chapter 1, emotions have long been known to affect memory (for reviews, see Kensinger, 2009; Mather & Sutherland, 2011), and mood and anxiety disorders have been found to be associated with alterations in memory functioning. For

example, studies suggest that low mood and anxiety leads to memory biases for negative compared to neutral events (Coles & Heimberg, 2002; Mathews & MacLeod, 2005), and it was found that people with major depression disorder (MDD) showed more difficulties in updating working memory content if the information in working memory was sad compared to happy (Levens & Gotlib, 2010), suggesting difficulties in disengaging from mood-congruent information that may also influence how memories are updated. Furthermore, healthy participants were found to have more difficulties updating associative memories of negative compared to neutral material (e.g., Novak & Mather, 2009). For example, studies show that it is more difficult to add new associations to already existing associations in memory when they contain emotional information (e.g., Mather & Knight, 2008). It has not been investigated yet how individual differences in anxiety and depression may influence how associative memories are updated.

Aims of the Study

It was examined (1) how participants update features of mildly negative material compared to neutral material, (2) whether individual differences in mood and anxiety affect the ability to update emotional and neutral memories, and (3) whether memory for the updated features remains stable over time. An associative memory updating paradigm modelled on Novak and Mather (2009) was applied. In this study, healthy participants first learn the location of negative and neutral stimuli on a computer screen. In an updating phase, half of the negative and neutral stimuli appear in a new location, and half of the pictures remain in their initial location. Participants were tested on how good they were at remembering the new picture locations. In this session, participants were re-invited after two days to test whether their memory for the updated picture locations remained stable over time. It was hypothesised that (1) in Session 1,

participants show more difficulties in updating locations of mildly negative compared to neutral pictures, (2) in Session 1, higher depression and higher anxiety scores are associated with more difficulties in updating locations of negative compared to neutral pictures, and (3) in Session 2, participants make more errors in remembering updated locations of negative compared to neutral pictures.

Methods

Overview

Participants attended two research sessions two-days apart. In the first session, participants completed a location updating task, in which they first learned the locations of 48 mildly negative and neutral pictures up to three times (or until they reached a learning criterion of 47 pictures). Memory of the picture locations was tested after each learning trial. Then, half of the negative and neutral pictures appeared in a different location, and the other half of the pictures appeared again in their initial location. Participants were asked to memorise the picture locations of the updated learning trial. Location memory for all pictures (those that had switched location and those that had remained in the initial location) was tested after having completed several filler tasks (Session 1), and at two-days follow-up (Session 2). No new encoding or reactivation took place in the second session.

Participants

Previous research found a large to very large effect size for the within-subject difference between highly negative and neutral material (Novak & Mather, 2009). As the present study used mildly negative and neutral material, we expected a medium effect size. We used power calculation software G*power to calculate the sample size needed to detect a medium effect size of ES = 0.5 for the within-subject difference

between mildly negative and neutral material. A total sample size of 34 participants was determined to give 80% power at α = .05. To detect an effect size of ES = 0.4 at alpha = .05, 52 participants were needed. A sample of 39 healthy participants (30 female, 9 male), aged between 18 and 55 years (*M* = 25.57; *SD* = 7.13) was recruited via a circular email sent to students of the University of Oxford, and through online adverts. Inclusion criteria was age between 18 and 65, and being able to read and write in English. Mean anxiety and depression scores of participants are displayed in Table 2.1. Participants that agreed to participate in the research session were invited to attend two research sessions two-days apart. Thirty-three participants (85%) attended the second session. The first session lasted for one hour, the second session for about 30 minutes. Participants were reimbursed with £15 for their time and travel expenses.

Table 2.1

Mean depression and anxiety scores in Session 1

Measure	Mean	SD
BDI	6.97	8.28
STAI-Trait	37.69	9.79
STAI-State	31.21	9.21

Note. BDI = Beck Depression Inventory-II. STAI-Trait = State and Trait Anxiety Inventory Trait version. STAI-State = State and Trait Anxiety Inventory State version.

Location Updating Task

This task comprised an **initial encoding phase** where participants learned the locations of pictures, and an **updating encoding phase** where the location of half of the pictures changed and participants had to encode the changes. Location learning and recall was repeated up to three trials, or until participants identified at least 47 picture

locations correctly. This was followed by filler tasks, before the **updating test** was given. Instructions are found in Appendix A. Stimuli were presented on the screen of a 21.5" iMac. Pictures were sized 20x15cm, and were presented in one of six locations on the screen. In the initial encoding and updating encoding phase, pictures were presented for 3000ms, followed by a white screen for 500ms. In the test phases, the pictures appeared in the centre of a white screen until the participants indicated the learned location. Figure 2.1 displays the picture locations and timings of picture presentation.

Initial encoding phase. In the initial encoding phase, 24 mildly negative and 24 neutral pictures were presented on a computer screen. Each picture was presented in one of six locations, followed by a white screen, before the next picture appeared. Participants were instructed to memorise the location of each picture. Negative and neutral pictures appeared in a random order, and an algorithm ensured that no more than three negative or three neutral pictures were presented consecutively.

Encoding test. After each learning trial (presentation of all 48 pictures) the pictures appeared in the centre of a white screen and participants were asked to indicate the picture location by using the numbers one to six on the number pad on the keyboard. Location for each number key on the keyboard corresponded to the picture location on the screen. For example, Key 1 is in the lower left on the number pad on the keyboard, and corresponded to the lower left picture location on the screen. The next picture appeared only after participants had indicated the learned location of the previous picture.

Updating encoding phase. Once the picture locations were learned, or participants had completed all three learning and test trials, participants completed the updating encoding phase. In this phase, half of the pictures (12 randomly selected negative and 12 randomly selected neutral pictures) appeared in a new location

(updating condition) and the remaining half of the pictures appeared in the same location as before (control condition). Negative and neutral pictures were evenly distributed across locations. Pictures were only learned once in this phase. Participants were asked to remember the location of the pictures. Memory for new picture locations was not tested immediately.

Filler tasks. After the participants encoded the new location for each picture, they completed filler tasks and questionnaires for 20 minutes.

Updating test. The updating test followed where each picture appeared in the centre of a white screen separately and participants were asked to indicate where they had last seen the pictures.

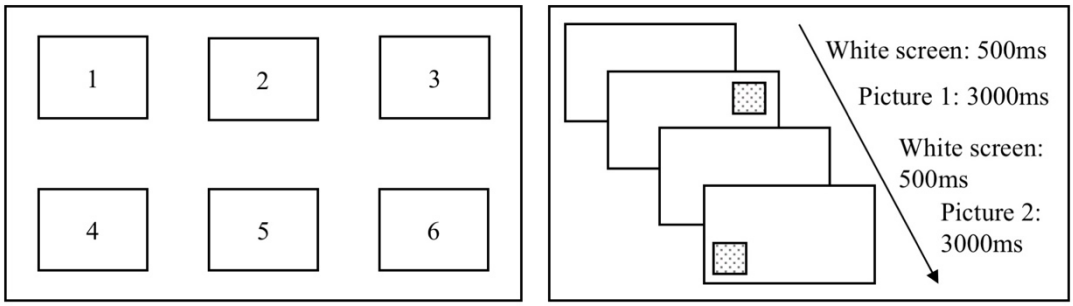


Figure 2.1. Picture locations and picture presentation of the location updating task (adapted from Novak & Mather, 2009)

Stimulus Material

Pictures were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005). Mildly negative pictures displayed negative scenes, such as a sinking ship or environmental disasters, that were only mildly arousing according to the IAPS norm ratings (Lang et sl., 2005). Neutral pictures depicted scenes of everyday life, such as a person in front of a computer or a building site. Negative and

neutral pictures were matched in terms of complexity of the scene shown in the picture. Furthermore, two parallel sets of negative and neutral pictures were created. Pictures were matched according to valence, arousal, and dominance ratings provided by the IAPS norms (Lang et al., 2005), for which pictures had been rated with the Self-Assessment Mannequins (Bradley & Lang, 1994). Mean norm ratings according to the IAPS database (Lang et al., 2005) for each set are displayed in Table 2.2. Picture sets were also matched for themes. The main themes of the content of the picture sets are found in Appendix B.

Table 2.2

Mean IAPS norm ratings of matched neutral and negative picture sets (Lang et al., 2005)

	Set 1				Set 2			
	Negative		Neutral		Negative		Neutral	
SAM ratings	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Valence	2.79	1.60	5.37	1.38	2.79	1.61	5.37	1.35
Arousal	5.26	2.15	3.66	1.98	5.35	2.23	3.66	2.00
Dominance	3.99	2.15	5.69	1.89	3.97	2.11	5.72	1.89

Note. Valence: 1 = *negative* to 9 = *positive*. Arousal: 1 = *low activation* to 9 = *high activation*. Dominance: 1 = *low dominance* to 9 = *high dominance*.

Questionnaires

General Information Questionnaire. This questionnaire assesses information about demographic characteristics such as gender and education (Appendix E).

State and Trait Anxiety Inventory. The State and Trait Anxiety Inventory (STAI) contains 20 items measuring state and trait anxiety (Spielberger, Gorusch, &

Lushene, 1970). State anxiety (STAI-State) is measured with items assessing the current state, for example 'I am tense', whereas trait anxiety (STAI-Trait) is measured with items assessing general traits, for example 'I worry too much about something that really does not matter'. Items are rated on a 4-point Likert scale (1 = *almost never* and 4 = *almost always)*. Higher scores indicate more state and trait anxiety.

Beck Depression Inventory. Severity of depression symptoms was assessed with the Beck Depression Inventory-II (BDI-II Beck, Steer, & Brown, 1996). The BDI-II assesses depressive symptoms over the past two weeks. Each of the 21-items has four different statements that the participant can choose from. The BDI has been found to have high internal consistency (Cronbach's $\alpha = .91$) and showed good correlation with other depression inventories (Beck, Steer, Ball, & Ranieri, 1996).

Self-Assessment Mannequins. Arousal and valence ratings were assessed for each picture with a paper-pencil version of a nine-step version Self-Assessment Mannequins (SAM; Bradley & Lang, 1994). Each scale is represented by non-verbal pictures that represents persons' affective reactions that they might experience towards different stimuli. The arousal scale comprises mannequins with sad and happy faces and ask participants to tick the mannequin that mostly corresponds to how they felt while seeing each picture. The arousal scale comprises mannequins with different activation levels, indicated by a small heart (calm) to a big heart (racing heart). The scales ranged from 1 = *negative* to 9 = *positive* for valence, and from 1 = *low activation* to 9 = *high activation* for arousal. Dominance ratings were not assessed in this study.

Filler Tasks

As filler tasks, participants completed the d2 test of attention (Brickenkamp, Schmidt-Atzert, & Liepmann, 2002), the National Adult Reading Test (NART; H. E.

Nelson, 1982) and the digit span task, a subtest from the Wechsler Adult Intelligence Scale IV (Wechsler, Coalson, & Raiford, 2008), and a reading task.

Procedure

Participants responded to advertisements for the study and were sent an information sheet via email. When participants agreed to take part in the study, appointments for the two laboratory sessions (two-days apart) were arranged, allowing at least 24 hours between reading the information sheet and the first session. On arrival in the laboratory, participants had the opportunity to ask further questions and gave written informed consent. Before completing the location updating task, participants were asked to fill in the General Information Questionnaire and the STAI-State. After the updating encoding phase, participants were asked to fill in the STAI-State a second time and then completed the filler tasks for about 20 minutes. After completing the filler tasks, participants were asked to complete the updating test. As described earlier, pictures were presented in the middle of a white screen and participants had to indicate the location for each picture. In Session 2, participants were presented with the same pictures that they had seen during the location updating task in Session 1, and were asked to indicate the final location for each picture from the previous session. At the end of the session, participants were asked to rate each picture for valence and arousal using SAM ratings.

Data Analysis

Results were calculated in IBM SPSS Statistics (Version 22.0); significance levels were set at $\alpha = .05$. Assumptions of normal distributions for the variables were tested and non-parametric measures were used if applicable.

Three different types of error rates were calculated, namely updating error rates, binding error rates, and updating error difference rates. Updating error rates were calculated using the number of location errors for the pictures in the updating condition (E_{switch}), the number of location errors for the pictures in the control condition (E_{contr}), and the number of initially learned picture locations in the learning phase (L_T). Updating error rates were calculated as the number of incorrectly indicated locations of the pictures that changed locations in the updating test (E_{switch}), divided by the number of initially learned picture locations in the learning phase (L_T). To control for differences in baseline memory recall, error rates of pictures that had not changed location were subtracted from error rates: Updating error rates = (E_{switch} / L_T) – (E_{contr} / L_T). Binding error rates were calculated for the pictures in the updating condition only. They were calculated as the number of errors in which participants indicated the initially learned picture location of the encoding phase instead of the new, updated location (E_I), divided by the number of correctly learned picture locations in the learning phase (L_T): binding error rate = E_I / L_T. Finally, updating error difference rates were calculated by subtracting updating error rates for neutral pictures from updating error rates for negative pictures. Higher updating error difference rates indicate a higher updating error rate for negative compared to neutral pictures.

Control analyses were conducted. Paired-sample t-tests compared arousal and valence ratings for negative and neutral pictures, state anxiety before and after test completion, binding error rates, and the number of correctly learned picture locations for negative and neutral pictures. To check that the pictures that subsequently occurred in updated locations were learned equally well as those that were displayed in the same location during the subsequent updating encoding phase, a repeated-measures ANOVA with the within-subject factors valence (negative, neutral) and condition (updating,

control) was conducted. Then, hypotheses were tested. To test whether participants committed more errors in updating the location of negative compared to neutral pictures, a repeated-measures ANOVA for updating error rates in Session 1 was calculated with the within-subject factors valence (negative, neutral) (Hypothesis 1). As depression and anxiety variables were skewed, Spearman rank correlations were calculated in order to see whether depression and anxiety were associated with updating error difference rates in Session 1. As only depression showed a potential relationship with updating error difference rates, tertile splits were performed for depression scores. Participants were split into two groups (high vs. low), with participants from the highest tertile being allocated to the high symptom group, and participants from the lowest tertile allocated to the low symptom group. Afterwards, mixed-measure ANOVAs for updating error rates in Session 1 were calculated with the within-subject factors valence (negative, neutral) and the between-subject factor group (high, low) (Hypothesis 2). Finally, to test whether the patterns were stable over time, repeated-measures ANOVAs for updating error rates were calculated with the within-subject factors valence (negative, neutral) and time (Session 1, Session 2) for location error rates (Hypothesis 3).

Results

Control Analyses

Table 2.3 displays mean scores for all measures.

Picture ratings. As expected, participants rated the negative pictures as significantly more negative (lower valence ratings), $t(38) = -15.04$, $p < .001$, and more activating (higher arousal ratings), $t(38) = 10.34$, $p < .001$, than neutral pictures.

State anxiety. Participants did not differ in state anxiety before ($M = 31.21$, $SD = 9.21$) and after ($M = 32.14$, $SD = 9.10$), completing the location updating task, $t(38) =$

-0.67, p = .51. This indicates that the location updating task did not have an effect on participants' anxiety levels.

Binding error rates. Binding error rates are the errors in which participants indicated the initially learned instead of the newly learned locations. Participants did not differ in binding error rates for negative and neutral pictures, $t(38) = 1.74$, p = .09, indicating that there was no difference in the degree to which participants did not remember that the location had changed for negative and neutral pictures in the updating learning phase.

Initially learned locations. On average, participants correctly identified the same number of locations of neutral and negative pictures, $t(38) = 0.73$, p = .47. Participants needed a mean number of $M = 2.33$ ($SD = 0.70$) learning blocks to reach the learning criterion (or move on after three learning trials if they had not reached the learning criterion). The mixed-measures ANOVA for correctly identified pictures showed non-significant main effects for valence, $F(1, 38) = 0.53$, p = .47, and condition, $F(1, 38) = 0.89$, p = .35, and no significant interaction effect, $F(1, 38) = 0.27$, p = .61, indicating that pictures were learned equally well, independent of valence and condition.

Table 2.3

Mean arousal and valence ratings for negative and neutral pictures, and binding error rates and number of initially learned pictures

	Negative pictures		Neutral pictures	
	Mean	SD	Mean	SD
Arousal ratings	4.89	0.05	3.22	1.52
Valence ratings	2.90	0.82	5.54	0.55
Binding error rate	.19	.19	.15	.15
Initially learned picture locations	22.64	2.01	22.82	1.50

Location Updating in Session 1

Negative and neutral pictures. Mean updating error rates for Session 1 are displayed in Table 2.4. The repeated measures ANOVA for updating error rates showed a non-significant main effect for valence, $F(1, 38) = 1.19$, $p = .28$, $\eta_p^2 = .03$, indicating that there was no difference in updating performance for locations of negative and neutral pictures.

Table 2.4

Updating error rates for negative and neutral pictures in Session 1 and 2

	Negative		Neutral	
Updating error rates	Mean	SD	Mean	SD
Session 1	.20	.23	.17	.21
Session 2	.64	.26	.59	.30

Influence of depression and anxiety. Spearman rank correlations were calculated to test whether depression, state and trait anxiety were related to the updating difference error rates in Session 1. Depressive symptoms tended to be related to the difference scores of updating error rates (negative updating error rate – neutral updating error rate) in Session 1, indicating that higher depression scores may be associated with more updating error rates for negative compared to neutral pictures. However, the correlation did not reach significance. All other correlations were non-significant. Correlation coefficients are displayed in Table 2.5.

Table 2.5

Spearman rank correlations between updating difference error rates (updating error rate for negative pictures minus updating error rates for neutral pictures) and anxiety and depression scores in Session 1 and Session 2

	Updating difference error rates	
	Session 1 (n = 39)	Session 2 (n = 33)
BDI	.29[I]	-.29
STAI-Trait	.19	-.11
STAI-State	.22	.13

Note. BDI = Beck Depression Inventory-II. STAI-Trait = State and Trait Anxiety Inventory Trait version. STAI-State = State and Trait Anxiety Inventory State version.

[I] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

To better understand the effect of low mood on negative and neutral updating error rates, participants were divided into groups of high and low depressive symptoms. Tertile splits were performed for BDI to compare updating performance in high and low

mood. Participants in the upper and lower tertile were compared. Mean arousal and valence ratings, as well as depression, trait and state anxiety scores for high and low depression group are displayed in Table 2.6.

Table 2.6

Mean scores for high and low depression group

	Depression					
	High (n = 11)		Low (n = 15)			
Measures	Mean	SD	Mean	SD	*U*	*p*
BDI	16.64	9.73	0.87	1.30	165.00	< .001
STAI-Trait	47.73	8.15	32.07	6.24	154.00	< .001
STAI-State	37.77	11.06	27.40	5.26	130.00	.013
Arousal ratings						
Negative	4.99	0.90	4.17	1.64	69	.24
Neutral	4.29	1.63	2.74	1.37	80	.045
Valence ratings						
Negative	2.89	0.37	3.11	0.97	36	.65
Neutral	5.40	0.37	5.59	0.76	32	.43

Note. BDI = Beck Depression Inventory-II. STAI-Trait = State and Trait Anxiety Inventory-Trait version. STAI-State = State and Trait Anxiety Inventory-State version.

The mixed measures ANOVA for updating error rates revealed a significant interaction effect, $F(1, 24) = 6.18$, $p = .02$, $\eta_p^2 = .21$. The main effects for valence, $F(1, 24) = 2.04$, $p = .17$, $\eta_p^2 = .08$, and the main effect for group, $F(1, 24) = .10$, $p = .76$, $\eta_p^2 = .004$, were non-significant. Figure 2.2 displays the interaction effect. Post-hoc tests

followed up the interaction effect by testing the effect of valence separately in both groups. The low depression group did not show any differences in updating error rates for negative and neutral pictures, $t(14) = -0.79$, $p = .44$, $d = 0.42$, whereas the high depression group showed a significant difference, $t(10) = 2.69$, $p = .02$, $d = 1.70$, indicating that the high depression group had more difficulties in updating the locations of negative compared to neutral pictures.

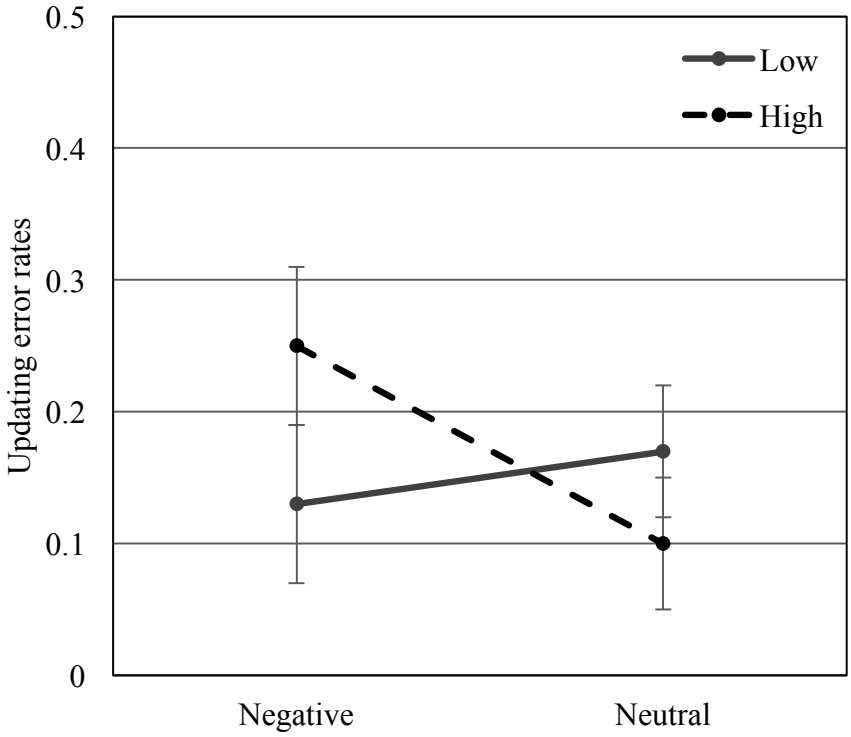


Figure 2.2. Negative and neutral error rates in high and low depression group

Location Updating in Session 2

Stability over time. Stability in updating error rates over time was examined. Mean updating error rates for Session 1 and Session 2 are displayed in Table 2.4. The repeated-measures ANOVA did not show a significant main effect for valence, $F(1, 32) = 0.38$, $p = .54$, $\eta_p^2 = .01$, or time, $F(1, 32) = 1.20$, $p = .26$, $\eta_p^2 = .03$, indicating that

participants updating error rates did not differ between negative and neutral pictures, or between Session 1 and 2. Furthermore, there was no significant time x valence interaction effect, $F(1, 32) = 0.00$, $p = .99$, $\eta_p^2 = .00$, indicating that there was no different pattern in updating error rates for negative and neutral pictures between Session 1 and Session 2.

Influence of depression and anxiety. Spearman rank correlations were calculated to test whether depression, as well as state and trait anxiety influenced for the difference score of neutral and negative updating error rates in Session 2. However, no significant correlations were found, indicating that depression and anxiety may not have a long-term effect on how well neutral and mildly negative material is updated. Correlations are displayed in Table 2.5. Groups in Session 2 were too small to perform group comparisons with tertile splits.

Discussion

The present study investigated whether healthy participants showed more difficulties in updating associative memories of mildly negative compared to neutral material, and whether mood and anxiety influenced how mildly negative and neutral material is updated. Overall, healthy participants did not show differences in updating mildly negative and neutral material in Session 1 and 2. However, the results indicated that depressive symptoms tended to influence the performance in updating negative compared to neutral memories. Participants with higher depression scores had more difficulties updating negative compared to neutral material in Session 1, whereas participants with lower depression scores did not show differences in how they updated negative and neutral material. As the sample sizes were small, results need to be interpreted carefully.

The findings suggest that depressive symptoms tended be associated with difficulties updating mildly negative material. This may reflect a bias towards mildly negative material in depression. Previous studies showed that healthy participants had more difficulties updating highly negative material, such as mutilated bodies, compared to neutral material (Novak & Mather, 2009). It can be speculated that people with higher depression symptoms may respond to mildly negative material in a similar way as healthy participants respond to highly negative material. This would be in line with studies showing that depression is associated with negative attention and memory biases (Gotlib et al., 2004). Furthermore, several studies that examined the ability to update negative and neutral information in working memory found that people with depression had more difficulties disengaging from negative material in working memory, and in updating irrelevant negative information in working memory with relevant positive or neutral information (e.g., Joormann & Gotlib, 2008).

Participants with lower depression symptoms did not show differences in updating negative and neutral material. This indicates that healthy participants may not have difficulties in updating mildly negative material. This may be explained by a lack of high arousal during the encoding of mildly negative material, which was suggested to lead to stronger feature binding and more difficulties in updating these initial bindings afterwards (Novak & Mather, 2009). However, this suggestion is not mirrored by the subjective arousal ratings. Participants gave statistically higher arousal ratings for the mildly negative than neutral pictures, indicating that mildly negative material evoked more arousal than the neutral pictures. It is possible, however, that in previous studies, the highly negative material resulted in higher arousal and more initial binding, than mildly negative material. This could explain why no differences in updating error rates were found in this study.

Interestingly, the high depression group tended to show more difficulties in updating negative compared to neutral material, yet had similar arousal ratings for the negative pictures as the low depression group. This suggests that other processes than strong initial binding due to arousal may play a role in updating difficulties in people with high depression symptoms. The high depression group indicated, however, that they experienced the neutral material as more arousing compared to the low depression group, whilst not showing more difficulties in updating neutral material compared to the low depression group. This suggests that subjective arousal was not associated with memory updating performance. However, it needs to be considered that arousal and valence ratings were only assessed in Session 2, in order to not affect the memory scores by re-exposing participants to the same pictures after Session 1. Therefore, the ratings may reflect how the pictures made participants feel in Session 2, rather than during encoding, and may reflect a negative interpretation bias of the neutral pictures by the high depression group. It is possible that arousal during the first session may have mapped onto the pattern of difference in updating error rates between participants high and low in depression.

Trait anxiety was not found to be significantly associated with updating performance of negative or neutral pictures. However, there was a positive correlation that did not reach significance, indicating that more anxiety lead to a similar updating pattern as with depression. The sample size may have been too small to detect these differences. Post-hoc power calculations tested how much power the correlations between individual differences in mood and anxiety and memory updating scores had. There was 47% power to detect a correlation of $r = .30$, which is a medium effect size, and 27% power to detect a correlation of $r = .20$, which is a small effect size. A sample

size of n = 84 would have been needed to detect a correlation of small to medium effect size.

The study further investigated whether the ability to update negative and neutral memories was stable over time. The pattern remained stable as no differences were found in updating negative and neutral material in Session 1 and 2, indicating that negative material was updated and remembered similarly to neutral information across time. As there were no initial differences in memory updating performance in Session 1, it is difficult to interpret these findings. The negative material was only mildly negative, and may not have been strong enough to evoke differences in healthy participants. It is further unclear whether patterns in the high and low depression group remained stable, as the analyses could not be calculated due to the small sample size. More research is needed to better understand the effect of depression on memory updating over time.

The study has several limitations. Firstly, depression and anxiety were assessed in a sample of healthy participants, which means that only few people showed high depression or anxiety scores. Furthermore, depression and anxiety scores were highly correlated in this sample, *rho* = .60, $p < .001$, which makes it difficult to distinguish between people with high depression and high anxiety scores. Findings may not replicate in samples of people with anxiety and / or mood disorders. Therefore, this study can only give some initial suggestions about the influence of mood and anxiety in updating negative and neutral memories, but research with clinical samples is needed. Secondly, the sample size was small and tertile splits led to a significant reduction in sample size. As discussed above, post-hoc power analyses showed that the current sample gave only 60% power to detect within-subject differences of small effect sizes, and only 27% power to detect correlations of small effect size.

Therefore, the study cannot draw conclusions about whether or not there are differences in updating of mildly negative and neutral material, and whether there is an association between anxiety and updating mildly negative and neutral material. Future studies should expect only small effect sizes and need to investigate the influence of anxiety and depression in a bigger sample. It would also be important to further investigate memory updating performance over time, as the current sample was not large enough to examine differences in updating performance in low mood and anxiety with time. Thirdly, the study investigated memory updating of intrinsic characteristics, such as locations of pictures. A recent review by Chiu and colleagues (2013) showed that there are differences in the effect of emotions depending on features and characteristics that are updated (for more detail, see also Mather & Sutherland, 2011). Future research should for example address the differences in updating intrinsic (e.g., location or colour of an object) or non-intrinsic (e.g., object that is related to another object) features. Fourthly, the study presented the stimuli only once in the picture updating phase. There may be primacy and recency effects that influenced the memory for picture locations. However, as the pictures were presented in a random order for each participant (random location, random valence, and random condition), these effects may have balanced out over all participants. It may be helpful for future studies, however, to use the initial paradigm with eight picture locations, and more pictures (Novak & Mather, 2009) to reduce the potential influence of these effects for each participant. Finally, the study did not compare updated stimuli to newly learned stimuli. Including new stimuli in the updating phase would give valuable information on the differences in updating new information compared to learning new information.

In conclusion, the present study can provide initial evidence that individual differences in mood may influence the updating performance for intrinsic features of

negative and neutral material. Findings suggest that depression might lead to greater immediate difficulties updating negative compared to neutral material. More research is needed to better understand the effect of memory consolidation for updated negative and neutral material and its interaction with depression.

3

UPDATING NEGATIVE AND NEUTRAL ASSOCIATIVE MEMORIES IN TRAUMA SURVIVORS

Introduction

Theories suggest that trauma memories retain their threatening meanings in people with posttraumatic stress disorder (PTSD) long after the trauma is over. The worst moments of trauma memories are thought to lack connection with other relevant information in memory (e.g., 'I am safe now', 'It was not my fault'), which would help update the meaning of the trauma and could put the threat in the past (Ehlers & Clark, 2000). Updating trauma memories is a core procedure in trauma-focused Cognitive Therapy for PTSD (CT-PTSD; Ehlers et al., 2005; Ehlers & Clark, 2000). It aims to link context information (often post-trauma information, e.g., 'I am safe') to the worst moments of the trauma in order to change their threatening meaning in memory (Ehlers et al., 2005). To the author's knowledge, it has not yet been investigated whether people with PTSD show general deficits or biases in integrating new information into existing memories.

As discussed in Chapters 1 and 2, studies with healthy participants suggest that adding new information to existing emotional memories is more difficult than adding new information to neutral memories (e.g., Mather & Knight, 2008; Novak & Mather, 2009). It has been suggested that the higher arousal associated with emotional stimuli

may lead to strong binding of the initial associations of the emotional stimuli with other stimuli or their context, and impair the binding of new information to the existing memory (Novak & Mather, 2009). In Chapter 2, healthy participants were asked to complete a location updating task that was adapted from Novak and Mather (2009). It was found that higher depression but not anxiety was associated with more difficulties updating mildly negative compared to neutral material. Even though trauma survivors with PTSD show high levels of depression, they also have high levels of general arousal (APA, 2013) and often show hypervigilance towards potential threat cues (for reviews, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Buckley, Blanchard, & Neill, 2000). It remains unclear how high arousal and low mood in PTSD may influence associative memory updating of negative and neutral material.

Aims of the Study

The present study investigated (1) whether and in what way trauma survivors with PTSD and control participants differ in memory updating of neutral and negative associative memories. It was further examined (2) whether a history of trauma and past PTSD may influence how good participants are at updating associative memories. Finally, it was explored whether (3) individual differences in memory updating are related to trauma memory characteristics post treatment and treatment outcomes in PTSD. It was hypothesised (1) that trauma survivors with PTSD differ in memory updating from controls without PTSD. The direction could not be predicted. Worse updating of mildly negative compared to neutral associative memories in the PTSD compared to control group would support the *strong initial binding hypothesis,* whilst worse updating would support the *hypervigilance hypothesis*. Furthermore, it was explored (2) whether within the control group a history of trauma, past PTSD, or depression influences the performance in updating neutral and negative memories.

Finally, it was explored (3) whether individual differences in memory updating in a subsample of PTSD patients receiving treatment predicted trauma memory chracteristics and PTSD severity post treatment.

Methods

Overview

Trauma survivors with PTSD and a control group (including traumatised and non-traumatised individuals) completed the same location-updating task as described in Chapter 2. Participants learned the location of 48 mildly negative and neutral pictures up to three times, or until they reached a learning criterion (initial encoding phase). Participants completed an encoding test after each learning trial in which the picture appeared in the centre of the screen and participants had to indicate the learned location. In the encoding updating phase, half of the pictures appeared in different new locations, and half of the pictures remained in their previous locations. Participants were asked to learn the new locations, and completed an updating test after a period of about 20 minutes, in which they completed several filler tasks. A subset of PTSD patients completed the location-updating task before a course of trauma-focused PTSD treatment. Patients also completed a questionnaire that assessed the subjective quality of their memory for the trauma and a negative control event before and after their treatment.

Participants

It was anticipated that people with and without PTSD could be recruited at a ratio 1 : 2. As no previous studies had used the paradigm in the population and we were interested in clinically meaningful effects, we aimed to be able to detect a moderate to large effect size. In order to have 80% power to detect a group difference with an effect

size of ES = 0.6 at alpha = .05, we needed to recruit at least 97 participants. For an effect size of ES = 0.5 at alpha = .05, 141 participants were needed. Thirty-nine trauma survivors with PTSD (27 PTSD patients awaiting treatment and 12 traumatised participants with PTSD recruited from the community) and 73 control participants without PTSD were invited for a two-hour research session at the Department of Experimental Psychology, Oxford, or the Institute of Psychiatry, London. Inclusion criteria for all participants were age between 18 and 65 years and the ability to read and write in English. For the PTSD group, a further inclusion criterion was meeting the DSM-5 diagnostic criteria for PTSD as main diagnosis and if taking any psychotropic medications, having been on a stable dose for at least two months. Exclusion criteria were a history of psychosis, current substance dependence, and for the control group a diagnosis of PTSD at the time of recruitment. The responses of three participants (two participants of PTSD group, one of control group) in the experimental task were not recorded due to technical problems. Furthermore, four participants were excluded, as they did not reach the learning criterion of more than 30 pictures correctly identified during the initial encoding phase of the memory updating task (two participants from the PTSD group, two participants from the control group). Therefore, the final sample consisted of 35 trauma survivors with PTSD (24 PTSD patients), and 70 control participants (20 participants with a history of past PTSD, 20 participants with a history of trauma but no past PTSD, 30 non-traumatised participants). Table 3.1 shows demographics, as well as symptom scores for the PTSD and control groups. Table 3.2 displays trauma characteristics of the PTSD group. Furthermore, 20 out of the total 24 PTSD patients were assessed before and after a course of trauma-focused cognitive behavioural therapy (CBT). Four patients did not attend the second session as they could either not be reached over the phone or had dropped out of treatment. Memory

characteristics and PTSD symptom measures were assessed at baseline and after treatment. Memory questionnaire data for one patient was missing. The final sample for the follow-up assessment was therefore 19 patients with PTSD for the memory questionnaires and 20 patients for treatment outcomes. Table 3.3 displays demographics of the PTSD patient subsample that attended Session 2 and drop-outs.

Table 3.1

Demographics and symptom scores of PTSD and control group

	PTSD (N = 35)				Control (N = 70)				
	Mean	SD	n	%	Mean	SD	n	%	x^2 *or t, p*
Age (years)	31.82	9.96			33.11	15.92			.44, .79
Years of education	15.97	3.35			17.00	2.63			1.87, .06
Ethnicity									3.89, .049
Caucasian			25	71%			61	87%	
Ethnic Minority			10	29%			9	13%	
Gender									0.90, .34
Male			11	31%			16	31%	
Female			24	69%			54	69%	
PDS (*n* = 77, with history of trauma)	37.61	12.49			9.95	7.33			-11.96, < .001
BDI (*n* = 101)	22.82	9.40			6.97	7.65			-8.51, < .001

Note. BDI = Beck Depression Inventory-II. PDS = Posttraumatic Diagnostic Scale.

Table 3.2

Trauma characteristics for the PTSD group

Trauma type	n
Road traffic accidents	8
Other accidents	0
Natural disaster	1
Non-sexual assault	3
Sexual assault	10
Terrorist attack	1
Unwanted sexual contact (Child)	2
Childhood abuse	2
Imprisonment	1
Life-threatening illness	0
Sudden traumatic death of significant other	1
Life-threatening illness of significant other	0
Armed robbery	0
Other	7

Table 3.3

Demographics of the PTSD patient sub-sample who attended Session 2 and drop-outs

	PTSD Patients Session 2 (*n* = 20)				PTSD Patients Drop-out (*n* = 4)				
	Mean	SD	n	%	Mean	SD	n	%	x^2 *or U, p*
Age (years)	33.52	9.48			35.91	16.51			40.00, 1.00
Gender									.53
Female			14	70			4	100	
Male			6	30			0	0	
Years of education (n = 16)	15.00	3.37			16.50	5.26			30.00, .90
PDS	37.5	11.94			41.09	9.22			36.50, .79
BDI (n = 18)	22.28	8.10			27.50	7.85			23.00, .79

PDS = Posttraumatic Diagnostic Scale. BDI = Beck Depression Inventory – II.

Recruitment and Group Allocation

Recruitment for the study started in June 2014 and ended in April 2016. The control group was recruited via circular emails to staff and students of the university, and through adverts on the homepage of the Department for Experimental Psychology and other research participant recruitment websites. Participants who expressed interest

in the study were sent a link to a short screening questionnaire via email to determine whether they were in principle suitable for the study. PTSD patients were recruited from the wait list of the South London IAPT outpatient services (Lewisham, Lambeth, and the Centre for Anxiety Disorders and Trauma [CADAT]), as well as from the Oxford Centre for Anxiety Disorders and Trauma (OxCADAT). Patients were contacted via phone if they had consented to being contacted about ongoing research and met inclusion criteria for the study. If patients were interested in taking part in the research study, they received a full information sheet via email or post. In addition, participants who had responded to an advert and met diagnostic criteria for a current diagnosis of PTSD in a diagnostic interview at Session 1 were included in the PTSD group (n = 11). A flow-chart of the recruitment process is displayed in Figure 3.1. When participants agreed to take part in the study, the first research session was arranged at least 48 hours after, so that they had the opportunity to reconsider their decision. Furthermore, PTSD patients waiting for treatment were asked if they were willing to attend a second research session at the end of their treatment. Patients were assessed at the end of their treatment (except for two patients who were assessed after three months, i.e., the planned end of their treatment, but they still had some further sessions afterwards).

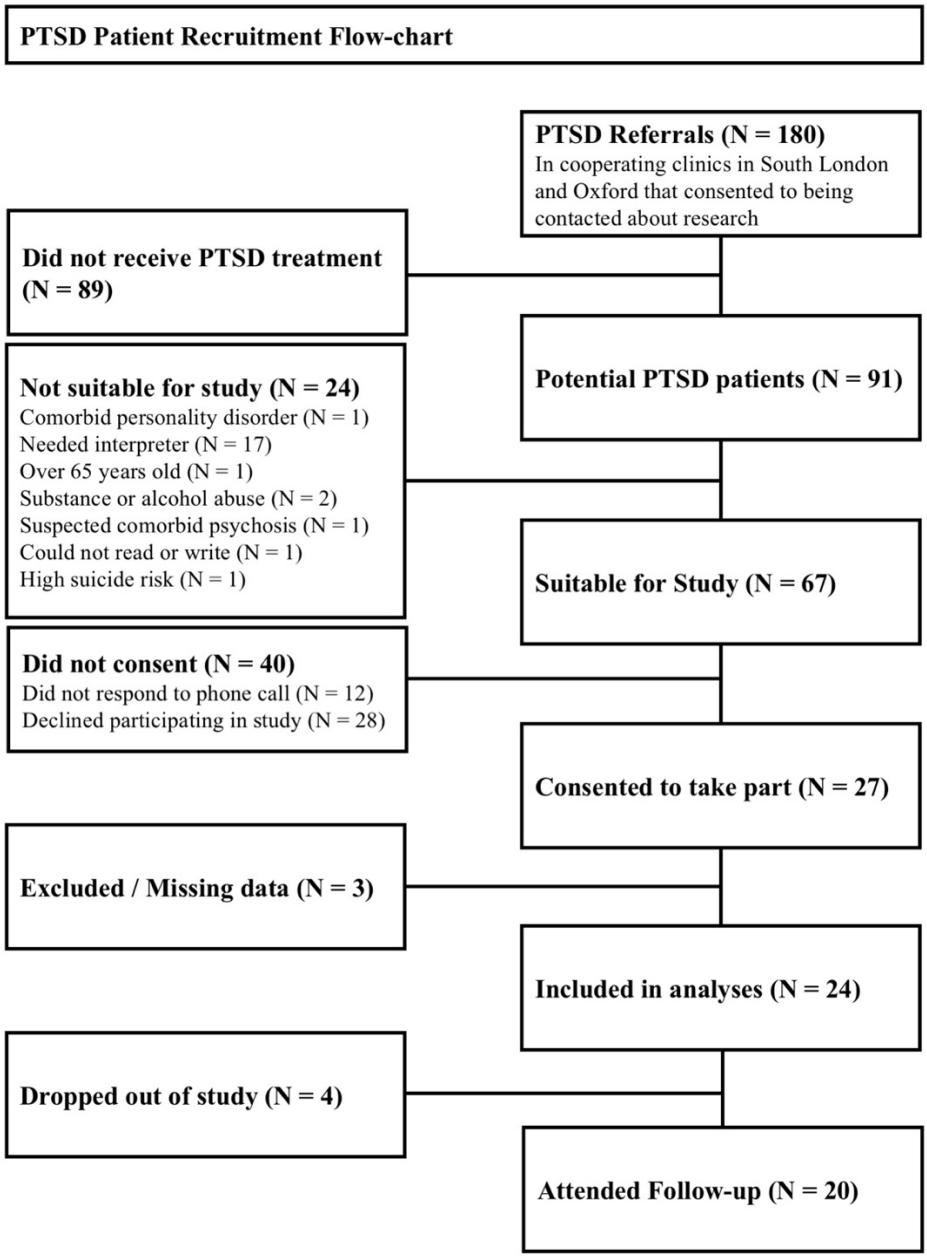


Figure 3.1. Recruitment flow-chart for PTSD patients

Ethical Considerations

The study received ethical approval from the South-Central Oxford C Research Ethics Committee under the reference number 14/SC/0198. Participants gave written informed consent after the nature of the study had been fully explained. Ethical issues were considered carefully in planning and administering the study. Trauma survivors

with PTSD are a vulnerable group and exposure to stress should be minimised as much as possible. Researchers were well trained to make sure that patients with PTSD were feeling comfortable during the session. No trauma reminders were shown in any of the tasks to minimise the risk of triggering re-experiencing symptoms. Furthermore, the timeframe of the session and the task difficulties were designed and adapted with patients having concentration problems in mind. To minimise any negative effects of reminding participants of their trauma, participants did not have to give any details about their traumatic experience. Furthermore, clinical psychologists were available in case participants felt distressed after the session. None of the participants felt that they wanted to make use of this. Participants with PTSD recruited from the community were referred for treatment if they wished. None of the participants reported distress from the study.

Symptom Measures

Posttraumatic Diagnostic Scale (PDS; Foa, Cashman, Jaycox, & Perry, 1997)**.** The PDS is a standardised and validated self-report questionnaire that assesses the severity of PTSD symptoms. It is widely used in research with traumatised populations and has shown high reliability. Subjects are asked to rate each of the symptoms for a DSM-5 diagnosis on a scale from 0 = *not at all / only one time* to 3 = *5 or more times a week / almost always*. The sum score of all items is the total severity score. The 17-item version of the PDS for DSM-IV was administered with four additional items that account for the new category of the DSM-5 diagnosis (Foa et al., 2015).

Beck Depression Inventory-II (BDI-II Beck, Steer, & Brown, 1996). Severity of depression symptoms was assessed with the BDI. The BDI is described in more detail in Chapter 2.

Clinician-Administered PTSD Scale for DSM-5 (CAPS-5; Weathers et al., 2013). The CAPS is a structured interview that provides a DSM-5 diagnosis of PTSD.

Each of the 20 symptoms is rated for severity on a scale from 0 = *absent* to 4 = *extreme / incapacitating* during the past month. The CAPS-5 also assesses a lifetime diagnosis of PTSD, by asking participants whether there was ever a period longer than four weeks, more than one month after the trauma, where they had PTSD symptoms. In the present study, lifetime diagnosis of PTSD was only assessed if participants did not meet criteria for current PTSD.

Location Updating Task

Participants completed the location updating task as described in Chapter 2. Twenty-four mildly negative and 24 neutral pictures were presented for three seconds in one of six locations on a computer screen, one after the other. After up to three learning trials, half of the pictures changed their locations (updating condition), whereas the other half of the pictures remained in the same location (control condition). After several filler tasks, participants had to indicate the newly learned locations for each of the pictures (updating test phase).

Questionnaires

Participant's registration form. This form assesses information about the demographic characteristics and education of the participants. It can be found in Appendix F.

Positive and Negative Affect Schedule. Mood was assessed with the 20-item version of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). This questionnaire assesses both positive and negative affect separately with a total of 20 items (10 items for each affect).

Self-assessment mannequins. Arousal and valence ratings for each picture were assessed with Lang et al.'s Self-Assessment Mannequins (SAM; Bradley & Lang, 1994).

Please see Chapter 2 for a more detailed description of the measure.

Stressful Events Checklist (Foa et al., 1997). Stressful Life Events were assessed with an adapted version of the stressful events checklist. Participants were asked to indicate whether they had experienced any of the stressful life events listed in the checklist sometime during their lifetime. These included either traumatic events according to DSM-IV (APA, 1993) from the original checklist, e.g., sexual assault or severe road traffic accident, or stressful, but non-traumatic events, such as divorce or major argument with partner. The latter were added to assess exposure to negative control events. Follow-up questions were asked for events that could not clearly be defined as traumatic or not with the information provided on the stressful events checklist. Firstly, it was asked whether at the time of the event, they had felt that their life had been in danger or that there was the threat of an injury. If the participant answered yes, the event was classified as a trauma. If the participant answered no, it was explored whether at any point during or after the event they might have felt the threat of death or a serious injury. If the answer was yes, the event was classified as a traumatic event. If the answer was no, the event was classified as a non-traumatic event. A version of the Stressful Events Checklist with only the negative control events is found in Appendix G.

Negative Event Memory Questionnaire (MQ; Halligan et al., 2003). Self-reported memory disorganisation was assessed with an eight-item disorganisation subscale of the MQ, which participants completed for their trauma memory (e.g., serious road traffic accident) and for a negative control event (e.g., severe argument with family or friends). The disorganisation items assess difficulties with intentional recall, for example whether the trauma memory feels incomplete (e.g., 'I cannot get what happened during the event straight in my mind'), as well as disjointedness of the trauma memory,

for example whether parts of the trauma are not properly linked to one another (e.g., 'I remember different parts of the events like separate experiences'). The disorganisation scale has been found to predict PTSD symptomatology after exposure to an analogue trauma (distressing film clip; Halligan et al., 2002) and after trauma (Halligan et al., 2003). All items of the disorganisation subscale can be found in Appendix M.

Filler Tasks

As filler tasks, participants completed the d2 test of attention (Brickenkamp et al., 2002), the National Adult Reading Test (NART; H. E. Nelson, 1982) and the digit span task, a subtest from the Wechsler Adult Intelligence Scale IV (Wechsler et al., 2008). Furthermore, participants completed a scenario reading task.

Procedure

On arrival, all control participants were screened for history of trauma, and current or past diagnosis of PTSD. To explore whether participants had a history of trauma, they filled in the Stressful Events Checklist. Participants with a history of trauma were then assessed with the CAPS for current and past PTSD symptoms. Patients with PTSD had completed the CAPS as part of their clinical assessment. At the start of the session, both the PTSD group and control participants filled in the BDI and PDS with regards to their traumatic event, or, for participants who did not have a history of trauma, with regards to their most distressing control event. All participants then completed the PANAS before they started the first part of the location updating task. Afterwards, participants completed several filler tasks (about 20 minutes – d2, NART, digit span & scenario reading task). Then, participants completed the updating test for the newly learned picture locations. At the end of the session, participants filled in the MQ and rated the pictures seen during the location updating task for valence and arousal using

the Self-Assessment Mannequins' valence and arousal scales. The session further involved several computer tasks, some other memory tasks, and completing some questionnaires, the results of which will be reported in Chapter 4 and 5. Participants had a break after completing about half of the session. PTSD patients who were going on to have treatment were invited for a second two-hour research session at the end of treatment that took either place in the Institute of Psychiatry, King's College London or at the Department for Experimental Psychology, University of Oxford. They were assessed with the CAPS for current PTSD symptoms to assess whether their symptoms had changed, and completed the PDS, the BDI, as well as the MQ.

Data Analysis

Statistical analyses were calculated in IBM SPSS Statistics (Version 22.0) and significance levels were set at $\alpha = .05$. Assumptions of normal distribution for the variables were tested and non-parametric measures were used if applicable.

First, updating error rates and binding error rates were calculated as described in Chapter 2. Updating error rates were calculated in two steps for negative and neutral pictures separately. (1) For pictures in the updating condition, switch error rates were calculated as the number of incorrectly indicated locations in the updating test (E_{switch}), divided by the number of initially learned locations of the pictures in the updating condition in the initial encoding phase (L_{TUpd}). For pictures in the control condition, control error rates were calculated as the number of incorrectly indicated locations in the updating test (E_{contr}), divided by the number of initially learned locations of the pictures in the control condition in the initial encoding phase (L_{TContr}). (2) To control for general memory biases, updating error rates were then calculated from the difference scores of error rates for pictures that had changed location (switch error rate; E_{switch} / L_{TUpd}) and those that had not changed location (control error rates; E_{contr} / L_{TContr}), for negative and

neutral pictures separately (updating error rates = (E_{switch} / L_{TUpd}) − (E_{contr} / L_{TContr}). Binding error rates were calculated as errors in the updating phase where participants indicated the previous location of the learned pictures, divided by number of initially learned pictures.

Then, the hypotheses were tested. Firstly, it was tested whether groups differed in the updating error rates of negative and neutral pictures (Hypothesis 1). A mixed-design ANOVA for updating error rates with the within-subject factor valence (negative, neutral) and the between-subject factor group (PTSD, control) was calculated. Interactions were followed up with paired t-tests. Secondly, the effects of past trauma and past PTSD on updating error rates in the control group were examined (Hypothesis 2). Three regression analyses were calculated for updating error rates of negative and neutral pictures separately, as well as for the difference scores of updating error rates. History of past trauma (yes, no), past PTSD (yes, no), and depression at time of assessment (high, low) were entered in the regression to test which factors predicted the updating error rates. The high and low depression groups were defined by median-split of the BDI (control group only). Thirdly, it was tested whether individual differences in memory updating before PTSD treatment were related to memory characteristics and PTSD symptoms post-treatment (Hypothesis 3). Partial correlations were calculated to control for baseline scores.

Some control analyses were calculated to make sure the hypothesis tests were valid. A manipulation check compared how the groups perceived negative and neutral pictures. Ratings were available for 23 participants from the PTSD group and 57 participants from the control group. Paired t-tests were calculated to compare whether the PTSD and control groups differed in arousal and valence ratings for negative and neutral pictures, respectively. Furthermore, independent t-tests tested whether groups

differed in binding error rates. Finally, differences between the groups in performance and response to the task were checked. An independent t-test tested whether the groups differed in the number of learning trials they completed. Furthermore, a mixed-design ANOVA was calculated to test for group differences in the number of initially learned pictures, with the between-subject factor group (PTSD, control) and the within-subject factor valence (negative, neutral). To test whether the groups differed in how well they had initially learned the locations of the pictures that later occurred in the same location (control) or a new location (updating), a further mixed-design ANOVA for initially learned pictures was calculated, with the between-subject factor group (PTSD, control), and the within-subject factors valence (negative, neutral) and condition (updating, control).

Results

Comparison Between the PTSD and Control Group

Figure 3.2 displays mean updating error rates by picture valence and group. A mixed ANOVA with the within-subject factor valence (negative, neutral) and the between-subject factor group (PTSD, control) showed a significant interaction effect, $F(1, 103) = 5.13$, $p = .026$, $\eta_p^2 = .05$, indicating that the groups differed in updating error rates for the locations of negative and neutral pictures. The significant interaction effect was followed up with paired t-tests for the PTSD and control group separately. In the control group, a trend was found for greater updating error rates for negative compared to neutral pictures, $t(69) = 1.81$, $p = .07$, $d = 0.44$. In the PTSD group, no differences in updating error rates were found for neutral and negative pictures, $t(34) = -1.47$, $p = .15$, $d = 0.50$. This indicates that the interaction is caused by a different pattern of negative and neutral updating error rates in each group. Relative to individuals without PTSD,

trauma survivors with PTSD had more difficulties in updating neutral compared to negative pictures.

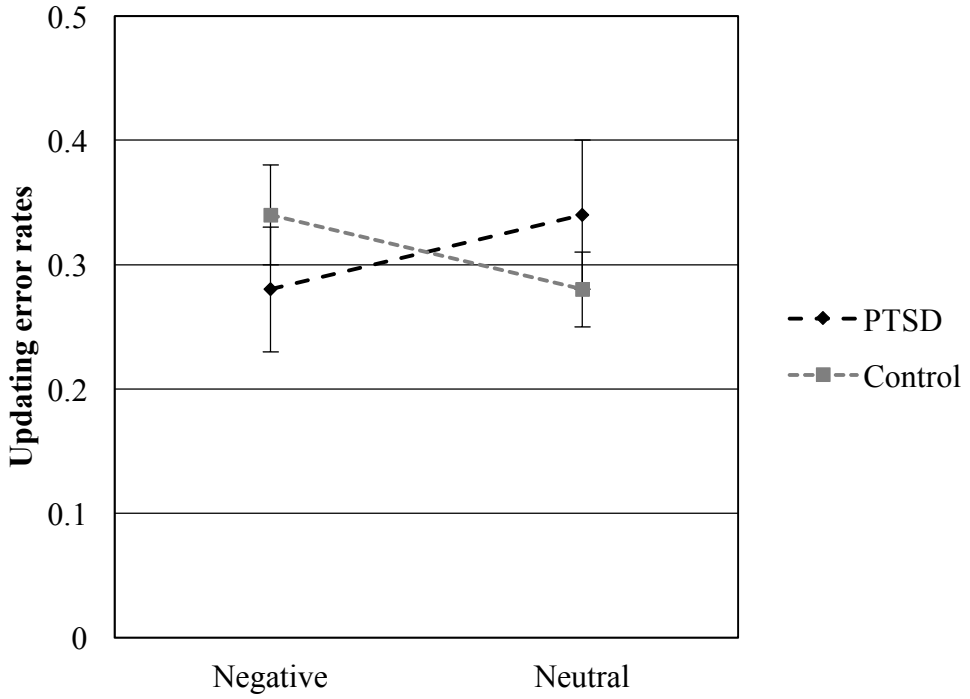


Figure 3.2. Updating error rates in the PTSD and control group

Influence of History of Trauma and Past PTSD (Control Group)

Regression analyses tested if depression, history of trauma and history of PTSD influenced negative and neutral updating error rates in the control group (n = 66). Results for the regression analyses are shown in Table 3.4. The overall regression was significant for negative pictures, $F(3, 63) = 3.03$, $p = .036$, $R^2 = .13$, but not for neutral pictures, $F(3, 63) = 1.34$, $p = .27$, $R^2 = .06$. As in Chapter 2, greater depression predicted greater updating error rates for locations of negative pictures. Furthermore, there was a trend for history of PTSD to predict smaller negative updating error rates. However, the regression for updating error rate difference scores was non-significant, $F(3, 63) = 2.10$,

p = .11, R^2 = .09. The non-significant results indicate that even though depression was associated with difficulties in updating negative updating error rates, it was not associated with more difficulties in updating negative compared to neutral error rates.

Table 3.4

Regression analysis for updating error rates of negative picture, neutral pictures and difference scores of updating error rates in the control group

	B	*SE B*	*Beta*
Negative picture updating error rates			
History of trauma (yes, no)	.04	.07	.07
History of PTSD (yes, no)	-.14	.08	-.25[I]
Depression (high, low)	.16	.06	.31*
Neutral picture updating error rates			
History of trauma (yes, no)	-.10	.05	-.21
History of PTSD (yes, no)	-.001	.07	-.002
Depression (high, low)	.08	.06	.17
Updating error rates difference score			
History of trauma (yes, no)	14	.07	.26[I]
History of PTSD (yes, no)	-.14	.08	-.26[I]
Depression (high, low)	.08	.06	.16

[I] p < .10, *p < .05

Prediction of Treatment Outcomes in Treated PTSD Patient Sample

Table 3.5 displays mean scores for memory characteristics and PTSD symptoms post-treatment. Partial correlations tested whether individual differences in updating

error rates for neutral and negative pictures before the start of trauma-focused CT for PTSD predicted trauma memory characteristics and PTSD symptoms after treatment over and above initial baseline scores. Table 3.6 displays the correlations for each of the variables in the PTSD patient group. Neutral and negative updating errors did predict neither trauma memory recall, trauma memory disjointedness, or PTSD symptoms post treatment, when controlled for initial baseline scores.

Table 3.5

Treatment change scores in memory characteristics and PTSD symptoms in the PTSD patient sample

Post-treatment scores	Mean	SD
Poor recall	0.71	0.96
Disjointedness	1.00	1.09
PDS	19.26	14.80

Note. MQ = Negative Event Memory Questionnaire. PDS = Posttraumatic Diagnostic Inventory. Positive scores represent a decrease in memory scores and PDS symptoms.

Table 3.6

Partial correlations for updating error rates for negative and neutral pictures with trauma memory characteristics and PTSD symptom scores post-treatment, controlled for initial PTSD baseline scores

	Updating error rates	
Post-treatment scores	Negative	Neutral
Poor recall	-.40	.04
Memory disjointedness	-.18	.14
PDS	-.03	.15

Note. PDS = Posttraumatic Diagnostic Inventory. Correlations are controlled for baseline scores of each variable.

Control Analyses

Initially learned pictures. Means for the number of negative and neutral pictures that participants initially learned in the learning phase are displayed in Table 3.7. A mixed-design ANOVA did not reveal a main effect of valence, $F(1, 103) = 1.95$, $p = .17$, indicating that after completing all learning trials, participants had learned negative and neutral pictures equally well. There was no main effect of group, $F(1, 103) = 2.02$, $p = .16$, indicating that the groups did not differ significantly in the number of picture locations that they had learned. Furthermore, there was no interaction effect, $F(1, 103) = 0.12$, $p = .73$, indicating that the groups did not differ in the number of negative and neutral pictures that they had learned. Further, it was tested whether the groups differed in the number of negative and neutral pictures that they learned, depending on whether pictures were in the updating condition or not. The mixed-design ANOVA showed a non-significant main effect of condition, $F(1, 103) = 0.69$, $p = .69$, indicating

that participants did not differ in how well they learned the pictures that later switched or did not switch location. Furthermore, the three-way interaction was non-significant, $F(1, 103) = 1.72$, $p = .19$, indicating that the groups did not differ in the number of pictures that they initially learned depending on their valence or whether they switched location. Thus, there were no differences between the groups in the initial learning phase.

Picture ratings. Mean arousal and valence ratings for negative and neutral pictures for the PTSD and control groups are displayed in Table 3.7. The groups did not differ in arousal ratings for negative, $t(78) = 0.91$, $p = .36$, and neutral, $t(78) = 1.10$, $p = .23$ pictures, nor in valence ratings of negative, $t(78) = -1.60$, $p = .12$ or neutral pictures, $t(78) = 0.69$, $p = .49$.

Binding error rate. The binding error rates (indication of originally learned location in updating test) for negative and neutral pictures are displayed in Table 3.7. It was tested whether groups differed in their binding error rate. Independent sample t-tests did not reveal differences in binding error rates of negative, $t(103) = -0.01$, $p = .99$, and neutral pictures, $t(103) = -0.47$, $p = .64$ between the groups.

Number of learning trials. The mean number of learning trials for the PTSD and control groups are displayed in Table 3.7. There were no group differences, $t(1, 103) = 1.16$, $p = .25$.

Table 3.7

Ratings of negative and neutral pictures, number of learning trials, and initially learned picture locations by groups

	PTSD		Control	
	Mean	SD	Mean	SD
Learned negative picture locations				
Updating	11.14	1.09	11.43	0.93
Control	11.34	1.09	11.46	0.86
Learned neutral picture locations				
Updating	11.26	1.04	11.39	1.03
Control	10.94	1.51	11.33	1.03
Negative picture ratings				
Arousal	7.52	1.46	7.90	1.20
Valence	4.55	0.82	4.26	0.72
Neutral picture ratings				
Arousal	5.58	1.79	5.98	1.78
Valence	6.98	0.87	7.11	0.87
Binding error rates				
Negative	.28	.20	.27	.20
Neutral	.28	.16	.26	.20
Learning trials	2.60	0.48	2.80	0.47

Discussion

The current study investigated whether trauma survivors with PTSD and control participants differed in location updating performance of negative and neutral associative memories. Furthermore, it examined the influence of history of trauma, history of PTSD, as well as current depression on difficulties updating negative and neutral material in control participants. Finally, it explored the relationship between memory updating performance in PTSD patients before treatment and changes in trauma memory characteristics, and in PTSD symptoms with treatment. The PTSD and control group showed opposite patterns in memory updating performance of negative and neutral material. Whereas the PTSD group tended to have more difficulties updating the location of neutral pictures, the control group tended to have more difficulties updating the location of negative pictures, replicating the findings of Novak and Mather (2009). In the control group, more difficulties updating negative information was related to higher depression scores, replicating findings from Chapter 2. However, findings were not significant for difference scores of the negative and neutral updating error rates and results need to be interpreted carefully. A history of past PTSD tended to be associated with a better updating performance for negative material.

Compared to control participants, trauma survivors with PTSD tended to have more difficulties updating features of neutral rather than negative information. These findings give some support for the *hypervigilance hypothesis*, which predicts that people with PTSD may track negative information due to a sense of current threat that is a common phenomenon in PTSD (e.g., Ehlers & Clark, 2000). This hypervigilance may have directed their attention towards negative material and therefore led to better memory performance for changes in negative material, at the expense of changes in neutral material. This would account for the poorer updating of neutral information in

the PTSD group, relative to the control group. This finding is in line with studies that showed attention biases towards threat cues in people with PTSD (e.g., Thomas et al., 2013; Kimble et al., 2010; for reviews, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Buckley, Blanchard, & Neill, 2000). It also adds to previous studies that found more proactive interference of previously learned neutral material in trauma survivors with PTSD compared to those without PTSD (Uddo et al., 1993; Yehuda & McFarlane, 1995). Furthermore, clinical observations show that people with PTSD often track information about their trauma or information that might confirm their negative beliefs or appraisals, whilst not considering information that might be able to update their fears or negative beliefs. For example, a rape survivor who was assaulted by an acquaintance might track exactly where the perpetrator is. This is also in line with the studies described in Chapter 1, showing that trauma survivors with PTSD show hypervigilance towards potential threat cues in visual search tasks (Pineles et al., 2007), dot probe tasks (e.g., Dalgleish et al., 2001) and modified stroop tasks (e.g., Beck et al., 2001). Recent studies using eye tracking also confirmed increased attention to visual threat cues for people with PTSD (e.g., Felmingham et al., 2011).

Control participants tended to have more difficulties updating negative compared to neutral information. This finding is in line with a study by Novak and Mather (2009) who used a similar paradigm with highly negative stimuli. They found that healthy participants had more difficulties updating negative compared to neutral information. Furthermore, in the control group, more difficulties in updating negative material were found to be associated with higher depression scores. This is in line with Study 1 which used the same mildly negative material (see Chapter 2) and found that higher depression scores were associated with difficulties updating negative material. The findings of this study further support that higher depression scores may lead to difficulties updating

mildly negative material. In healthy participants with low depression scores, these difficulties may only occur when highly negative material is used, as in Novak and Mather (2009).

The present study gave some initial evidence for the importance of the memory updating of neutral material in people with PTSD. The findings suggest that hypervigilance towards changes in negative material may lead to an attention deficit for changes of neutral information but results need to be interpreted carefully. Several alternative processes could also account for the finding that participants with PTSD tended to show more difficulties updating neutral compared to negative material. Firstly, previous studies suggested that more difficulties updating negative material may reflect stronger initial feature binding of negative material. Strong binding may then interfere with newly learned information (Novak & Mather, 2009). In the present study, trauma survivors with PTSD may have showed less initial binding for negative pictures and their locations in general. This would decrease the interference of initially bound associations and thereby facilitate the integration of new information, and could account for the findings in the present study. To test this alternative hypothesis, it was assessed whether participants indicated the initially learned location when making errors in updating picture locations. Fewer binding errors could indicate that participants showed weaker initial binding and were therefore less likely to indicate the previously learned location. However, no group differences were found, indicating that the initial binding for negative material between groups did not differ. Secondly, trauma survivors with PTSD may have perceived the neutral material as negative, or the negative material as less negative compared to the control group. To test this, self-reported valence and arousal ratings towards the stimuli were assessed. No differences were found between groups. This suggests that the alternative processes do not play a role in the different

patterns of updating negative and neutral material in the groups. However, more research is needed to understand the processes that may underlie the group differences in memory updating.

The study has several limitations. Firstly, the study assessed how participants remembered previously learned pictures that changed locations and controlled for memory performance of previously seen pictures that did not switch location. To determine the effect of previous learned material on new learning, it would be important to include new pictures in the updating test phase that the participant has not encountered beforehand. Secondly, pictures were presented in a random order, with no more than three consecutive pictures of the same valence condition. In the encoding and updating test, participants were presented with the pictures in the same order as in the learning phase. This may have facilitated retrieval and makes it difficult to ensure that associations rather than order were learned for each picture. However, as pictures were presented in a different order in each learning trial, the effect may be minimal. Nevertheless, future studies should account for this effect. Thirdly, the task used only six instead of eight picture locations of the original task (Novak & Mather, 2009), which was adapted to account for the PTSD patients having difficulties with concentration. This led to certain ceiling effects. Participants had to choose between six possible locations, giving participants a 17% chance that they guessed correctly. Consequently, participants showed low error rates for the pictures that did not switch location. Some participants also showed low error rates for the pictures in the updating condition. In addition, chances to detect differences were low as each condition only contained 12 pictures with dichotomous scoring (correct / incorrect). Furthermore, some participants had already learned 47 out of 48 pictures after completing only two instead of three learning trials, and then continued with the updating phase. Future studies may need to

make the task more difficult, or present pictures only once, to be able to better compare individual performances. Fourthly, valence and arousal ratings were assessed retrospectively and may not reflect the initial response that participants had towards them. It is therefore conceivable that participants differed in how they perceived the pictures and that these differences may account for the findings. Future studies could use physiological measures of arousal to measure responses towards the pictures. Fifthly, when interpreting these findings, it needs to be considered that the present study used mildly instead of highly negative material. It remains therefore unclear whether the stimuli evoked sufficient arousal to replicate findings of Novak and Mather's (2009) study. Nevertheless, the overall findings in the control group are parallel to their findings, suggesting replicability of the effect. Finally, the study examined how people with PTSD update associations of pictures and locations. When interpreting the results of this study, it needs to be considered that trauma survivors often associate their experience with a location, and avoidance behaviours are executed to minimise potential triggers. It is therefore conceivable that especially updating picture locations is related to a sense of current threat in trauma survivors with PTSD and influences how locations are updated. However, it is not clear whether other associated context features, such as colours, background, time or other items would lead to similar results. More research is needed to better understand the relationship between hyperarousal and memory updating of context features in PTSD.

In conclusion, this study gives some initial evidence for differences in updating performance in people with PTSD. Interestingly, relative to the control group, the PTSD group showed a lower performance in updating neutral material. The nature of these differences needs further exploration, and more research is needed to fully understand how they relate to treatment outcomes.

4

DEVELOPMENT AND MAINTENANCE OF NEGATIVE PERSON IMPRESSIONS IN PTSD

Introduction

Trauma survivors with PTSD hold strong negative beliefs about themselves (e.g., 'I have permanently changed for the worse'), others (e.g., 'I cannot trust anyone'), or the world (e.g., 'The world is a dangerous place') (Foa, Ehlers, Clark, Tolin, & Orsillo, 1999). Cognitive theories of PTSD suggest that the development and maintenance of excessively negative or distorted trauma appraisals play an important role in the development and maintenance of PTSD symptoms (e.g., Foa et al., 1999; Dalgleish, 2004; Ehlers & Clark, 2000; Resick & Schnicke, 1993). Updating expectations and impressions that people had during the trauma is necessary to overcome the sense of current threat in people with PTSD (e.g., 'I did not die'; 'Other people came to help me'). The experience of an interpersonal traumatic event, such as an assault or sexual assault, puts people at higher risk to develop PTSD, compared to non-interpersonal traumatic experiences, such as road traffic accidents for example (e.g., Kilpatrick et al., 2013). A recent study by Badour and colleagues (2015) found that fear, anger, and shame were particularly elevated in PTSD after the experience of interpersonal trauma compared to other trauma types. This suggests that interpersonal trauma may be

associated with strong negative appraisals about others (e.g., fear: 'No one can be trusted'; anger: 'Others should have come to help'; shame: 'Others will think that I am a horrible person if they find out'), that are difficult to overcome. Studies from social psychology on person impressions suggest that healthy participants find it more difficult to update negative impressions of others when presented with positive information, compared to update positive impressions when presented with negative information (e.g., Mende-Siedlecki, Baron, et al., 2013; Mende-Siedlecki, Cai, et al., 2013). However, only little is known about how people with PTSD appraise others, and how they adapt their first appraisals when new information becomes available.

Aims of the present Study

The present study used an adapted version of the person impression task (Mende-Siedlecki, Cai, & Todorov, 2012). Pictures of strangers were presented alongside neutral, positive or negative information about their behaviours. Participants were asked to rate how kind they thought the person was after each piece of information. Participants initially always received neutral information about the stranger. Then, they received either negative or positive information about them. Finally, they received additional negative or positive information about them, either confirming or contradicting the information they received previously. Kindness ratings were assessed at each stage. The study examined how PTSD and the experience of interpersonal trauma (1) influence how positively people appraise strangers, (2) influence the way negative and positive information affects how strangers are appraised, and (3) influence whether appraisals about strangers are changed when receiving new contradicting information about them. It was hypothesised that compared to non-traumatised controls, and people with PTSD without interpersonal trauma, survivors of an interpersonal trauma with PTSD (1) show lower kindness ratings of strangers, (2) are more likely to change their kindness rating

of strangers when receiving negative compared to positive information about them, and (3) show less changes in their kindness ratings after receiving incongruent positive compared to incongruent negative information about strangers.

Methods

Overview

Trauma survivors with PTSD who had experienced interpersonal or non-interpersonal traumatic events, and non-traumatised control participants who had experienced distressing interpersonal or non-interpersonal experiences completed a person impression updating task. In this task, participants were presented with images of neutral faces of strangers that were paired with neutral, negative, and / or positive information about them. Participants saw the same face three times in a row, and received new information about the person each time. The first piece of information was always neutral (their name). Then, in the congruent condition, participants received either two pieces of negative information or two pieces of positive information about the person. In the incongruent condition, participants received one piece of negative information and one piece of positive information (or one positive, one negative). After the presentation of each picture-information pair, participants were asked to complete a kindness rating about the individual.

Participants

As no previous studies had used the paradigm in the population and we were interested in clinically meaningful effects, we aimed to be able to detect a moderate effect size. We used the power calculation software G*Power to calculate the sample size needed to have 80% power to detect a within-between interaction with a medium to large effect size. We needed to recruit at least 48 participants to detect an ES = 0.6 at

alpha = .05. In total, 22 participants with PTSD and 25 non-traumatised control participants completed an impression updating task. Sample characteristics are displayed in Table 4.1. Both groups were divided according to whether or not the nature of their trauma (PTSD group) or unpleasant event (non-traumatised controls) was interpersonal. Trauma characteristics of interpersonal and non-interpersonal traumatic or unpleasant events are displayed in Table 4.2. Subjective distress scores of the event were available for 10 trauma survivors with PTSD and 24 non-traumatised controls. Mean distress scores of the most distressing event were higher in the PTSD group (M = 93.50, SD = 7.84) compared to the non-traumatised control group (M = 74.58, SD = 27.66), $t(32)$ = 4.58, $p < .001$, indicating that the PTSD group experienced the traumatic event as more distressing at the time than the non-traumatised control group experienced the negative event. Event distress scores did not differ between interpersonal (M = 80.00, SD = 13.23) and non-interpersonal events (M = 80.26, SD = 14.76), $t(32)$ = .05, p = .96. Sample characteristics for each group by interpersonal event are displayed in Table 4.3.

Recruitment and Group Allocation

Non-traumatised participants were recruited via circular emails to students and staff of the University of Oxford, and through adverts on several participant recruitment websites. Participants with PTSD were recruited from South London NHS outpatient services, and the Oxford Centre for Anxiety Disorders and Trauma. For a detailed description of the recruitment procedure, as well as inclusion and exclusion criteria, see Chapter 3. People who expressed an interest in the study were sent a full information sheet via email, and given at least 48 hours to consider their decision to take part. As described in Chapter 3, participants who responded to the advert and met diagnostic criteria for a current diagnosis of PTSD at Session 1 were included in the PTSD group (n = 4) along with the treatment seeking PTSD patients. If participants agreed to take

part in the study, they were invited to participate in a two-hour research session in the Institute of Psychiatry, London, or the Department of Experimental Psychology, Oxford.

Table 4.1

Demographics and symptom scores of PTSD and control group

	PTSD (*n* = 22)				Control (*n* = 25)				
	Mean	SD	n	%	Mean	SD	n	%	x^2 or t, p
Age (years)	31.46	9.72			33.96	20.39			-0.88, .39
Years of education	16.75	3.23			17.52	2.66			-0.52, .40
Ethnicity									4.97, .026
Caucasian			18	72%			25	100%	
Ethnic Minority			4	28%			0	0%	
Gender									3.63, .06
Male			9	41%			4	16%	
Female			13	59%			21	84%	
PDS (trauma / negative control	35.91	13.01			7.52	8.81			5.65, < .001
event)	21.95	8.93			4.92	5.99			7.66, < .001
BDI (n = 46)									

Note. PDS = Posttraumatic Diagnostic Scale. BDI = Beck Depression Inventory-II.

Table 4.2

Trauma and negative events characteristics for PTSD and control group

PTSD	N Total	n
Non-interpersonal trauma	10	
Road traffic accident (RTA)		7
Witnessing others die / being seriously hurt		1
Other non-interpersonal traumatic event		2
Interpersonal trauma	12	
Non-sexual assault		2
Sexual assault		4
Terrorist attack		1
Childhood abuse (sexual or physical)		2
Other interpersonal traumatic event		3
Non-traumatised control group	**N Total**	**n**
Non-interpersonal event	15	
Medical incidents		6
Negative experiences at school / work		4
Negative incidents whilst travelling		3
Other negative event		2
Interpersonal event	10	
Relationship break-up		5
Major argument with family or friends		2
Parents separating		1
Other negative event		2

Table 4.3

Demographics of PTSD group with and without interpersonal trauma and non-traumatised control group with and without interpersonal negative event

	Interpersonal trauma (n = 12)				Non-interpersonal trauma (n = 10)					
PTSD	Mean	SD	n	%	Mean	SD	n	%	*U*	*p*
Age (years)	29.27	8.99			34.10	10.37			74.00	.05
Years of education (n = 20)	17.92	3.26			15.00	2.39			57.50	.047
PDS	37.92	12.57			33.50	13.77			73.50	.38
BDI (n = 18)	22.17	8.30			21.70	19.08			57.50	.87
Gender										
Female			5	42			4	40		.94
Male			7	58			6	60		
Ethnicity										
Caucasian			9	75			9	90		.36
Ethnic minorities			3	25			1	10		

	Interpersonal negative event (n = 10)				Non-interpersonal negative event (n = 15)					
Non-traumatised controls	Mean	SD	n	%	Mean	SD	n	%	*U*	p
Age (years)	29.07	11.06			36.72	24.86			60.00	.43
Years of education	17.80	2.30			17.47	2.92			85.00	.61
PDS (for negative event)	11.30	10.79			5.00	6.42			103.50	.12
BDI (n = 23)	5.67	6.06			3.67	5.38			87.50	.24
Gender										
Female			9	90			11	73		.62
Male			1	10			4	27		
Ethnicity										
Caucasian			10	100			15	100		--
Ethnic minorities			0	0			0	0		

Impression Updating Task

Four parallel picture and behaviour sets were created. Picture sets contained 60 photos of neutral faces derived from the AR Face Database (Martines & Benavente, 1998). The sets were balanced for gender (7 male, 8 female) and ethnicity (7 white, 8 non-white) of the individuals displayed on the pictures. Behaviour sets contained sentences introducing the name of the individual (neutral), or sentences describing either 15 negative or positive behaviours ascribed to the person shown in the photos (e.g., 'Person A spat at someone' vs. 'Person A volunteers in a homeless shelter'). Behaviours were adapted from Fuhrmann et al. (1989). All negative behaviours that included a traumatic event were excluded, such as 'Person A beat Person B'. To create parallel sets for negative and positive behaviours, in the present study, 120 potential behaviours were selected and rated by 15 people for their kindness on a scale from 1 = *not at all* to 7 = *very much so*. All stimuli that were used in this task (faces, behaviours and names) are listed in Appendices D - F. Mean scores for kindness ratings for each behaviour set is displayed in Table 4.4.

Table 4.4

Mean scores of kindness ratings for behaviour sets that were used in the present study

	Negative		Positive	
Behaviour sets	Mean	SD	Mean	SD
Set 1	2.19	0.86	5.56	0.79
Set 2	2.19	0.86	5.56	0.79
Set 3	2.19	0.89	5.56	079
Set 4	2.20	0.86	5.56	0.79

Stimulus presentation. The task was programmed on Matlab (Version R2013b). Stimuli were presented on the screen of a 21.5" iMac. Pictures and behaviours were presented within a black frame. Faces were presented in a size of 15x10cm and behaviours were presented underneath the picture so that they were easy to read. The first slide always introduced the name of the individual on the picture. Figure 4.1 displays example items for positive and negative incongruent behaviour conditions. Participants rated kindness on a 7-point Likert scale from 1 = *not at all* to 7 = *very much so*, using a 7-point scale on the keyboard.

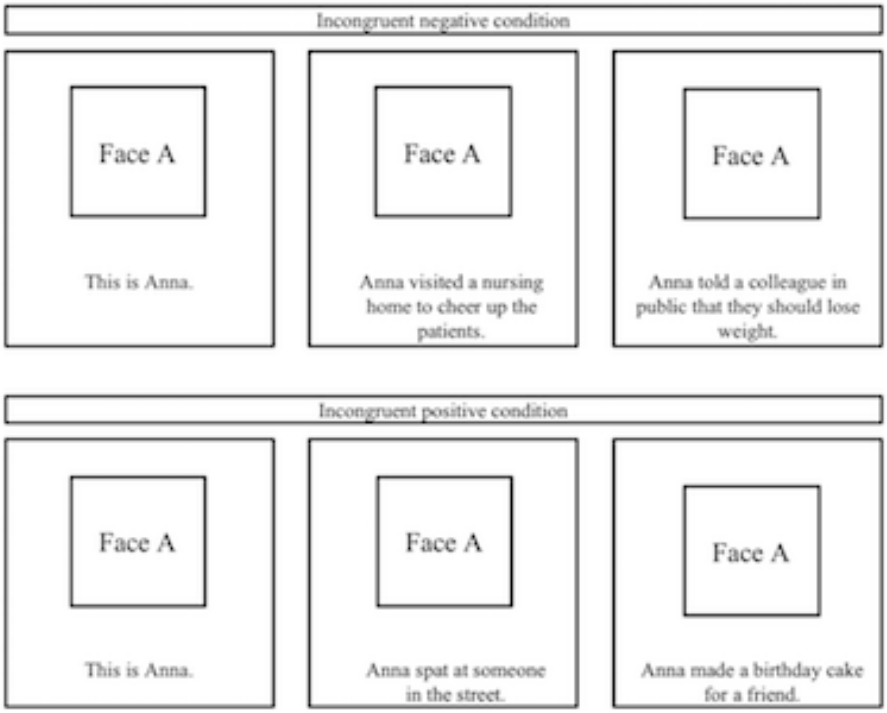


Figure 4.1. Example items for stimuli sequence in the incongruent positive – negative and negative – positive condition.

Stimulus material. The 12 behaviour sets (four neutral, four negative, four positive) with 15 different pieces of information were paired to create four different conditions, (1) neutral – negative – positive, (2) neutral – negative – negative, (3) neutral – positive – negative, (4) neutral – positive – positive. For the two congruent conditions,

one neutral and either two positive or two negative behaviour sets were needed. For the two incongruent conditions, one neutral, one positive, and one negative behaviour set were needed. Hence, over all conditions, four neutral, four negative and four positive sets needed to be allocated. For each participant, each of the four neutral, four negative and four positive behaviour sets was randomly allocated to one of the four conditions according to this pattern. Within each behaviour set, the behaviours were ranked according to their mean kindness ratings that had been given by 15 independent raters (see section on creation of behaviour sets), to assure that highly negative behaviours would be paired with highly positive behaviours, and vice versa. Behaviour pairs were presented in a randomised order, with the constraint that the same condition could be presented no more than three times in a row. Picture-behaviour-pairs were presented for three seconds. Then, a white screen appeared. Participants were asked to rate how kind they thought the person on the picture was. Participants were always first presented with a picture of a person that introduced their name (neutral information, e.g., 'This is Anna'), and asked to rate how kind they thought the person was (t1). Second, participants were presented with the same picture, paired with a positive or negative behaviour (t2). Third, participants were presented with the same picture a third time with either a congruent (positive if positive at t2, or negative if negative at t2) or incongruent (positive if negative at t2, or negative if positive at t2) behavior (t3). Ratings were assessed after t2 and t3. Participants completed two practice trials before starting the actual task. Figure 4.2 displays an example of how stimuli were presented. All instructions for the task are found in Appendix D.

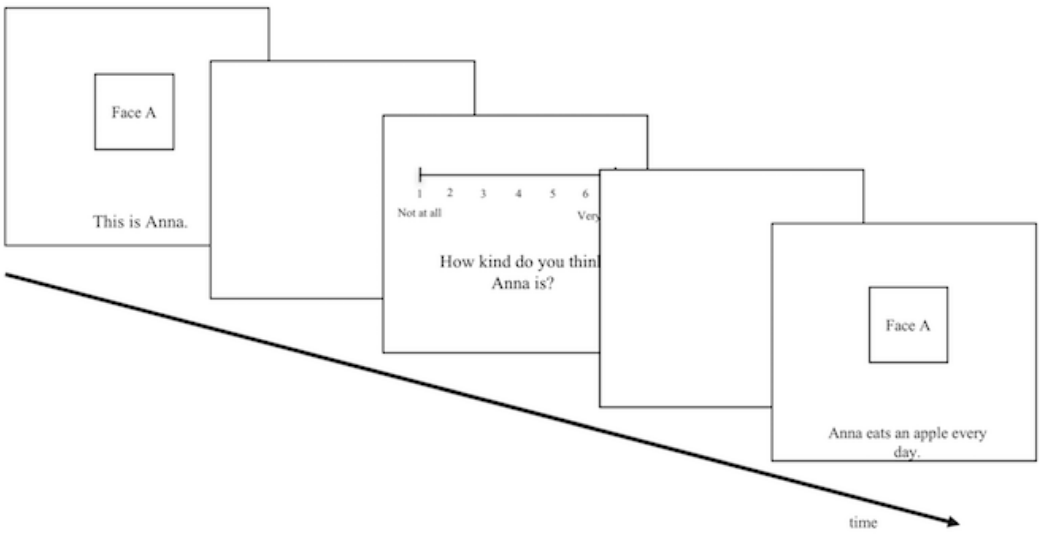


Figure 4.2. Example of stimulus presentation. Pictures and sentences were presented for three seconds. Afterwards, a white screen followed by the rating scale appeared. Each photo was first shown with neutral information (their name) and then subsequently paired with two different behaviours, and was rated for their kindness three times.

Pilot Study

The task was piloted with 24 (16 female, 9 male) healthy participants. Participants were excluded if they had any mental health problems, and if they reported having had an experience of an interpersonal trauma. Figure 4.3 displays mean kindness ratings by time and condition. Absolute change scores were calculated to detect changes after the presentation of negative and positive information from t1 to t2, and t2 to t3. Paired t-tests were calculated for change scores from t1 (neutral information) to t2 (negative or positive information). A trend for a significant valence effect (positive, negative) was found, $t(23) = 2.04$, $p = .05$, indicating that participants tended to show more absolute change after receiving negative compared to positive information about strangers. Furthermore, paired t-tests were calculated for change scores from t2 to t3, after incongruent and congruent information (negative – positive or positive – negative).

Participants showed significantly less change after incongruent positive compared to incongruent negative information, $t(23) = 3.33$, $p = 003$, indicating that it was more difficult to update negative impressions with positive information than vice versa. Participants did not show differences in change scores after congruent information, $t(23) = 1.35$, $p = .19$, indicating that appraisals were adapted similarly for negative and positive congruent information.

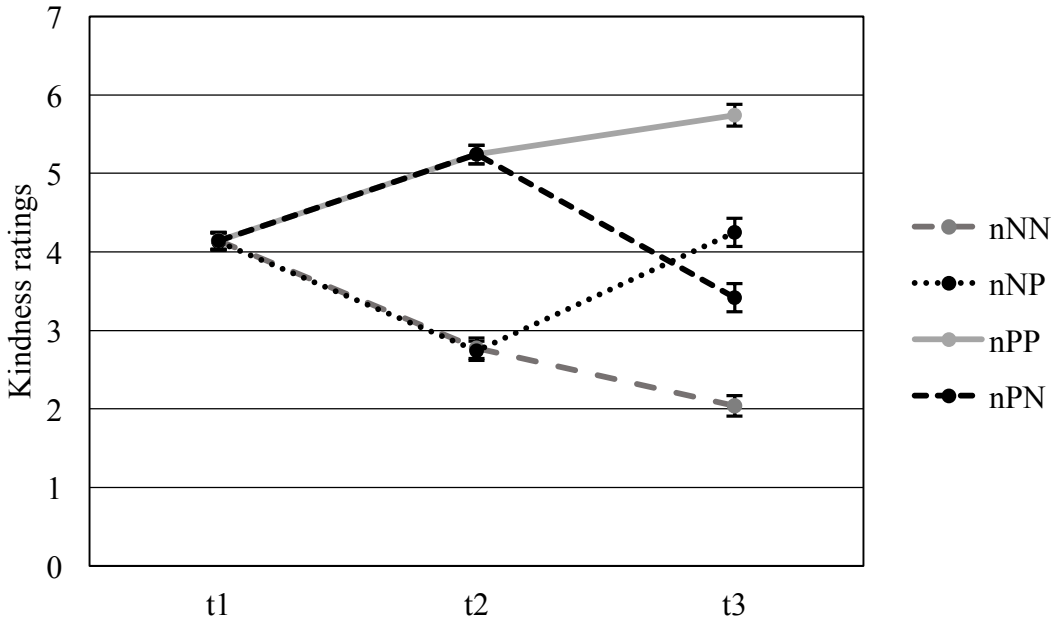


Figure 4.3. Kindness ratings in pilot study by time and condition. nNN: Neutral – Negative – Negative; nNP: Neutral – Negative – Positive; nPP: Neutral – Positive – Positive; nPN: Neutral – Positive – Negative. t1 = first rating. t2 = second rating. t3 = third rating.

Symptom Measures

The diagnosis of PTSD was assessed with the CAPS-5 (Weathers et al., 2013). Self-reported severity of PTSD symptoms according to the DSM-5 was assessed with the PDS (Foa et al., 1997). Severity of depression symptoms was assessed with the BDI-

II (Beck, Steer, & Brown, 1996). Symptoms measures are described in detail in Chapter 2 (BDI-II) or 3 (CAPS-5 and PDS).

Questionnaires

Participants filled in the General Information Questionnaire, and completed the Stressful Events Checklist (Foa et al., 1997) to assess whether they had experienced a traumatic event. Participants also indicated how distressing they found the event at the time, on a scale from 0 = *not at all* to 100 = *very much so*. More detailed information about the questionnaires is reported in Chapter 3.

Procedure

Participants were invited for a two-hour research session to the Institute of Psychiatry, King's College London, or the Department of Experimental Psychology, University of Oxford. On arrival, participants completed a set of questionnaires, and some memory tasks, which are partly reported in Chapter 3 and 5. At the end of the session, participants completed the impression updating task.

Data Analysis

Firstly, as the groups differed in some demographic characteristics, control analyses were conducted to see whether age, ethnicity and years of education moderated the effects that were found. ANCOVAs for absolute change scores from t1 to t2, and t2 to t3 were calculated with the within-subject factor valence (negative, positive), and the between-subject factors group (PTSD, non-traumatised controls) and interpersonal event (yes, no), adding each variable as a covariate separately.

Then, it was tested how the groups responded to initial neutral picture presentation. Univariate ANOVAs with the between-subject factor group (PTSD, non-traumatised controls) and interpersonal event (yes, no) were calculated for the initial

kindness ratings after the neutral picture presentation (t1). Then, the influence of negative and positive information on appraisals about strangers was examined. Change from t1 to t2 (change in kindness ratings from neutral to positive information; or neutral to negative information) was computed as the absolute difference (kindness ratings at t2 minus kindness ratings at t1), and compared in a mixed-measures ANOVA with the within-subject factor valence (negative, positive), and the between-subject factors group (PTSD, non-traumatised controls) and interpersonal event (yes, no). In addition, to test whether differences in initial ratings at t1 influenced changes in ratings from t1 to t2, an ANCOVA was conducted, with the same within-subject and between-subject factors, but including mean initial ratings at t1 as a covariate. Thirdly, it was examined how incongruent and congruent negative and positive information at t3 influenced changes in kindness ratings in the PTSD and control group, and between interpersonal and non-interpersonal negative events. Change in kindness ratings from t2 to t3 was calculated as the absolute difference (kindness ratings at t3 minus kindness ratings at t3). Mixed-measure ANOVAs for change scores after congruent and incongruent information were calculated separately, with the within-subject factor valence (negative, positive), and the between-subject factors group (PTSD, non-traumatised control) and interpersonal event (yes, no).

Results

Control Analyses

The ANCOVAs for change scores from t1 to t2 with years of education as a covariate showed a significant main effect of years of education, $F(1, 40) = 1.56$, $p = .04$, indicating that years of education influenced the kindness ratings independently of valence, group and interpersonal event. The effect was further explored. Pearson

correlations showed that years of education was negatively correlated with absolute change scores, $r(45) = -.33$, $p = .03$, indicating that more education was associated with less change in impression ratings with new information. The other ANCOVAs (with the covariates age or ethnicity) did not reveal significant main effects of age, $F(1, 42) = 0.11$, $p = .74$, or ethnicity, $F(1, 42) = 1.44$, $p = .24$. There were also no interaction effects of valence x age, $F(1, 42) = 0.34$, $p = .56$, valence x ethnicity, $F(1, 42) = 2.30$, $p = .14$, or valence x years of education, $F(1, 42) = 0.00$, $p = .99$. None of the ANCOVAs for change scores from t2 to t3 showed a significant main effect of age, $F(1, 42) = 1.09$, $p = .30$, ethnicity, $F(1, 42) = 0.18$, $p = .68$, or years of education, $F(1, 42) = 2.23$, $p = .14$. They also did not reveal interaction effects of valence x age, $F(1, 42) = 0.88$, $p = .30$, valence x ethnicity, $F(1, 42) = 1.92$, $p = .17$, or valence x years of education, $F(1, 42) = 1.03$, $p = .32$. This indicates there were no moderation effects of any variables except for years of education so the other variables were not included in the following analyses. Years of education was included in the analysis for change scores from t1 to t2.

Initial Ratings of Strangers

Mean kindness ratings are displayed in Table 4.5. The univariate ANOVA did not show a main effect of group, $F(1, 46) = .77$, $p = .38$, $\eta_p^2 = .02$, or interpersonal event, $F(1, 46) = 2.19$, $p = .15$, $\eta_p^2 = .05$, and there was no interaction effect, $F(1, 46) = 1.85$, $p = .18$, $\eta_p^2 = .05$. This indicates that there were no differences in the way the groups initially perceived strangers at t1.

Table 4.5

Initial kindness ratings by group and interpersonal event

	PTSD		Non-traumatised control	
Interpersonal event	Mean	SD	Mean	SD
Yes	4.02	0.44	4.09	0.24
No	4.45	0.91	4.11	0.29

Influence of Negative and Positive Information on Ratings

Change scores after negative and positive information were compared. Positive change scores after positive information indicate an increase in kindness ratings, while positive change scores after negative information represent a decrease in kindness ratings. The mixed-measure ANOVAs for change scores from t1 to t2 did not reveal a significant main effect of group, $F(1, 43) = .25$, $p = .62$, $\eta_p^2 = .01$, or interpersonal event, $F(1, 43) = 1.83$, $p = .18$, $\eta_p^2 = .04$. There was also no significant group x interpersonal event interaction effect, $F(1, 43) = .06$, $p = .81$, $\eta_p^2 = .001$, valence x interpersonal event interaction effect, $F(1, 43) = 2.58$, $p = .12$, $\eta_p^2 = .07$, and no significant valence x group x interpersonal event three-way interaction effect, $F(1, 43) = .90$, $p = .35$, $\eta_p^2 = .02$.

There was, however, a significant main effect of valence, $F(1, 43) = 45.19$, $p = .01$, $\eta_p^2 = .15$, indicating that kindness ratings generally changed more after the presentation of negative information compared to positive information. There was also a significant valence x group interaction effect, $F(1, 43) = 5.00$, $p = .03$, $\eta_p^2 = .10$, indicating that the PTSD and control groups showed different patterns in the way they adapted their kindness ratings after receiving negative or positive information. Mean change scores from t1 to t2 for the PTSD group and non-traumatised control group by valence are displayed in Figure 4.4. The significant valence x group interaction effect

was followed up with paired t-tests for the PTSD group and non-traumatised control group separately. The PTSD group showed significantly greater changes in their kindness ratings after negative compared to positive information, $t(21) = 2.49$, $p = .02$, $d = 1.09$, indicating that the PTSD group showed a smaller change in their kindness ratings after positive information (increase), compared to the change in kindness ratings after negative information (decrease). The non-traumatised control group did not show any differences in their change scores depending on valence, $t(24) = .71$, $p = .48$, $d = 0.29$. The valence x group interaction effect remained stable when controlling for differences in initial ratings at t1, $F(1, 42) = 5.41$, $p = .03$, $\eta_p^2 = .11$. The valence x group interaction effect also remained stable but no longer reached significance when controlling for years of education, $F(1, 40) = 3.36$, $p = .07$, $\eta_p^2 = .08$.

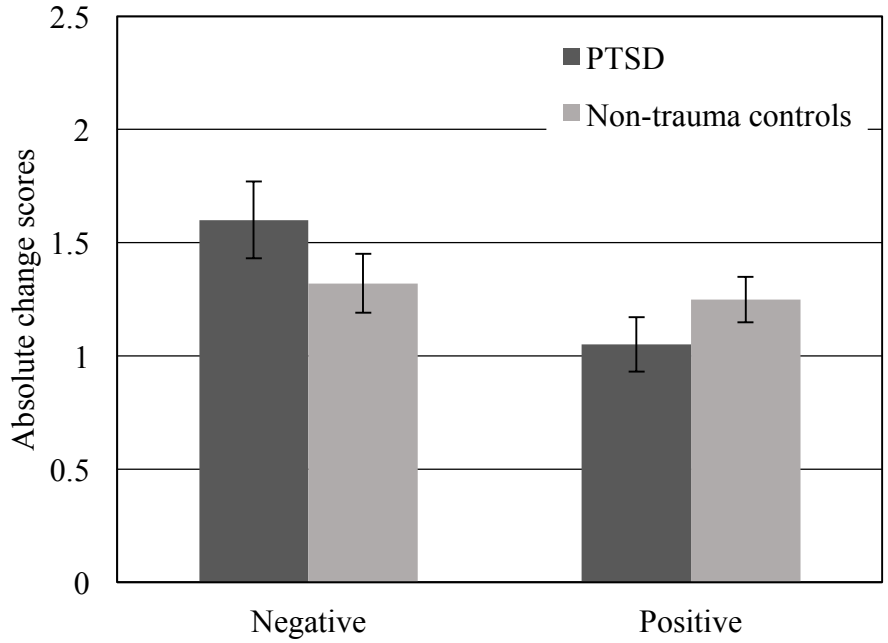


Figure 4.4. Mean change scores in kindness ratings about strangers from t1 (neutral information) to t2 (negative or positive information) by group. Positive change scores for negative information represent a decrease in kindness ratings, while a positive change scores for positive information represent an increase in kindness ratings.

Influence of Incongruent Information on Kindness Ratings

Mean absolute change scores in ratings from t2 to t3 after congruent and incongruent negative or positive information are displayed in Figure 4.5. The mixed-measures ANOVA revealed a main effect of valence, $F(1, 43) = 28.28$, $p < .001$, , $\eta_p^2 = .40$, indicating that participants showed greater changes in ratings after incongruent negative (positive – negative condition) compared to inconsistent positive (negative – positive condition) information. Furthermore, there was a trend for a significant main effect of interpersonal event, $F(1, 43) = 3.16$, $p = .08$, $\eta_p^2 = .07$, indicating that those participants who had experienced an interpersonal trauma (PTSD group) or other upsetting interpersonal event (control group) tended to show smaller changes in their

kindness ratings of other people after receiving incongruent negative or positive information, compared to those who experienced other upsetting events. No significant interaction effects were found.

Influence of Congruent Information on Kindness Ratings

The mixed-measures ANOVA revealed a trend for a main effect of valence, $F(1, 43) = 3.68$, $p = .06$, $\eta_p^2 = .08$, indicating that participants tended to show greater changes in their ratings after receiving congruent negative compared to positive information. There was also a significant main effect of interpersonal event, $F(1, 43) = 10.08$, $p = .003$, $\eta_p^2 = .19$, indicating that participants who had experienced an interpersonal upsetting event showed greater changes in their kindness ratings after receiving negative or positive consistent information than those who experienced other upsetting or events. There were no other main effects or interaction effects.

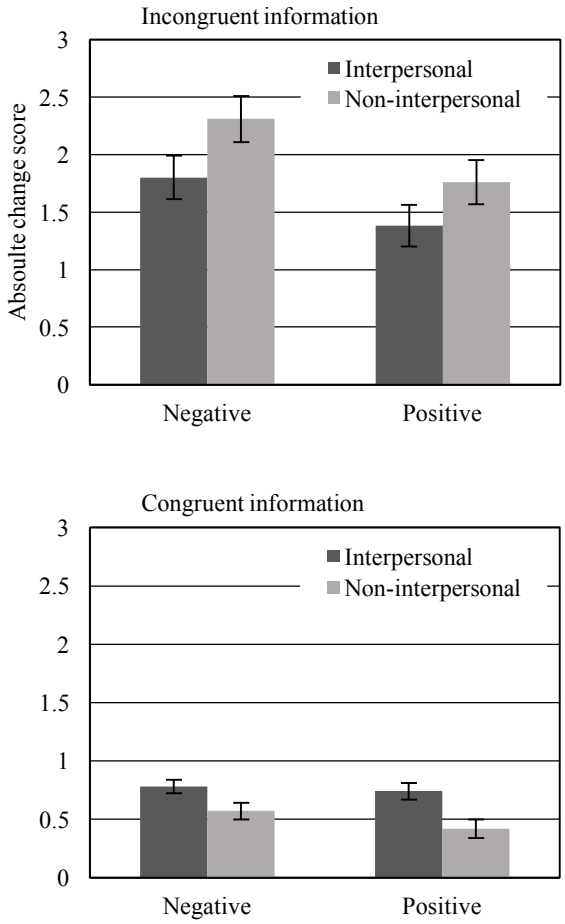


Figure 4.5. Changes in kindness ratings from t2 to t3 after incongruent and congruent negative and positive information by interpersonal event. In the incongruent condition, participants received either positive information at t2 and negative information at t3 (negative incongruent condition), or negative information at t2 and positive information at t3 (positive incongruent condition). In the congruent condition, participants either received negative information at t2 and t3 (negative congruent condition), or positive information at t2 and t3 (congruent positive condition).

Discussion

The study explored how trauma survivors with PTSD and non-traumatised control participants appraise strangers, how negative and positive information influences these appraisals, and how appraisals are updated after incongruent information. It also

examined the effect of interpersonal trauma on person appraisals and appraisal updating. The PTSD group showed greater changes in their appraisals in response to negative compared to positive information, indicating a bias in PTSD towards the development of negative appraisals. Trauma survivors with PTSD did not show different patterns in appraisal updating after incongruent information compared to non-traumatised controls. However, the experience of an interpersonal negative event (trauma or control event) tended to be associated with more difficulties in changing appraisals of others according to new incongruent negative and positive information. In addition, the experience of a negative interpersonal event was associated with greater change in appraisals when receiving congruent negative or positive information.

In line with the hypothesis, trauma survivors with PTSD changed their initial appraisals of strangers more readily after receiving negative compared to positive information about them, as indicated by a greater decrease in kindness ratings. This effect was independent of whether they had experienced an interpersonal traumatic event. Non-traumatised controls, on the other hand, did not differ in how much they adapted their appraisals depending on the valence of the information they received. This finding is in line with clinical observations suggesting that people with PTSD often develop excessive negative appraisals in the aftermath of the trauma, and struggle to trust others and to regain a feeling of safety (e.g., Ehlers & Clark, 2000). Furthermore, PTSD is characterised by being easily irritable and showing outbursts of anger (APA, 2013), which may contribute to the negative appraisal bias. These findings are consistent with PTSD literature suggesting that trauma survivors show selective attention towards threat-related stimuli (e.g., Pauvonic et al., 2002), and with suggestions that selective attention towards negative material may contribute to the maintenance of PTSD symptoms (e.g., Beard, Sawyer, & Hofmann, 2012; Hakamata, Lissek, Bar-Haim, & Britton, 2010).

Furthermore, participants generally more readily updated their appraisals about strangers to more negative kindness ratings after incongruent negative information, compared to how they updated their appraisals to more positive kindness ratings after incongruent positive information. This finding replicates previous studies on person impression-updating, showing that healthy participants had more difficulties updating initial negative impressions with positive information than vice versa (e.g., Mende-Siedlecki, Cai, & Todorov, 2012). Interestingly, people with negative interpersonal experiences tended to show less updating of initial appraisals after incongruent information, regardless of its valence, than those who had experienced other negative events. On the other hand, those with negative interpersonal experiences showed greater appraisal updating after congruent information, independent of the valence of this information. This pattern of findings suggests that a history of interpersonal difficulties may be linked to a tendency to form lasting initial evaluations of other people on first impressions that are not easily changed, but easily confirmed with congruent information. However, findings need to be interpreted carefully as they are only statistical trends.

Contrary to the hypothesis, the groups did not differ in their initial appraisals of strangers, indicating that people with PTSD and interpersonal trauma did not generally perceive strangers as less kind, or potentially more threatening. Furthermore, the PTSD group did not generally show more difficulties updating their appraisals with new information. There are several explanations for this. Firstly, participants were asked to give kindness ratings about others. It is possible that people with PTSD do not generally have difficulties updating appraisals about other people unless those people produce a sense of current threat. It is conceivable that the person impression task is particularly relevant to people with interpersonal negative experiences, but not for trauma survivors

with PTSD in general. It would therefore be important to assess appraisals in other situations that are often related to PTSD, such as safety appraisals about places (e.g., street, shopping mall), or appraisals in situations that may be less closely linked to PTSD, such as abstract objects, in order to better understand how people with PTSD form and update appraisals. Secondly, it is conceivable that it is not a general feature of PTSD to have biases in the immediate formation of appraisals and their updating. The tasks may have assessed explicit appraisals that are subject to social desirability and the ratings may reflect the participants' own view about how they should feel about the persons in the task, rather than their immediate appraisals that are formed automatically in everyday life. To address this issue in future studies, it may be helpful to give participants less time to respond in order to prevent that participants engage in rumination processes. More research is needed to better understand appraisal updating and its relationship with PTSD.

The study has several limitations. Firstly, the study only used non-traumatised participants as a control group. It is surprising that the non-traumatised control participants showed a similar pattern as the PTSD group after the experience of an interpersonal negative event. It could be speculated that interpersonal negative events are similarly distressing, regardless of whether they are classified as a trauma. The retrospective distress ratings of the traumatic (PTSD group) and distressing negative events (control group) showed that the PTSD group reported that their events had been more distressing compared to the control group. However, distress ratings may be influenced by PTSD symptomatology and not mirror the actual distress at the time. More research is needed to understand how appraisals are updated in healthy participants, and why healthy participants with negative interpersonal experiences show similar patterns to PTSD patients. This may help to better understand differences in PTSD, as well as

risk factors for the development of PTSD after trauma. Secondly, the appraisals assessed in this task were dissociated from the self in that participants only rated photos of people, and not people that they interacted with. It is possible that participants tried to give objective, rational kindness ratings, rather than their emotional and initial response. Other variables, such as trustworthiness, may be more sensitive to biases in PTSD and more likely to detect potential differences and should be included in future studies. Thirdly, the impression updating task assessed appraisals right after the information became available. The process of forming and updating appraisals right after receiving information may differ from the process of maintaining these reappraisals over time. It would therefore be interesting to assess appraisals after completing filler tasks, or once new information has entered working memory. Finally, the study used only three trials for each individual. Previous studies used five trials to test the effect of incongruent information. It is possible that one negative or positive piece of information is not enough to create a stable initial person impression. Future studies should therefore use the original version of the task. Finally, the sample size was small for each group and the groups differed in some variables, such as age, ethnicity, and years of education. Post-hoc power analyses suggest that there was about 80% power to detect between-subject differences of large effect sizes (SE = 0.80). As the group differences were of medium effect size, it is conceivable that statistical trends may not have reached significance because of a lack of statistical power due to the small sample size. Therefore, this study can only give some initial ideas about appraisals and changes in appraisals in PTSD and after interpersonal negative experiences. More research with bigger sample sizes is needed to better understand the role of appraisals and updating appraisals in the development and maintenance of PTSD symptoms.

In conclusion, people with PTSD did not respond differently to strangers initially, but they changed initial person impressions more in response to negative compared to positive information, reflected in a greater reduction in kindness ratings. The experience of an interpersonal negative event tended to be associated with more difficulties in updating appraisals after incongruent information, and stronger updating with congruent information. More research is needed to better understand impression-updating in PTSD, and the effect of interpersonal negative events. Results may help better understand how updating appraisals contributes to the maintenance of PTSD symptoms in the aftermath of trauma.

Note. A version of this chapter was published as:
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5

DISJOINTEDNESS OF TRAUMA MEMORIES IN POSTTRAUMATIC STRESS DISORDER

Introduction

Trauma survivors with PTSD intrusively re-experience sensory impressions of their trauma, such as images, sounds or smells (e.g., Ehlers & Steil, 1995; van der Kolk & Fisler, 1995). On the other hand, they often report difficulties in voluntarily remembering certain details of the trauma, such as the order in which the event happened (e.g., Ehlers et al., 2004). Cognitive theories of PTSD suggest that the trauma memory is poorly elaborated and not well integrated into the rest of the autobiographical memory base (e.g., Brewin et al., 2010; Ehlers & Clark, 2000; Foa et al., 1989). Clinical observations further suggest that trauma survivors with PTSD do not re-experience the entire traumatic memory, but rather re-experience certain parts of the event that often relate to the worst moments of the trauma (e.g., Hackmann et al., 2004). Ehlers et al. (2004) therefore suggested that the worst moments of the trauma may be particularly disorganised. Trauma-focused treatments for PTSD aim to reduce re-experiencing symptoms by elaborating the trauma memory through repeated exposure and/or discussion or imagery techniques. It is thought that this helps lay down the event memory in a coherent and complete way. Even though trauma-focused treatments are highly effective (Ehlers et al., 2013; 2005), the quality of trauma memories is not yet

understood, and it is unclear how the memory quality changes with trauma-focused cognitive therapy for PTSD (CT-PTSD; Ehlers et al., 2005; Ehlers & Clark, 2000).

As discussed in Chapter 1, many studies have examined the overall quality of the trauma memory in PTSD using self-report measures and objective ratings of trauma narratives. Most studies found that people with PTSD had more disorganised trauma memories compared to trauma survivors without PTSD (e.g., Hagenaars et al., 2009; Halligan et al., 2003; Jelinek et al., 2009), but it remains unclear whether these findings only apply to trauma memories, or also to the memory of other negative events. Whilst some studies found that the overall trauma memory in PTSD was more disorganised compared to the memory of a negative control event with self-report measures (e.g., Halligan et al., 2003) and objective ratings of the trauma narrative (e.g., Jelinek et al., 2009), others could not replicate these findings (e.g., Rubin, 2011). Some studies also examined the disorganisation of the worst moments of the trauma in PTSD. They found that the worst moments of the trauma memory were more disjointed compared to other parts of the trauma narratives on most measures (Evans et al., 2007; Jelinek et al., 2010).

Aims of the Study

The present study examined two aspects of trauma memory disorganisation in trauma survivors with and without PTSD, and non-traumatised controls. Firstly, it examined memory disorganisation of the overall trauma memory, which is often associated with difficulties in remembering certain aspects of the event or the order in which it happened (poor memory recall). Secondly, it examined memory disorganisation of the worst moments of the trauma (memory disjointedness). It aimed to better understand whether these aspects of trauma memory disorganisation differ from memories of other negative events, and their relationship with trauma and PTSD. It further examined the effects of trauma-focused CT-PTSD (Ehlers et al., 2005; Ehlers &

Clark, 2000) on self-reported memory quality. It was hypothesised that (1) trauma survivors with PTSD report poorer memory recall of the trauma memory in general, and more disjointed trauma memories than traumatised and non-traumatised control groups without PTSD, (2) trauma survivors with PTSD, but not traumatised controls without PTSD, report poorer memory recall for the traumatic compared to negative control events, and the worst moments are more disjointed compared to negative control events, and (3) trauma-focused CT-PTSD leads to improvements in memory disjointedness and poor recall of the trauma memory.

Methods

Overview

Trauma survivors with PTSD, and traumatised and non-traumatised control participants completed a memory questionnaire that assessed subjective memory disorganisation (poor memory recall and memory disjointedness of the worst moments) for the traumatic event and a negative control event (trauma survivors with and without PTSD), or for the memory of two negative control events (non-traumatised controls). A subsample of 19 PTSD patients and 23 traumatised control participants completed the questionnaire before and after trauma-focused PTSD treatment, or an equivalent wait period. Non-traumatised controls were only assessed once.

Participants

Previous studies that examined memory characteristics in PTSD found small to medium effect sizes (e.g., Kleim, Wallott & Ehlers, 2007; Kleim & Ehlers, 2008). We therefore aimed to be able to detect a moderate effect size for differences between the groups. In order to have 80% power to detect a group difference with an effect size of ES = 0.5 at alpha = .05, we needed to recruit at least 63 participants per group, 189 in total.

Participants with PTSD were recruited from out-patient clinics in London and Oxford, as well as through posters and adverts in Oxford. Other participants were recruited through circular emails and public adverts in Oxford and London. Inclusion criteria for the control groups was age 18 and above, having experienced a stressful but not traumatic experience in their lives (control groups), diagnosis of PTSD (PTSD group) and being willing to answer questions about this event. Exclusion criteria were no memory for the event, current substance dependence and a history of psychosis. A total of 68 trauma survivors with PTSD, 104 trauma survivors without PTSD (traumatised controls), and 58 non-traumatised controls completed an updated version of Halligan's Negative Event Memory Questionnaire (MQ; Halligan et al., 2003). To match groups for gender, age, education, trauma type, time since trauma, and trauma duration, 19 traumatised controls and six non-traumatised controls were excluded, resulting in a final sample of 68 trauma survivors with PTSD, 85 traumatised controls, and 52 non-traumatised controls for the between-group comparisons. Traumatised participants with and without PTSD completed the questionnaire for their traumatic event, as well as for a negative but non-traumatic control event. Non-traumatised controls completed the questionnaire for two negative control events. Table 5.1 displays group characteristics, as well as characteristics of the traumatic and control events. The groups did not differ on any variable except for ethnicity. Table 5.2 displays trauma types in trauma survivors with and without PTSD. A sub-sample of 19 PTSD patients, as well as 24 trauma survivors without PTSD attended a second session at post-treatment or an equivalent interval, respectively and filled in the MQ again. Characteristics for PTSD patients and traumatised controls who attended Session 2 are displayed in Table 5.3. Table 5.4 further displays the characteristics of the subsamples of the traumatised controls who attended and did not attend Session 2. PTSD patient drop-outs are discussed in Chapter 3.

Table 5.1

Group and event characteristics for trauma survivors with and without PTSD, and non-traumatised controls

	PTSD				Trauma				Control					
	Mean	SD	n	%	Mean	SD	n	%	Mean	SD	n	%	*F*, X^2	*p*
Age in years (n = 202)	32.77	10.99			31.89	12.83			28.88	11.97			1.63	.20
Years of education (n = 199)	15.52	3.35			16.52	3.35			16.21	2.52			2.12	.12
Gender													0.98	.61
Male			23	34			34	40			17	33		
Female			45	66			51	60			35	67		
Ethnicity (n = 199)														
Caucasian			47	70			58	72			46	90	7.72	.02
Ethnic Minority			20	30			23	28			5	10		
Years since trauma (negative event for controls) (n = 204)	7.48	8.90			9.27	9.58			7.84	8.65			0.82	.44

Years since control event (n = 187)	6.43	6.97	6.68	6.95	6.52	9.54	0.16	.81
Trauma duration in years (negative event for controls) (n = 160)	3.51	2.16	2.75	1.95	3.38	1.81	2.36	.10
Control event duration in years (n = 153)	3.63	2.06	3.23	1.86	3.40	1.92	0.53	.59
PDS (n = 128)	29.61	12.71	7.14	6.46	--	--	178.91	< .001
BDI (n = 177)	19.82	10.19	8.02	6.92	4.88	4.87	50.10	< .001

Table 5.2

Trauma characteristics for trauma survivors with and without PTSD

	PTSD (n = 67)		No PTSD (n = 85)			
	n	%	n	%	χ^2	*p*
Trauma Type					7.73	.36
Interpersonal violence[a]	33	49	30	35		
Road traffic accident	9	13	12	14		
Witnessing events/Learning someone died	5	7	15	17		
Disasters	1	1	3	3		
Medical-related incidents[b]	2	3	6	7		
Childhood trauma	6	9	9	10		
Military/War	5	7	3	3		
Other	6	9	7	8		

Note. [a]Interpersonal violence includes assault, sexual assault, abuse. [b]Medical incidents include diagnosis of life-threatening disease, life-threatening experiences during procedures in hospital.

Measures

Stressful Events Checklist (Foa, Cashman, Jaycox, & Perry, 1997). Stressful life events were assessed with an adapted version of the Stressful Events Checklist. The checklist comprises traumatic events according to DSM-IV (APA, 1993), which people might have experienced throughout their life, e.g., a sexual assault or a severe road traffic accident. To assess experience of negative control events, a number of non-traumatic events were added, such as divorce or major argument with partner. Participants were

asked to indicate (with yes or no) whether or not they had experienced any of the stressful life events that were listed. A version of the Stressful Events Checklist with negative control events only is found in Appendix G.

Characteristics of events follow-up questions. All traumatic events that were circled with a yes were followed up with several questions. Participants were asked to indicate the date of the traumatic event, its duration, and how distressing they found the event at the time, on a scale from 0 = *not at all* to 100 = *very much so*. Participants were also asked for the dates and duration of each control event that they circled with a yes. The questions are found in Appendix G.

Negative Event Memory Questionnaire (MQ; Halligan et al., 2003). The MQ assesses self-reported memory disorganisation with eight items. Participants completed the questionnaire for their trauma memory (e.g., serious road traffic accident) and for a negative control event (e.g., severe argument with family or friends). Two aspects of memory disorganisation were assessed: (1) difficulties with intentional recall, for example whether the trauma memory feels incomplete (e.g., 'I cannot get what happened during the event straight in my mind'), and (2) disjointedness of the trauma memory, for example whether parts of the trauma are not properly linked to one another in memory (e.g., 'I remember different parts of the events like separate experiences'). The four best original items (out of the five) of the disorganisation subscale from Halligan et al. (2003) were used to assess difficulties with intentional recall (poor memory recall). Four additional items were added to assess disjointedness of the worst moments (memory disjointedness). The original five-item version of the disorganisation subscale has been found to predict PTSD symptomatology after analogue trauma film studies (Halligan et al., 2002) and trauma (Halligan et al., 2003; Ehring et al., 2008). Content validity for the two subscales was tested. Five clinical psychologists and one experienced PTSD

researcher rated independently which aspect of memory disorganisation each of the eight items assessed (poor memory recall or memory disjointedness). The items were attributed to the proposed subscales with 97.9% consistency over all items and raters. The subscales showed acceptable internal consistency in the present sample. Cronbach's alphas were .89 for the 'poor memory recall' subscale, and .72 for the 'memory disjointedness' subscale. The individual items can be found in Appendix H.

Table 5.3

Subsample of PTSD patients and traumatised control group who attended Session 2

	PTSD Patients (N = 19)				Traumatised controls (N = 24)					
	Mean	SD	n	%	Mean	SD	n	%	*t*, χ^2	*p*
Age	33.71	9.39			32.78	14.30			0.06	.81
Years of education (n = 40)	15.50	3.48			16.33	2.93			0.67	.42
Gender									0.23	.63
Female			13	68			18	75		
Male			6	32			6	25		
Ethnicity									1.32	.25
Caucasian			13	68			20	83		
Ethnic Minorities			6	32			4	17		
PDS	34.79	10.02			8.17	6.13			115.31	< .001
BDI (n = 42)	22.28	8.12			7.08	7.02			42.12	< .001

Table 5.4

Characteristics of trauma control group who attended and did not attend Session 2

	Attended Session 2 (n = 25)				Did not attend Session 2 (n = 80)					
	Mean	SD	n	%	Mean	SD	n	%	*t*, χ^2	*p*
Age (n = 102)	32.78	14.30			32.07	12.37			0.06	.83
Years of education (n = 103)	16.33	2.97			16.44	2.86			0.03	.87
Gender									3.83	.05
Female			18	73			42	42		
Male			6	27			38	47		
Ethnicity (n = 99)									1.24	.27
Caucasian			20	85			54	67		
Ethnic Minorities			4	15			21	33		
PDS	8.17	6.05			6.29	6.13			1.77	.19
BDI (n = 102)	7.08	7.02			7.71	6.92			015	.70

Symptom Measures

Severity of PTSD symptoms was assessed with the 17-item version of the Posttraumatic Diagnostic Scale (PDS; Foa et al., 1997), a standard measure to assess PTSD symptoms according to DSM-IV (APA, 2000). Severity of depression symptoms was assessed with the Beck Depression Inventory-II (BDI-II; Beck, Steer, Ball, et al., 1996), which assesses depressive symptoms on a 21-item scale. PTSD diagnosis in PTSD patients was also assessed with the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5; Weathers et al., 2013). For more details about these measures, see Chapter 2 and 3.

Procedure

Participants filled in the Stressful Events Checklist. All events that participants had experienced were followed up with the characteristics of event follow-up questions. Participants were allocated to the traumatised and non-traumatised control groups depending on whether they indicated that they had experienced a traumatic event. As the PTSD group had already identified their main trauma in a clinical interview, they filled in the Stressful Events Checklist for control events only. From this list, a distressing negative control event was chosen that was matched as closely to the trauma as possible for length and time since the event. The participants without PTSD completed the full stressful event checklist, which included both control and traumatic events. If participants indicated one or more traumatic events, the traumatic event that was most distressing at the time of the event was chosen. The control event was chosen using the same procedure as in the PTSD group. If participants did not indicate any traumatic event, the two most distressing negative control events were selected from those indicated on the checklist. The participants who had experienced a trauma completed the

PDS referring to the traumatic event, and all participants completed the BDI. Afterwards, they were asked to fill in the MQ for both events (trauma and control event in counterbalanced order). Participants were then debriefed and reimbursed with £15 for their time. Participants who filled in the MQ as part of a different study were reimbursed for their time as part of their participation in the other study. In the second session, PTSD patients and traumatised control participants were assessed with the CAPS for their current PTSD symptoms in order to see whether their symptoms had changed. Participants also completed the PDS, BDI, and MQ a second time.

Data Analysis

Firstly, it was tested whether traumatised participants with and without PTSD, and non-traumatised controls differed in their self-reported memory characteristics for the trauma and / or negative control event. Mean scores of Items 1 to 4 (poor memory recall) and Items 5 to 8 (memory disjointedness) were calculated if participants filled in at least three items for each subscale. Data for poor recall was incomplete for five trauma survivors with PTSD and one non-traumatised control participant. Data for memory disjointedness was incomplete for five trauma survivors with PTSD and two non-traumatised controls. As groups differed in ethnicity, univariate ANOVAs were calculated to see whether ethnicity had an influence on poor memory recall and memory disjointedness. Then, mixed ANOVAs were calculated, with the between-subject factor group (PTSD, traumatised control, non-traumatised control) and the within-subject factor event type (trauma [PTSD and traumatised control group] / negative [non-traumatised control group], control). Interactions were followed-up with separate one-way ANOVAs for traumatic (negative event for the control group) and other negative control event. Significant main effects of group were then followed-up with independent t-tests. The PTSD and traumatised control groups were compared to examine the effect

of PTSD on memory characteristics. The traumatised and non-traumatised control groups were compared to examine the effects of trauma on memory characteristics.

Secondly, it was examined whether memory characteristics changed with treatment. Mixed-measures ANOVAs for poor recall and disjointedness were calculated separately with the between-subject factor group (PTSD patients, traumatised controls) and the within-subject factors event type (trauma, control) and session (pre, post). Significant interaction effects were followed up with mixed-design ANOVAs for trauma and control event separately. Paired t-tests then followed up the significant interaction effects for the PTSD and traumatised control group separately. Finally, it was tested whether changes in memory characteristics were related to PTSD recovery. First, pre- to post-treatment change in memory characteristics was compared between the recovered and non-recovered groups using non-parametric Mann-Whitney tests due to the small sample size of the non-recovered PTSD group. Second, Pearson correlations were calculated to see how changes in PDS scores correlated with changes in memory scores from pre- to post-treatment.

Results

Control Analyses

Univariate ANOVAs with the between-subject factors group (PTSD, traumatised control, non-traumatised control) and ethnicity (non-ethnic minority, minority) did not show a main effect of ethnicity for poor recall of the trauma / negative event, $F(1, 188) = 1.79$, $p = .30$, poor recall of the control event, $F(1, 188) = 0.01$, $p = .97$, for disjointedness of the trauma / negative event, $F(1, 188) = 0.39$, $p = .57$, and for disjointedness of the control event, $F(1, 187) = 0.23$, $p = .67$. Furthermore, no group x ethnicity interaction effect was found for poor recall of trauma / negative event, $F(2, 188)$

= 2.64, p = .07, poor memory recall of the control event, $F(2, 188) = 0.07$, p = .94, memory disjointedness for the trauma / negative event, $F(2, 188) = .54$, p = .58, and memory disjointedness of the control event, $F(2, 187) = 1.80$, p = .17. This suggests that ethnicity did not affect poor recall and disjointedness, and will not be controlled for in the following analyses.

Group Differences in Memory Disjointedness

The ANOVA for memory disjointedness showed significant main effects for event, $F(1, 196) = 60.66$, $p < .001$, $\eta_p^2 = .23$, and group, $F(2, 196) = 11.45$, $p < .001$, $\eta_p^2 = .13$, as well as a significant group x event interaction, $F(2, 196) = 30.91$, $p < .001$, $\eta_p^2 = .27$. The interaction effect was followed up with separate one-way ANOVAs for the trauma / negative and the control events. There was a significant main effect of group for the traumatic / negative event, $F(2, 196) = 33.88$, $p < .001$, $\eta_p^2 = .26$, but not for the control event, $F(2, 196) = .18$, $p = .84$, $\eta_p^2 = .01$. Planned contrasts showed that the PTSD group reported greater disjointedness for the memory of the traumatic event, compared to traumatised controls, $t(145) = -5.45$, $p < .001$, $d = 0.91$, indicating that memory disjointedness was greater in the PTSD compared to the traumatised control group. Traumatised controls reported significantly greater disjointedness for the traumatic event, $t(134) = 3.26$, $p < .01$, $d = 0.56$, than the non-traumatised control group reported for their negative event. This indicates that memory disjointedness was also elevated in the traumatised control group without PTSD, indicating that trauma may lead to more disjointed trauma memories than other negative events. Figure 5.1 displays mean scores for memory disjointedness and memory recall by group and event type.

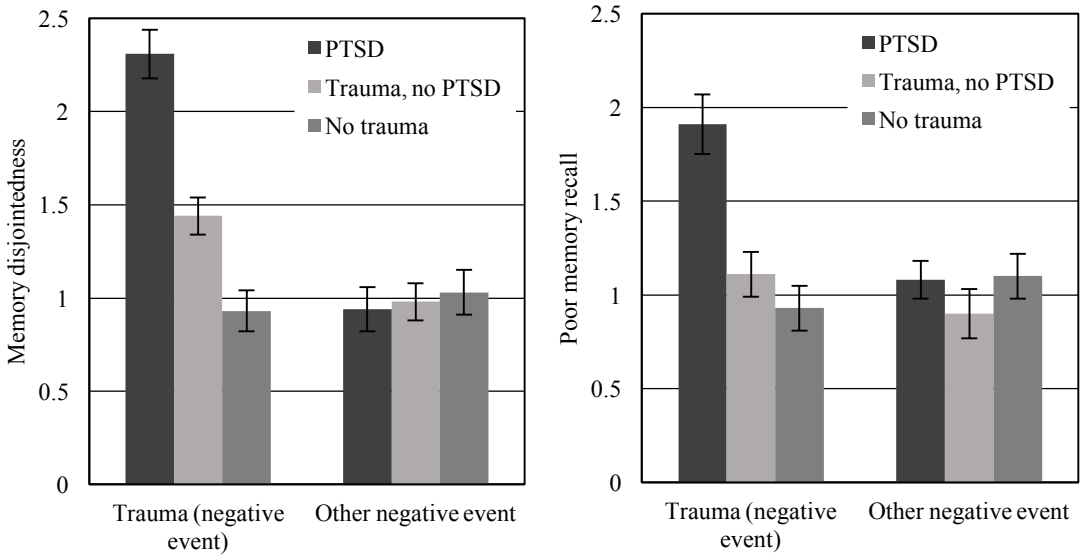


Figure 5.1. Mean scores for memory disjointedness and poor memory recall by groups.

Group Differences in Poor Recall

For poor recall, the ANOVA showed a significant main effect of event, $F(1, 196) = 9.10$, $p = .003$, $\eta_p^2 = .04$, and group, $F(2, 196) = 8.01$, $p < .001$, $\eta_p^2 = .08$, and a significant group x event type interaction, $F(2, 196) = 8.14$; $p < .001$, $\eta_p^2 = .08$. Separate one-way ANOVAs showed a significant main effect of group for the traumatic / negative event, $F(2, 196) = 13.80$, $p < .001$, $\eta_p^2 = .13$, but a non-significant main effect of group for the control event, $F(2, 196) = 0.90$, $p = .41$, $\eta_p^2 = .007$. Planned contrasts revealed that compared to trauma survivors without PTSD, those with PTSD reported significantly poorer recall for the traumatic event, $t(145) = -4.13$, $p < .001$, $d = 0.69$. The traumatised control group did not have more difficulties recalling the traumatic event than the non-traumatised control group had in recalling their negative event, $t(134) = -1.20$, $p = .23$, $d = .21$. This indicates that the PTSD group reported worse memory recall for the traumatic event compared to the other negative event, and compared to traumatised and non-traumatised control groups.

Changes in Memory Characteristics with PTSD Treatment

Mean scores for poor recall and disjointedness before and after treatment (or after an equivalent interval) are displayed in Figure 5.2.

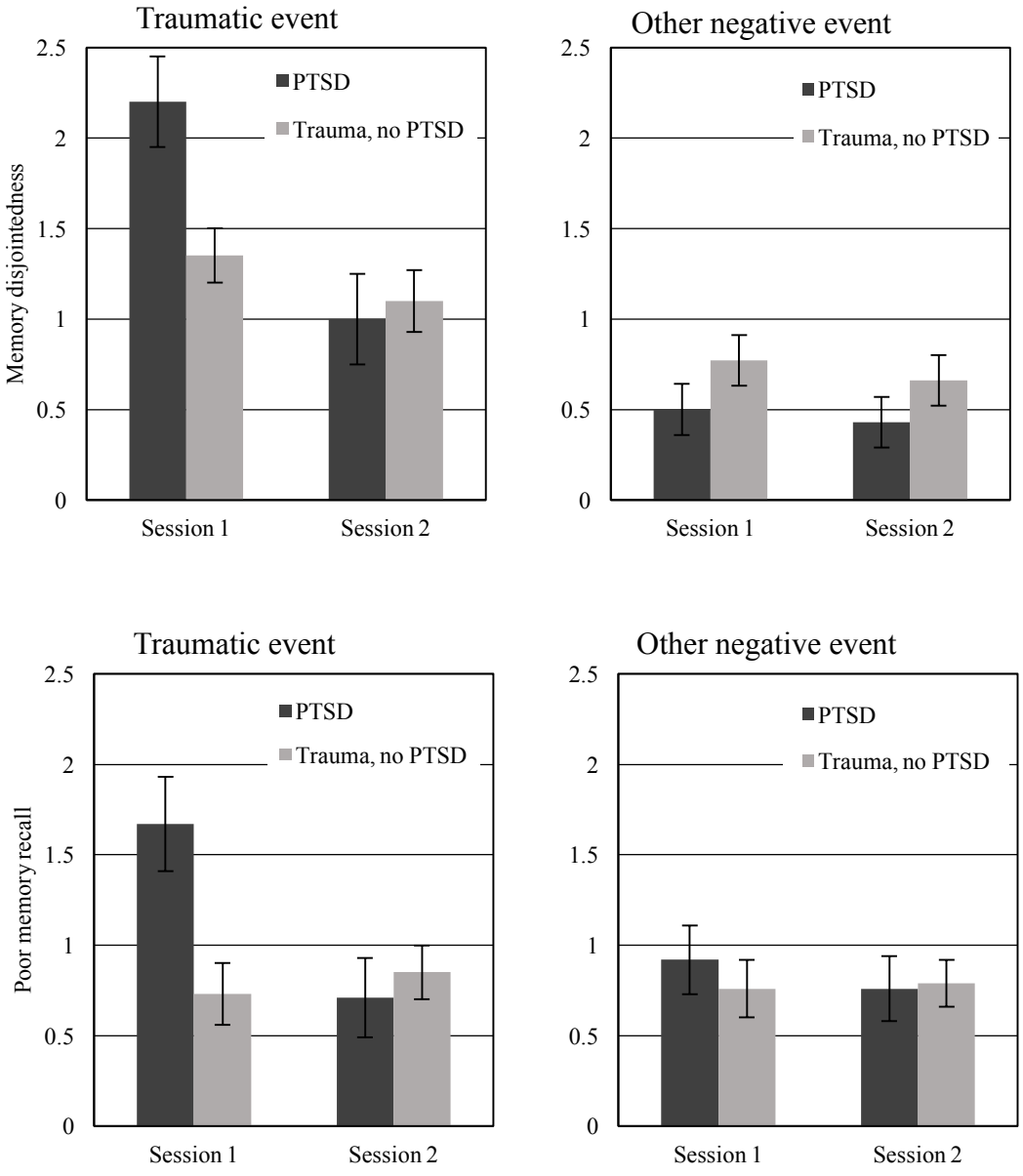


Figure 5.2. Memory disjointedness and poor memory recall in trauma survivors with and without PTSD at Session 1 and Session 2 (before and after CT-PTSD, or an equivalent wait period).

Memory disjointedness. The mixed-design ANOVA for memory disjointedness revealed significant main effects for session, $F(1, 42) = 39.72$, $p < .001$, $\eta_p^2 = .49$, and event type, $F(1, 42) = 21.02$, $p < .001$, $\eta_p^2 = .34$. It also showed significant two-way interactions for session x group, $F(1, 42) = 5.70$, $p = .02$, $\eta_p^2 = .12$, event type x group, $F(1, 42) = 6.51$, $p = .02$, $\eta_p^2 = .13$, and session x event type, $F(1, 42) = 28.41$, $p < .001$, $\eta_p^2 = .40$. There was a three-way session x event type x group interaction, $F(1, 42) = 17.28$, $p < .00$, $\eta_p^2 = .291$. To better understand the interaction effects, follow-up analyses were calculated for the traumatic and control events separately. The mixed-design ANOVA for memory disjointedness of the control event did not reveal a main effect of session, $F(1, 42) = 1.16$, $p = .29$, $\eta_p^2 = .03$, indicating that disjointedness for the control event did not change with time, and no significant group x session interaction, $F(1, 42) = 0.07$, $p = .79$, $\eta_p^2 = .002$. On the other hand, the mixed-design ANOVAs for disjointedness of the traumatic event revealed a significant main effect of session, $F(1, 42) = 32.67$, $p < .001$, $\eta_p^2 = .44$, indicating that disjointedness decreased from the first to the second session. It also showed a significant session x group interaction effect, $F(1, 42) = 14.00$, $p = .001$, $\eta_p^2 = .25$. The significant interactions were followed-up with paired t-tests for the groups independently. They showed that PTSD patients reported a decrease in the disjointedness of their trauma memories with treatment, $t(18) = 4.80$, $p < .001$, $d = 2.26$. The traumatised controls also showed a decrease during an interval of the same length, $t(24) = 2.20$, $p = .04$, $d = 0.90$. The amount of change between the two groups was compared. Independent t-tests compared the change scores in trauma memory disjointedness from Session 1 to Session 2. Higher positive change scores indicate a greater decrease in memory disjointedness. The PTSD group reported higher change scores in trauma memory disjointedness compared to the traumatised controls, $t(42) = -$

3.74, p = .001, d = 1.15, indicating that memory disjointedness decreased more in the PTSD patient group compared to the traumatised-control group.

Poor memory recall. The mixed-design ANOVA for poor recall revealed a significant main effect of event type, $F(1, 42) = 5.99$, $p = .02$, $\eta_p^2 = .13$, and significant two-way interactions of group x event type, $F(1, 42) = 9.07$, $p = .004$, $\eta_p^2 = .18$, and session x event type, $F(1, 42) = 4.19$, $p = .047$, $\eta_p^2 = .09$. There was also a significant group x event type x session three-way interaction, $F(1, 41) = 7.73$, $p = .004$, $\eta_p^2 = .16$. No significant main effect of group, $F(1, 42) = 2.19$, $p = .15$, $\eta_p^2 = .05$, and no session x group interaction effect was found, $F(1, 42) = 0.96$, $p = .33$, $\eta_p^2 = .02$. The significant three-way interaction was followed-up with separate ANOVAs for the two event types. The mixed-design ANOVA for poor recall of the control event did not show a significant main effect of session, $F(1, 42) = 0.16$, $p = .69$, $\eta_p^2 = .004$, and no significant group x session interaction, $F(1, 42) = 0.34$, $p = .56$, $\eta_p^2 = .003$, indicating that recall for the negative control event did not change with time. The mixed-design ANOVA for poor recall of the traumatic event revealed a main effect of session, $F(1, 42) = 11.95$, $p = .001$, $\eta_p^2 = .22$, and a significant group x session interaction, $F(1, 42) = 19.75$, $p < .001$, $\eta_p^2 = 32$. Follow-up analyses were calculated for groups separately. They revealed that with treatment, PTSD patients improved in recall for the traumatic event, $t(18) = 4.17$, $p = .001$, $d = 1.97$. The traumatised control group did not show changes in recall for traumatic event, $t(24) = -1.00$, $p = .33$, $d = 0.41$, nor control event, $t(24) = 0.06$, $p = .95$, $d = 0.02$. This indicates that in the PTSD group, but not the control group, memory recall improved for the traumatic but not the negative control event. Hence, trauma-focused treatment led to improvements in memory recall of the traumatic event. No changes in memory recall of trauma and control event could be found in the traumatised control group after an equivalent interval.

Memory characteristics and PTSD recovery. As a next step, changes in memory characteristics with treatment were compared depending on whether or not PTSD patients had recovered with treatment. Change scores were calculated for PTSD symptoms (change in PDS scores), memory disjointedness (change in memory disjointedness scores in the MQ), and poor memory recall (change in poor memory recall scores in the MQ). Positive change scores indicate greater decrease in memory disjointedness and poor recall. At post-treatment, 15 of 19 PTSD patients were recovered and did not meet diagnostic criteria for PTSD according to the CAPS-5 any longer. Mean changes in memory scores from pre- to post-treatment by recovery are displayed in Figure 5.3. Mann-Whitney tests revealed that recovered and non-recovered group differed significantly in pre- to post-treatment change scores for disjointedness of the trauma memory, $U = 8.5$, $p = .027$, indicating that disjointedness of the trauma memory decreased more in the patients that had recovered from PTSD. No differences in the change scores were found for recall of the traumatic event, $U = 31.00$, $p = 1.00$, recall of the control event, $U = 31.00$, $p = 1.00$, and disjointedness of the control event, $U = 14.00$, $p = .13$. Pearson correlations further showed that in the PTSD patient group, greater PDS change scores were positively correlated with greater changes scores in memory disjointedness of the trauma memory, $r(18) = .50$, $p = .03$, but not with change scores in poor memory recall of the trauma memory, $r(18) = .10$, $p = .69$. This indicates that greater decrease in PTSD symptoms was associated greater decrease in memory disjointedness of the trauma memory.

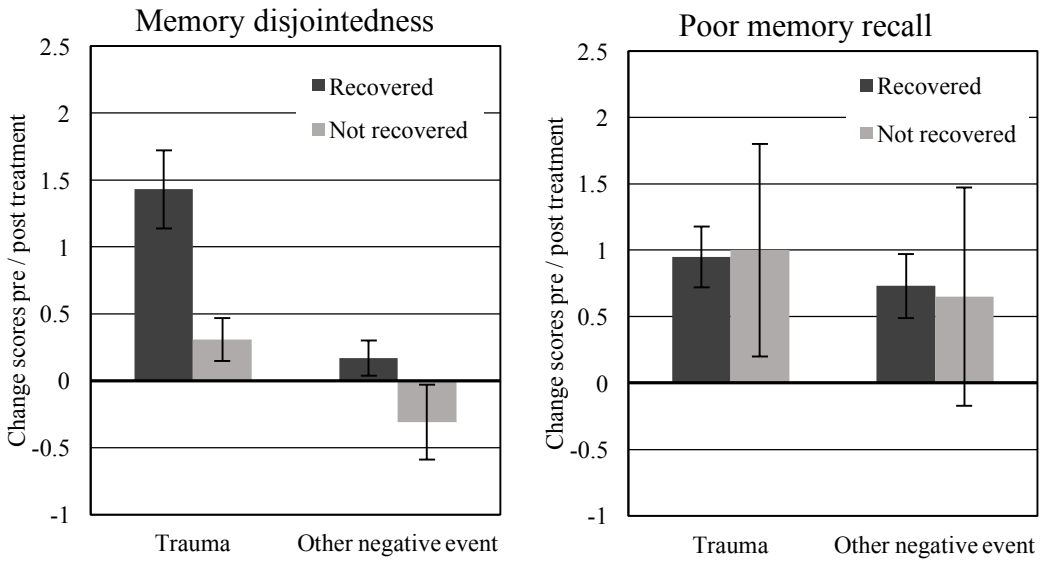


Figure 5.3. Change scores in self-reported memory disjointedness and poor memory recall in PTSD patients from before and after PTSD treatment by recovery status. Positive change indicates a reduction in memory disjointedness and poor recall with treatment. Negative change score indicates an increase in memory disjointedness and poor recall with treatment.

Discussion

The present study examined two different aspects of memory disorganisation, namely overall difficulties in memory recall, and disjointedness of the worst moments of the trauma. It compared difficulties in memory recall of the trauma and disjointedness of the worst moments of the trauma to the characteristics of another negative control event, and compared memory characteristics in trauma survivors with PTSD to traumatised and non-traumatised control participants. It further explored how trauma-focused treatment affected these memory characteristics. Trauma survivors with PTSD reported poorer memory recall and more memory disjointedness for the traumatic compared to another negative control event, and compared to traumatised and non-traumatised controls. The traumatised controls also reported more memory disjointedness of the trauma compared

to their negative control event, and compared to non-traumatised controls. With treatment, memory recall and memory disjointedness improved for the traumatic event. Improvements in poor memory recall were unrelated to recovery status, whereas the decrease in disjointedness was only found for those who recovered from PTSD. These findings contribute to the understanding of PTSD memory phenomenology and its relationship to PTSD symptoms.

Firstly, this study investigated difficulties in memory recall and memory disjointedness of the worst moments for trauma memories in PTSD. In line with the hypothesis, participants with PTSD reported more memory disjointedness for their trauma memory, but not the control memory, than both other groups. This indicates that in the PTSD group, the trauma memory was more disjointed compared to another negative control event, and more disjointed compared to the other groups. The traumatised control group also reported more disjointed trauma memories compared to the negative event in the non-traumatised control group (but less disjointedness compared to the PTSD group). This indicates that trauma memories were more disjointed in both traumatised groups, but more disjointed in the PTSD compared to the traumatised control group. These findings are in line with the suggestion that the worst moments of the trauma memory are disjointed (Ehlers et al., 2004), and adds to previous studies suggesting that the worst moments of the trauma are more disjointed from other autobiographical memories compared to other parts of the trauma memory, or other negative events (Evans et al., 2007; Kleim et al., 2008).

Secondly, the PTSD group reported more difficulties in memory recall for the traumatic but not for the negative control event, and more difficulties in memory recall compared to both control groups. This indicates that PTSD is associated with difficulties in memory recall for the trauma memory, but not with difficulties in memory recall for

other negative events. This is in line with a study by Halligan and colleagues (2003) who found more memory disorganisation for the traumatic compared to a control event in PTSD using self-report measures. However, another study did not replicate this finding (Jelinek et al., 2009), and found more disorganised memories in PTSD for both trauma and negative control events using self-report measures. One explanation for these contradicting findings may be the selection of the negative control event. Jelinek and colleagues (2009) asked their participants to pick a negative control event that happened shortly before the trauma, but it is not clear how distressing these events were, or whether they had a significant impact on people's lives. The present study aimed to match the time of the traumatic and control event as closely as possible, but asked participants to select one of the most distressing negative control events that they could remember. In the present study, distress ratings of the negative control events in the PTSD group were similar to those of the most distressing event in the non-traumatised control group (PTSD: $M = 73.13\%$ vs. non-traumatised controls: $M = 75.52\%$). It may be that selecting an event close to the time of the trauma can account for memory decay with time, but may not be comparable in terms of salience and personal relevance of the event. More research is needed to better understand these differences.

Thirdly, it was found that poor memory recall and memory disjointedness of the trauma memory decreased with PTSD treatment. This suggests that treating PTSD influences self-reported memory characteristics of trauma memories. Memory recall improved in the PTSD group with treatment, but not in the traumatised control group after an equivalent wait period. This indicates that after PTSD treatment, PTSD patients showed improvements in recalling the memory of their trauma. Memory disjointedness decreased in the PTSD group after treatment, and in the traumatised control group after an equivalent wait period. This suggests that there might have been a general decrease in

disjointedness ratings with time. In the PTSD group, memory disjointedness decreased more compared to the traumatised control group, indicating that treatment may contribute to the integration of disjointed trauma memories. Furthermore, memory disjointedness only decreased in patients who recovered from PTSD with treatment, and decrease in disjointedness of the trauma memory was correlated with PTSD symptom change. This indicates that only patients who benefitted from treatment were able to integrate the worst moments of their trauma. This provides some evidence that PTSD treatment may contribute to the integration of the trauma memories and reduced memory disjointedness. It also suggests that PTSD recovery may be related to the integration of the worst moments of the trauma. This is in line with the memory updating procedure in trauma-focused CT-PTSD (Ehlers et al., 2005; Ehlers & Clark, 2000) and studies that suggest that memory disjointedness contributes to PTSD symptoms (e.g., Kleim et al., 2008). Memory recall, on the other hand, improved independently of PTSD recovery and was not related to PTSD symptom reduction. This suggests that the recall of trauma memories improves with PTSD treatment, even if PTSD persists. An explanation for this could be that the first step in treatment is to elaborate the trauma memories, which all patients do during treatment. However, as described in Chapter 1, updating the meaning of the trauma memories is thought to be associated with PTSD symptom change (e.g., Kleim et al., 2013).

The present study has several limitations. Firstly, the study did not objectively rate trauma and control event narratives but asked participants to subjectively rate the quality of their memories. This means that the ratings may relate to the subjective feeling about the quality of the trauma memory rather than to actual memory disorganisation caused by poor elaboration or poor memory integration of the trauma memory. More evidence is needed to better understand the differences in objective and subjective

measures of trauma memory characteristics. Secondly, the memory questionnaire relies on the assumption that the participants rate the quality of their memory for specific events. The memories that participants recalled in this study could not always be clearly defined and many of the events were extended and lasted for longer than a day. Even though participants were asked to remember specific events, it is not clear whether participants followed these instructions. Thirdly, the study found that people with PTSD reported more difficulties in memory recall and reported more memory disjointedness of the traumatic event. However, the mechanisms behind these findings remain unclear. It is conceivable that they reflect avoidance symptoms, poor concentration, or reporting biases. Future studies should assess these variables to gain a better understanding of the self-report measures. Fourthly, the present study did not include a PTSD wait list group to assess natural changes in trauma memory disorganisation without treatment. To better understand effects of treatment on memory characteristics in PTSD, it would be necessary to have a wait list group of patients that do not receive treatment. Fifthly, even though groups were matched for gender, age, time of trauma, and years of education, they were not matched for ethnicity. The non-traumatised control group had only a few people from ethnic minorities. As most people experience a traumatic event in their lifetime (e.g., Breslau et al., 1998), this group may therefore not accurately represent the normal population.

In conclusion, the study found evidence that difficulties in memory recall and memory disjointedness of the worst moments are more pronounced in PTSD compared to traumatised and non-traumatised controls. Furthermore, it was found that memory recall improved and memory disjointedness decreased with PTSD treatment. Memory disjointedness only decreased for those patients who recovered from PTSD. These results add to the current discussion about memory disorganisation in PTSD and suggest that

memory disorganisation is specific for trauma memories, adding to inconsistent findings in previous studies on memory disorganisation (e.g., Halligan et al., 2003; Rubin et al., 2008). It contributes to current cognitive theories of PTSD and highlights the importance of a more detailed analysis of the nature of autobiographical memory disturbances in PTSD.

6

MEMORY DISORGANISATION AFTER ANALOGUE TRAUMA

Introduction

Intrusive memories are one of the core symptoms of PTSD. Cognitive theories suggest that the nature of the trauma memory plays an important role in the development and maintenance of re-experiencing symptoms. It was also suggested that certain processing styles during trauma, such as strong dissociation or data-driven processing, as well as difficulties integrating the trauma memory into the autobiographical memory base may contribute to persistent re-experiencing (e.g., Ehlers & Clark, 2000). Findings from previous studies of PTSD suggest that the worst moments of the trauma memory are particularly likely to be disjointed (Evans et al., 2007; Kleim & Ehlers, 2008). In Study 4 (Chapter 5), it was found that trauma survivors with PTSD reported difficulties in memory recall of the trauma, compared to negative control events, and traumatised and non-traumatised participants without PTSD. People with PTSD also reported more memory disjointedness for the worst moments of the trauma, compared to a control event, and compared to traumatised and non-traumatised controls. This suggests that both, poor memory recall of the trauma and disjointedness of the worst moments are associated with PTSD. To date, it has not been examined how trauma exposure affects poor memory recall and memory disjointedness, and how these sub-factors of memory

disorganisation contribute to the development of re-experiencing symptoms. Furthermore, Study 2 found that trauma survivors with PTSD tended to have more difficulties updating neutral information, compared to a control group of traumatised and non-traumatised controls (Chapter 3). It remains unclear whether general memory flexibility, such as memory updating, may also play a role in the development of PTSD symptoms after trauma exposure.

Aims of the Study

The present study used a trauma film paradigm to investigate (1) how trauma exposure affects trauma memory characteristics (memory disjointedness and poor recall), (2) whether memory updating performance before trauma exposure is related to poor memory recall, memory disjointedness and trauma memory integration after trauma exposure, (3) whether data-driven processing and state dissociation during trauma film exposure are related to poor recall of the trauma memory, trauma memory disjointedness and development of intrusions, and (4) whether memory updating abilities before trauma film exposure and memory characteristics at three-days follow-up are related to the development of PTSD symptoms. It was hypothesised that (1) trauma film exposure leads to difficulties in memory recall and more memory disjointedness compared to neutral film exposure, (2) in the trauma film group, memory updating abilities before film exposure and peri-traumatic data-driven processing and dissociation predict poor memory recall, memory disjointedness and development of intrusions, (3) in the trauma film group, pre-trauma memory updating performance is related to integration of disjointed trauma memories in the week after trauma film exposure, and (4) in the trauma film group, poor memory recall and memory disjointedness after trauma film exposure mediates the relationship between peri-traumatic processing styles and the development of intrusions.

Methods

Overview

In this trauma film study, healthy participants attended two research sessions seven days apart. They also completed a daily diary for seven days after Session 1, and filled in an online questionnaire at three-days follow-up. In Session 1, participants firstly completed the location-updating task, in which they were asked to remember the locations and updated locations of mildly negative and neutral pictures (see Study 1 and 2). Participants were then exposed to either a trauma or neutral film. Re-experiencing symptoms and memory quality were assessed in the following week. Participants were asked to fill in a daily diary about their re-experiencing symptoms throughout the week. At three-days follow-up, participants also completed a memory questionnaire for their memory of the film online, which assesses the subjective quality of their memory. At one-week follow-up, participants attended Session 2. They completed the memory questionnaire again, as well as a detailed intrusion interview.

Participants

Participants in trauma and neutral film group were randomly allocated at a ratio of 2 : 1. Previous studies found differences in memory organisation with a medium effect size between different cognitive processing strategies the trauma film paradigm (e.g., Halligan et al., 2002), but no study to date had compared memory characteristics after exposure to trauma and neutral films. As we expected the effect to be larger than after the manipulation of cognitive processing during the trauma film, we aimed to be able to detect a moderate to large effect size. In order to have 80% power to detect a group difference between trauma and neutral film group with an effect size of ES = 0.6 at alpha = .05, 98 participants were needed. To detect an effect size of ES = 0.7, 72 participants

were needed. A sample of 90 participants (61 female, 28 male, 1 gender not specified) between 18 and 58 years (M = 24.08; SD = 5.70) were recruited via online and poster adverts and circular emails to students and staff of the University of Oxford. Inclusion criteria were healthy participants aged between 18 and 65 years. Exclusion criteria were a history of an interpersonal trauma. Participants were randomly allocated with a 2:1 allocation schedule, stratified by gender, to either exposure to a trauma film (60 participants) or to a neutral control film (30 participants). Demographics of participants in each group are displayed in Table 6.1. Of the initially recruited 90 participants, 75 participants (50 from the trauma film group and 25 from the neutral film group) filled in the online questionnaires at three-days follow up. All 90 participants attended the one-week follow-up (100%).

Film Material

In the trauma film condition, participants were exposed to a scene from the film Irreversible (Chioua & Noe, 2003). The 10 minutes and 30 seconds long film clip has been used in previous trauma film studies and has been found to induce low mood and intrusions (Weidmann et al., 2009). In the film, a young woman walks home at night and is raped by a stranger. In the present study, a sentence appeared in the middle of the screen at the end of the film clip, explaining that the woman was found and brought to hospital. In the neutral film condition, participants were exposed to a neutral film. The neutral counterpart to the trauma film was a YouTube clip, in which a man and a woman talk about language differences in Quebec. At the end of the film clip, a sentence appeared in the middle of the screen saying that the woman returned to Quebec and that both characters remained friends. The film was matched for colour, duration, and number of actors (one man, one woman). Both films were shown in French without subtitles. Participants watched the movies on an iMac in full screen mode and were sat

approximately 60cm away from the screen. Participants wore headphones and could stop the film clip if they felt too distressed (trauma film) or too bored (neutral film).

Table 6.1

Demographics of trauma and neutral film group

	Trauma (N = 60)				Neutral (N = 30)			
	Mean	SD	N	%	Mean	SD	N	%
Age in years	24.05	5.68			23.86	5.52		
Years of education	16.65	3.55			17.31	2.93		
Gender								
Female			41	68			20	68
Male			18	30			10	32
Not specified			1	2			0	0

Location Updating Task

The location updating task measures associative memory updating of mildly negative and neutral material. Participants first learn the location of 48 pictures (24 negative, 24 neutral), then half of the pictures change location, and participants are asked to remember the new picture locations. A more detailed description of the task can be found in Chapter 2.

Measures

General Information Questionnaire (see Appendix E)**.** This questionnaire gathers information about the participants' demographic characteristics and their education. It further included the bank details of the participants to reimburse their time and travel expenses via bank transfer.

Negative Event Memory Questionnaire (MQ; Halligan et al., 2003). The eight-item memory disorganisation scale of the MQ consists of two subscales. The first subscale, poor memory recall, was adapted from Halligan et al. (2003) and assesses difficulties in intentional memory recall (e.g., 'I cannot get what happened during the film straight in my mind'). The second subscale, memory disjointedness, was added to the questionnaire, and assesses the lack of links between different parts of the experience ('I remember different parts of the film like separate experiences'). The disorganisation subscale of the MQ has been described in detail in Chapter 4. In this study, participants filled in an adapted version of the questionnaire to describe their memory of the trauma or neutral film clip that they had watched. A previous version of the poor memory recall subscale has been found to predict PTSD-like symptomatology after an analogue trauma film (Halligan et al., 2002). The adapted version is found in Appendix I.

Impact of Event Scale-Revised. Severity of PTSD symptoms were assessed with the Impact of Event Scale (IES-R; Horowitz et al., 1979). The 33-item questionnaire measures severity of PTSD symptoms on three subscales, intrusions (e.g., 'I thought about it even if I did not mean to'), avoidance (e.g., 'I stayed away from reminders of it'), and arousal symptoms (e.g., 'I felt irritable and angry'). Participants are asked how much they were bothered or distressed by the difficulties described in each individual item in the last seven days on a scale from 0 = *not at all* to 4 = *extremely*. Studies have confirmed good internal consistency for the questionnaire (Beck et al., 2008). Wording was adapted to be suitable for exposure to the film clips, e.g., the word 'trauma' was changed to 'film'. Internal consistency was Cronbach's alpha = .91 in the trauma story group, and Cronbach's alpha = .44 in the neutral story group (Cronbach's alpha = .93 for both groups together).

State Dissociation Questionnaire (SDQ; Murray et al., 2002). State dissociation during the film was assessed with nine items, which assess different aspects of dissociation, for example, depersonalisation, derealisation and emotional numbing (e.g., 'I felt distant from my emotions'). Participants rated how much each statement applied to them while watching the stories on a scale from 0 = *not at all* to 4 = *very much so*.

Data-Driven Processing Scale (DDPS; Halligan et al., 2002). Data-driven processing during the film was measured with eight items that assess how much participants engaged into data-driven (surface-level) processing, for example by mainly processing sensory features (e.g., 'It was like a stream of unconnected impressions following each other'), rather than into conceptual level processing. Participants rated how much each statement applied to them while watching the stories on a scale from 0 = *not at all* to 4 = *very much so*.

Subjective Units of Distress. Subjective distress towards the film clip was assessed with an adapted version of the Subjective Units of Distress Scale (SUDS; Wolpe, 1969). In this version, participants rated their distress on a scale from 0 = *no distress, totally relaxed* to 100 = *highest anxiety / distress that you have ever felt*.

Intrusion diary. Intrusions during the week were assessed with an online daily diary designed using Qualtrics software (Qualtrics, Provo, UT), Version 01/2016. Participants were sent daily email reminders to fill in the diary in the morning and evening of each day. In this diary, participants were asked to fill in any unwanted intrusions that they had during the day or night. It was further assessed what they were (thought, image, bodily sensation), at what time they occurred, and how distressing they found them.

Intrusion interview. At follow-up, an intrusion interview was conducted to assess intrusions over the last seven days. The interview assessed the frequency and persistence of images, thoughts and emotional or physiological reactions. The experimenter assessed the five most frequent intrusions of each type, and asked participants to describe their content, their duration and the distress they caused. This provided some additional information to the daily diaries and ensured that participants had understood the concept of intrusive re-experiencing.

Procedure

Participants were invited for two research sessions at the Department of Experimental Psychology at the University of Oxford. The first session took about one hour, the second session about 30 minutes. On arrival, participants were informed about the nature and procedure of the study and it was made sure that they met inclusion criteria. If they did, written informed consent was taken. Participants were then randomly allocated, stratified by gender, to either the trauma or neutral film group (at a 2:1 ratio).

Participants then completed several computer tasks, including the location updating task and were then exposed to either the trauma or neutral film clip. They were reminded that they could stop at any time before watching the film. Afterwards, they filled in some manipulation check questions, and completed some questionnaires about their responses to the film (SDQ, DDPS, SUDS, IES-R). The experimenter made sure that participants were feeling ok before they went home. In the week after the session, participants were asked to fill in an online daily intrusion diary. Furthermore, at three-days follow-up, participants were asked to fill in the MQ online from home. At one week, participants came in for a follow-up session. Participants completed a set of questionnaires (MQ, IES-R) and completed an intrusion interview. Participants were reimbursed £30 for their time and travel expenses.

Data Analysis

Results were calculated with IBM SPSS Statistics (Version 22). Significance levels were set at $\alpha = .05$. The intrusion (diary and interview), memory characteristic (poor recall and disjointedness at three-days and one-week), and peri-traumatic processing (data-driven processing and dissociation) variables were skewed and transformed into normal with $ln(1 + x)$. Non-parametric tests were applied if necessary. As described in detail in Chapter 2, updating error rates were calculated as the number of incorrectly indicated locations in the updating test (updating condition: E_{switch}; control condition: E_{contr}), divided by the number of initially learned picture locations in the learning phase for each condition (L_T). To control for differences in baseline memory recall, error rates of pictures that had changed location (E_{switch} / L_T) were subtracted from error rates of those pictures that had not changed location (E_{contr} / L_T): Updating error rates = $E_{switch} / L_T - E_{contr} / L_T$.

Firstly, responses towards the film were compared between trauma and neutral film group. Independent t-tests were conducted to compare mean percentage of distress, IES-R scores, state dissociation and data driven processing during the film, and intrusion scores in the trauma and neutral film groups. Then, the hypotheses were tested. Firstly, mixed-measures ANOVA for memory characteristics with the between-subject factor group (trauma film, neutral film), and the within-subject factor time (three-days, one-week) and memory characteristics (disjointedness, poor recall) were calculated (Hypothesis 1). Only participants who completed the three-days follow-up were included in the analyses (n = 75). Secondly, Pearson correlations were calculated to investigate whether pre-traumatic memory updating performance and peri-traumatic processing (state dissociation and data-driven processing) were related to memory characteristics (memory disjointedness and poor recall at three-days and one-week follow-up) and PTSD symptoms (intrusion diary, intrusion interview, IES-R) at one-week follow-up (Hypothesis 2). Thirdly, Pearson correlations tested whether pre-trauma memory updating error rates were related to trauma film memory integration and poor recall, as measured by the difference score of memory disjointedness at one-week and three-days follow-up (Hypothesis 3). Finally, mediation models were calculated using the *process* macro for SPSS (Hayes, 2013). Four separate analyses were calculated using cognitive processing variables (dissociation, data-driven processing) as predictor variables X, memory disjointedness at 3-day follow-up as mediator M, and intrusions (diary, interview) as outcome variables Y. Direct and indirect effects were calculated using bootstrapping approximation with 5000 samples and a 95% confidence interval.

Results

Comparisons between the Trauma and Neutral Film Groups

Responses to films and development of PTSD-like symptoms. After film exposure, the trauma film group reported more distress, $t(88) = -14.56$, $p < .001$, higher scores on the IES-R, $t(88) = -9.26$, $p < .001$, data-driven processing, $t(88) = -6.52$, $p < .001$, and state dissociation during the film, $t(88) = -5.37$, $p < .001$, compared to the neutral film group. As expected, participants in the trauma film group reported more intrusions at one-week follow-up in the intrusion interview, $t(88) = -7.94$, $p < .001$, and in the intrusion diary, $t(88) = -7.96$, $p < .001$. Table 6.2 displays the mean or sum scores of responses towards the film clip, percentage of distress, and intrusion scores.

Table 6.2

Responses during the film and development of PTSD-like symptoms

	Trauma Film		Neutral Film	
Measures	Mean	SD	Mean	SD
Percentage of distress	63.47	21.44	1.61	3.73
Sum score IES-R	19.89	11.32	0.90	1.45
Mean score data-driven processing	1.13	0.63	0.39	0.30
Mean score dissociation	0.61	0.62	0.07	0.15
Intrusion scores				
Diary	4.74	6.88	0.03	0.18
Interview	6.21	7.66	0.20	0.55

Memory disjointedness and poor recall after trauma exposure. Mean scores for memory disjointedness and poor recall by group are displayed in Table 6.3. Mixed-

measures ANOVAs revealed a significant main effect of time, $F(1, 73) = 93.18$, $p < .001$, $\eta_p^2 = .56$, indicating that participants reported higher scores in disjointedness and poor recall at one-week compared to the three-days follow-up. Furthermore, there was a significant characteristics x group two-way interaction, $F(1, 73) = 44.31$, $p < .001$, $\eta_p^2 = .38$, a significant time x characteristics two-way interaction, $F(1, 73) = 7.21$, $p = .009$, $\eta_p^2 = .09$, and a significant time x characteristics x group three-way interaction, $F(1, 73) = 19.76$, $p < .001$, $\eta_p^2 = .21$. The significant interactions were followed up with mixed-measures ANOVAs for poor recall and memory disjointedness separately. The ANOVA for memory disjointedness revealed a significant main effect of time, $F(1, 73) = 58.56$, $p < .001$, $\eta_p^2 = .45$, and group, $F(1, 73) = 12.52$, $p = .001$, , $\eta_p^2 = .19$, suggesting that memory disjointedness scores increased with time, and that the trauma film group reported more memory disjointedness compared to the neutral film group. It also revealed a time x group interaction effect, $F(1, 73) = 12.52$, $p < .001$, $\eta_p^2 = .15$,. Independent t-tests compared the increase in memory disjointedness from three-days to one-week follow-up in the trauma ($M = 2.78$, $SD = 3.02$) and neutral film group ($M = .75$, $SD = 1.48$). It was found that in the trauma film group, memory disjointedness increased significantly more compared to the neutral film group, $t(73) = 3.15$, $p = .002$, $d = .74$. The ANOVA for poor recall revealed a significant main effect of time, $F(1, 73) = 72.19$, $p < .001$, $d = 16.90$, and group, $F(1, 73) = 4.96$, $p = .03$, $d = 1.16$, indicating that poor memory recall increased with time, and that the neutral film group reported poorer recall compared to the trauma film group. No group x time interaction effect was found, $F(1, 73) = 2.71$, $p = .10$, $\eta_p^2 = .04$, indicating that the two groups did not differ in their increase of poor recall over time.

Table 6.3

Mean scores for self-reported memory characteristics in trauma and neutral film group at three-days and one-week follow-up

	Trauma Film		Neutral Film	
	Mean	SD	Mean	SD
Disjointedness				
Three-days (n = 75)	0.72	0.81	0.21	0.33
One-week				
Sample used in analyses (n = 75)	3.50	3.58	0.96	1.72
Complete sample (N = 90)	3.55	3.51	0.90	1.60
Poor recall				
Three-days (n = 75)	0.32	0.47	0.64	0.98
One-week				
Sample used in analyses (n = 75)	2.12	2.70	4.16	4.31
Complete sample (N = 90)	2.02	2.66	4.07	4.14

Note. Scores at one-week follow-up are displayed for the sample that completed three-days follow-up (n = 75), and complete sample (N = 90).

Analyses of Associations in the Trauma Film Group

Memory updating, peri-traumatic processing and the nature of the trauma memory. Table 6.4 displays the relationship of pre-trauma memory updating performance, peri-traumatic processing and self-reported memory characteristics after trauma exposure. Negative and neutral updating error rates were not related to memory

disjointedness or poor recall at any time point. Peri-traumatic dissociation and data-driven processing were highly correlated with memory disjointedness at both three-days and one-week follow-up, indicating that more dissociation and data-driven processing during the trauma film was associated with more disjointedness of the worst moments after trauma exposure. Peri-traumatic dissociation was also positively correlated with poor recall at three-days follow-up, and a trend was found for a positive relationship with poor recall at one-week follow-up. Data-driven processing was not related to poor recall at any time point. This indicates that dissociation but not data-driven processing was related to difficulties in memory recall at three-days follow-up, and may be related to poor recall at one-week follow-up.

Table 6.4

Correlations between pre-traumatic memory updating performance, peri-traumatic processing styles and memory characteristics of the trauma memory at three-days and one-week follow-up

	Three-days		One-week	
	Disjointed	Poor recall	Disjointed	Poor recall
Updating error rates				
Negative	.03	-.05	-.18	-.09
Neutral	.08	-.03	-.03	-.08
Peri-traumatic processing				
Dissociation	.45**	.33*	.45***	.21[I]
Data-driven processing	.29*	.23	.27*	.16

* $p < .05$. ** $p < .01$. *** $p < .001$.

Memory updating, peri-traumatic processing and the development of intrusions and PTSD symptoms. Table 6.5 displays the relationship of pre-trauma memory updating performance, peri-traumatic dissociation and data-driven processing and intrusions, as well as PTSD-like symptoms as reported in the IES-R. Pearson correlations revealed that updating error rates were not related to the development of intrusive memories, or PTSD symptoms indicated by the IES-R. Pearson correlations showed a positive relationship between peri-traumatic dissociation and data-driven processing and the development of intrusive memories, as reported in the interview and diary. They further showed a positive relationship between peri-traumatic dissociation and data-driven processing and PTSD-like symptoms reported in the IES-R at one-week follow-up. This indicates that participants who engaged into stronger dissociation and more data-driven processing during trauma film exposure developed more intrusions and PTSD symptoms in the following week.

Table 6.5

Correlations of pre-traumatic updating performance and peri-traumatic processing with intrusions and PTSD-like symptoms at one-week follow-up

	Intrusions		
	Diary	Interview	IES-R
Updating error rates			
Negative	.08	-.02	-.09
Neutral	.03	.15	-.03
Peri-traumatic processing			
Dissociation	.44**	.42**	.31**
Data-driven processing	.37**	.33*	.30*

* $p < .05$. ** $p < .01$.

Memory updating performance and memory integration following trauma exposure. Pearson correlations did not show a relationship between negative updating error rates and changes in memory disjointedness from three-days to one-week follow-up, $r(50) = -.23$, $p = .11$. Partial correlations showed a significant negative correlation between negative updating error rates and increase in memory disjointedness when controlling for memory disjointedness at three-days follow-up, $r(47) = -.32$, $p = .03$. This indicates that less memory updating errors for negative material before trauma exposure were related to more increase in memory disjointedness from three-days to one-week follow-up. No relationship was found between changes in memory disjointedness and neutral updating error rates, $r(47) = -.23$, $p = .12$, or negative updating error rates, $r(47) = -.01$, $p = .97$. Also, no relationship was found between changes in poor memory recall

and negative updating error rates, $r(47) = -.05$, $p = .74$, and neutral updating error rates, $r(47) = -.02$, $p = .89$.

Memory characteristics as mediator for the relationship between peri-traumatic processing and PTSD symptoms.

Poor memory recall. No mediation analysis was calculated as poor memory recall at Day 3 was not a significant predictor of intrusions reported in the daily diary, $r(49) = .28$, $p = .05$, or the interview, $r(49) = .20$, $p = .44$.

Memory disjointedness. Results of the simple mediation analyses are displayed in Figure 1. The direct effect (c') of dissociation on intrusions lost significance for intrusions reported in the diary and interview (full mediation). The direct effect (c') of data-driven processing on intrusions in diary and interview remained significant (partial mediation). The predictors memory disjointedness and dissociation accounted for approximately 30% ($R^2 = .30$), and the predictors memory disjointedness and data-driven processing for approximately 32% ($R^2 = .32$) of the variance in intrusions reported in the interview and diary. The indirect effects were tested using bootstrap estimation approach with 5000 samples (Hayes, 2013). There were significant indirect coefficients of dissociation on intrusions in the diary, $b = .16$, $SE = .09$, 95% CI = [.03, .39], and on intrusions in the interview, $b = .16$, $SE = .09$, 95% CI = [.05, .39], via memory disjointedness. This indicates that an increase of one point in dissociation scores corresponded to an increase of 0.16 in intrusion scores at 1-week follow-up via more disjointed trauma film memories. There were also significant indirect coefficients of data-driven processing on intrusions in the diary, $b = .20$, $SE = .11$, 95% CI = [.04, .50], and on intrusions in the interview, $b = .22$, $SE = .11$, 95% CI = [.05, .50], via memory disjointedness. This means that an increase of one point in data-driven processing scores

corresponded to an increase of 0.20 to 0.22 in intrusion scores at 1-week follow-up via more disjointed memories of the trauma film.

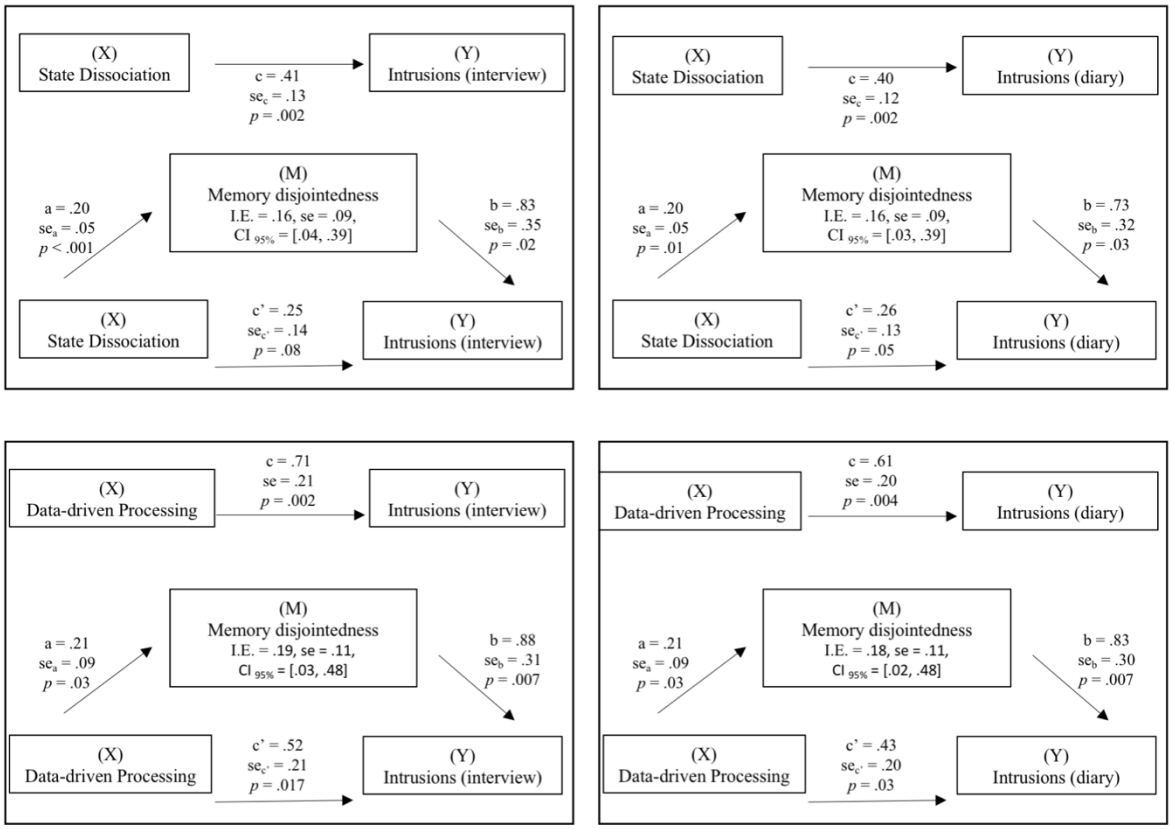


Figure 6.1. Mediation models with coefficients. I.E. = indirect effect (a * b); se = standard error; CI = bias-corrected confidence interval; c' = direct effect.

Discussion

The present study used a trauma film paradigm to investigate the role of trauma exposure in the formation of disorganised memories. It further investigated the relationship between pre-traumatic memory updating performance, peri-traumatic cognitive processing, and PTSD re-experiencing symptoms. Exposure to a trauma film led to more memory disjointedness, but not poorer memory recall, than exposure to a neutral film clip. Strong peri-traumatic dissociation and data-driven processing were associated with the development of disjointed trauma memories and intrusions after

trauma film exposure. It was found that memory disjointedness at three-days mediated the relationship between peri-traumatic processing and development of intrusions (at least partly).

Firstly, the findings suggest that exposure to a trauma film led to more memory disjointedness of the worst moments of the film, compared to neutral film exposure. Interestingly, trauma film exposure led to less difficulty in memory recall for the film than exposure to a neutral film. With time, trauma film group further reported a greater increase in memory disjointedness compared to the neutral film group, whereas the groups did not differ in their increase in poor memory recall. These findings indicate that trauma exposure may lead to the formation of disjointed memories but not necessarily to difficulties in memory recall. The findings are in line with Ehlers et al.'s (2004) suggestion that the disjointedness of the worst moments of the traumatic event from other relevant information in autobiographical memory may contribute to the development of PTSD symptoms. Furthermore, the findings are in line with a previous study (Chapter 5) that found that the worst moments of trauma memories were more disjointed than the memory of the worst moments of other negative events. However, Chapter 5 also found that trauma survivors with PTSD had more difficulties with memory recall of the traumatic event, compared to other negative events, and to trauma survivors without PTSD. It was further found that memory recall was not worse for trauma memories in trauma survivors without PTSD. This is in line with the finding that exposure to a trauma film did not lead to more difficulties in memory recall in the present study. The findings suggest that difficulties in trauma memory recall in PTSD may not be related to poor elaboration or encoding of the trauma, but rather to processes associated with PTSD symptoms, such as poor concentration or avoidance.

Secondly, peri-traumatic dissociation and data-driven processing predicted memory disjointedness at three-days and one-week follow-up, as well as the development of re-experiencing symptoms at one-week follow-up. Dissociation but not data-driven processing was also related to poor memory recall of the trauma film at three-days follow-up, but the relationship was no longer significant at one-week follow-up. This suggests that peri-traumatic cognitive processing is strongly related to the development of disjointed trauma memories, but less so to difficulties in trauma memory recall. This in line with the finding that trauma film exposure led to more disjointedness of the trauma memory but not to poor memory recall compared to neutral film exposure. These findings are also in line with findings from Chapter 5, suggesting that the difficulties in memory recall that are often witnessed in patients with PTSD may not be a consequence of poor memory encoding during trauma, but may be a consequence of PTSD symptomatology.

Thirdly, memory disjointedness at three-days mediated the effect of peri-traumatic dissociation and partly mediated the effect of data-driven processing on the development of re-experiencing symptoms at one-week follow-up. This suggests that peri-traumatic processing may influence how the trauma is encoded, which in turn contributes to the development of PTSD symptomatology. This is in line with current cognitive models of PTSD that suggest that peri-traumatic processes may contribute to the nature of the trauma memory in PTSD, which in turn is thought to influence the development of persistent PTSD symptoms. However, memory disjointedness only partly mediated the relationship between peri-traumatic data-driven processing and intrusions at one-week follow-up. This suggests that this is not the only path through which peri-traumatic ddata-driven processing leads to intrusions. In line with this, cognitive theories of PTSD (e.g., Ehlers & Clark, 2000) suggest that data-driven instead

of conceptual processing contributes to the easy triggering of re-experiencing symptoms by perceptually similar stimuli.

Finally, pre-trauma abilities to update negative and neutral material were not related to the development of PTSD symptoms or intrusions at one-week follow-up, and not related to memory disjointedness at any time point. This finding was surprising, as error rates were hypothesised to be related to the development of PTSD symptomatology. However, better memory updating performance for negative material was related to a greater increase of memory disjointedness from three-days to one-week follow-up. This suggests that hypervigilance towards negative material and increased updating of negative material may be related to difficulties with the trauma memory and may impair the integration of neutral information that would be relevant to update the meaning of the trauma. This is in line with a previous study that found that compared to control participants, trauma survivors with PTSD tended to be better in updating negative material than traumatised controls, which was interpreted as greater hypervigilance to negative stimuli, whilst at the same time neglecting updating information about neutral material (Chapter 3).

The study has several limitations. Firstly, the study used an analogue trauma paradigm to investigate memory processes in PTSD. Even though previous studies found that the trauma film paradigm produces re-experiencing symptoms with a similar quality to trauma survivors with PTSD (e.g., Weidmann et al., 2009), it remains unclear whether processes during trauma film exposure also correspond to those during real trauma experience. Secondly, the measures used in this study are mainly self-report measures. It would be interesting to investigate trauma memory characteristics with objective ratings of the trauma narrative to better understand discrepancies in the current PTSD literature, and to gain a better understanding of whether self-reported trauma memory

characteristics are similar to those that trauma survivors with PTSD report. Thirdly, processes during the trauma film were assessed retrospectively. It may be possible that participants were biased in their ratings, and that self-reported peri-traumatic dissociation was influenced by post-trauma cognitions and the impact of the film. Finally, the sample size of N = 60 in the trauma film group may have been too small to detect small correlations between variables. Post-hoc power analyses showed that the study only had 34% power to detect correlations of small effect sizes. It is therefore conceivable that poor memory recall is related to the development of PTSD symptoms, but that there was not enough power to detect these relationships. The findings should therefore be interpreted carefully and future studies should examine this relationships with a bigger sample size.

In conclusion, the study investigated the effects of trauma on memory characteristics, and the relationship in the trauma film group between pre-trauma memory updating performance, peri-traumatic cognitive processing, disjointedness of the worst moments, and development of PTSD symptoms. Trauma film exposure led to more disjointed memory of the trauma film, but not poorer memory recall of the trauma film, compared to the neutral film condition. Furthermore, in the trauma film group, self-reported memory disjointedness of the worst moments was the strongest predictor for re-experiencing symptoms, and at least partly mediated the relationship between peri-traumatic cognitive processing and the development of re-experiencing symptoms. Results support cognitive theories of PTSD that emphasise the role of the nature of the trauma memory in the development of PTSD symptoms. Results may contribute to refine cognitive theories of PTSD, and help to better understand the development of PTSD re-experiencing symptoms.

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7

GENERAL DISCUSSION

This thesis examined information updating and autobiographical memory characteristics in PTSD and explored their role in the development and maintenance of PTSD symptoms, and their relationship to PTSD treatment. The thesis builds on Ehlers and Clark's (2000) cognitive model of PTSD and examined some of the core processes that are proposed to play a role in the development and maintenance of PTSD symptomatology, namely memory updating, negative appraisals, quality of trauma memories, and cognitive processing before and during trauma. The following section will outline the main findings of this thesis, and relate them to the current literature in the field. It will also discuss the strengths and weaknesses of this project, and the theoretical, clinical and methodological implications of the findings.

Review of Research Questions and Studies

Four main research questions were addressed in this thesis. Firstly, it examined how low mood, anxiety and PTSD influenced how neutral and negative information is updated in memory, and how negative appraisals of other people may develop in people with PTSD (Studies 1- 3). Secondly, it investigated whether trauma exposure and PTSD were related to the quality of memories of negative experiences. Two aspects of memory disorganisation were examined, which were poor memory recall and disjointedness of

the worst moments (Study 4 and 5). Thirdly, it explored how individual differences in memory updating before treatment were related to PTSD treatment outcomes, and how memory characteristics changed with PTSD treatment (Study 3 and 4). Finally, it examined the role of cognitive processes before and during trauma in the development of disorganised trauma memories, and re-experiencing symptoms (Study 5).

Five studies addressed these questions. Study 1 examined the role of individual differences in mood and anxiety on associative memory updating of negative and neutral material, using a location-updating paradigm (Chapter 2). Study 2 used the same experimental paradigm to examine associative memory updating of non-trauma material in trauma survivors with PTSD. It further explored how individual differences in memory updating performance were related to memory characteristics and PTSD symptoms post-treatment (Chapter 3). Study 3 examined the development and maintenance of positive and negative appraisals about strangers in participants with PTSD and non-traumatised controls, and the role of interpersonal trauma in their development, using an impression updating task (Chapter 4). Study 4 examined self-reported memory disorganisation, and specifically poor memory recall and disjointedness of the worst moments of trauma and negative control events in trauma survivors with and without PTSD, and non-traumatised controls. It further examined changes in these memory characteristics with PTSD treatment (Chapter 5). Finally, Study 5 examined the effect of trauma on memory disorganisation in a trauma film paradigm, and examined the role of individual differences in pre-trauma memory updating and peri-traumatic cognitive processing in the development of disorganised trauma film memories and re-experiencing symptoms (Chapter 6). In the following section, the main findings will be briefly summarised and discussed.

Review of Main Findings

Memory Updating and Appraisals in PTSD

Chapters 2 to 4 (Studies 1 to 3) examined how negative and neutral information influenced associative memory updating in people with low mood, anxiety (Chapter 2, Study 1) and PTSD (Chapter 3, Study 2), and how negative and positive information affected the development of specific negative appraisals about other people in PTSD (Chapter 4, Study 3). Studies 1 and 2 used a location-updating task, in which participants were asked to remember location changes of mildly negative and neutral pictures. Study 3 used an impression updating task, in which participants rated how kind they found strangers after receiving either positive or negative information about them.

Study 1 showed that low mood tended to be associated with more difficulties updating features of mildly negative stimuli (picture locations) compared to neutral stimuli, as measured by the location-updating task. This finding was partly replicated in traumatised and non-traumatised controls in Study 2, using the same task. Anxiety, on the other hand, did not influence how negative and neutral information was updated, indicating that depression rather than anxiety may be related to difficulties updating negative compared to neutral memories (Study 1), or neutral and negative memories in general (Study 2). Study 2 revealed that trauma survivors with PTSD showed a different pattern when updating mildly negative and neutral information compared to a group of combined traumatised and non-traumatised control participants. The pattern also differed from the pattern that was found in participants with low mood (Study 1). Relative to the control group, trauma survivors with PTSD tended to have more difficulties updating neutral rather than negative information, indicating hypervigilance to changes in negative material. In line with this, Study 3 showed that compared to non-traumatised controls, trauma survivors with PTSD showed more negative change in their appraisals about

strangers after receiving negative information than positive change in their appraisals after positive information. Furthermore, the experience of an interpersonal trauma or distressing negative event tended to be associated with less updating of initial appraisals about strangers. For example, after having received initial negative information about a stranger, people who had experienced an interpersonal trauma (PTSD group) or a distressing negative interpersonal event (control group) were less likely to update their appraisal to a more positive rating when receiving positive information about the stranger, and vice versa. At the same time, they were more likely to change their appraisals towards lower kindness ratings when receiving consistent negative information, and towards higher kindness ratings when receiving consistent positive information. This suggests that they reinforced their initial impressions when information was presented that confirmed initial impressions, and developed more excessive (negative as well as positive) appraisals. Surprisingly, these findings were not specific to the experience of an interpersonal trauma in PTSD, but were also found in non-traumatised participants who had experienced an interpersonal negative event. This suggests that negative interpersonal experiences in general, rather than traumatic experiences, may be associated with difficulties in updating impressions of people.

Taken together, these studies support the hypothesis that trauma survivors with PTSD may not have general difficulties in integrating new negative information, but rather show selective attention towards negative material, resulting in better updating and integration of negative material, and the development of more negative appraisals. However, it also needs to be considered that in the impression updating task, positive information had a similar effect on appraisals as negative information. This may suggest that positive and negative information were equally salient, whereas the neutral stimuli used in the location-updating task may have been less salient compared to the negative

pictures. More research is needed to better understand differences and similarities in the effects of negative and positive information on memory and appraisals. Previous studies found that trauma survivors with PTSD showed increased attention towards trauma-related images compared to non-trauma related images (Kimble, Fleming, Bandy, Kim, et al., 2010; Thomas et al., 2013), and some found increased attention towards negative visual material compared to neutral material in PTSD (e.g., Kimble, Fleming, Bandy, Kim, et al., 2010), indicating that trauma survivors with PTSD show increased attention to potential threat cues. It is conceivable that people with PTSD perceived the negative pictures in the location updating and the negative information about strangers in the impression paradigm as threatening. Locations play an important role for trauma survivors with PTSD, and are often linked to the traumatic experience. For example, people who suffer from PTSD often avoid places that remind them of the trauma, as they are afraid of encountering potential triggers (e.g., Ehlers & Clark, 2000). People with PTSD perceive an ongoing sense of threat, and may use increased attention towards the location of threat, and changes related to it, as a strategy to stay safe. Similar to places associated with trauma, strangers may be perceived as threatening or triggering, as people with PTSD tend to mistrust others (Foa et al., 1993), and may see people, and particularly strangers, as a potential threat. These findings provide some support for cognitive theories of PTSD, suggesting that trauma survivors with PTSD often feel a sense of threat after the trauma, and develop strong negative appraisals about the world, others and themselves (APA, 2013). More research is needed, however, to better understand which information is perceived as threatening in PTSD, and how the sense of current threat as well as depression contributes to memory updating and the development and maintenance of negative cognitions.

Quality of Trauma Memories

Chapters 5 and 6 examined the quality of trauma memories in trauma survivors with PTSD (Study 4) and in healthy participants after exposure to an analogue trauma film (Study 5). Study 4 found that compared to traumatised and non-traumatised control participants, people with PTSD reported poorer memory recall for the trauma memory. It also found that people with PTSD showed more disjointed memories of the worst moments of the trauma. Study 5 found that exposure to a trauma film led to more disjointed memories of the worst moments of the trauma film, but to poorer overall memory recall of the film, compared to exposure to a neutral film. This suggests that disjointedness of the worst moments may contribute to the development of PTSD symptoms. However, it remains unclear whether difficulties recalling the trauma memory in PTSD help maintain PTSD symptoms, or are a consequence of PTSD symptoms (e.g., related to poor concentration). The findings are in line with the suggestion that PTSD is characterised by general disorganisation of the trauma memory, and underline the importance of the memory of the worst moments, which has been suggested to lead to the characteristic re-experiencing symptomatology in PTSD (Ehlers et al., 2004). It further adds to previous studies that showed that trauma memories are generally more disorganised (and associated with poor intentional recall) than negative control events (Halligan et al., 2003), and that the worst moments of the trauma are particularly disjointed in PTSD (Evans et al., 2007; Kleim & Ehlers, 2008). The findings support cognitive models of PTSD that suggest that the trauma memory is poorly elaborated and disorganised. However, more research is needed to better understand the effects of memory disjointedness and memory recall, and its relationship with PTSD symptomatology.

Memory Processes and PTSD Treatment

Chapters 4 and 5 examined memory processes in PTSD patients and their relationship with PTSD treatment (Study 3 and 4). Study 4 investigated whether memory characteristics in PTSD changed with treatment. Study 3 examined whether memory updating performance before treatment predicted changes in memory characteristics and treatment outcomes. Study 4 found that trauma memory characteristics changed with trauma-focused Cognitive Therapy for PTSD (CT-PTSD; Ehlers et al., 2005). After treatment, memory disorganisation in general and disjointedness of the worst moment of the trauma memory decreased, but only decreased disjointedness was associated with PTSD recovery. The findings indicate that treatment had an effect on memory disorganisation and add to studies showing that PTSD treatment leads to changes in memory characteristics (e.g., Ehlers et al., 2004; Speckens et al., 2006), and to improvements in specific memory recall (Sutherland & Bryant, 2007). Furthermore, they support theoretical models of PTSD that suggest that trauma-focused CT leads to an integration of the worst moments of the trauma with other relevant information (Ehlers et al., 2005; Ehlers & Clark, 2000).

Cognitive Processing, Disorganised Memory and Re-experiencing

Finally, Chapter 6 examined how disorganised trauma memories may develop and in what way they contribute to the development of re-experiencing symptoms after analogue trauma (Study 5). It explored the relationship between pre-trauma memory updating, peri-traumatic cognitive processes, and autobiographical memory characteristics after analogue trauma, using measures from the previous studies. Disjointedness of the worst moments, as well as difficulties in memory recall were related to the development of re-experiencing symptoms after an analogue trauma film. Similarly, peri-traumatic state dissociation and data-driven processing were related to the

development of re-experiencing symptoms. Memory disjointedness of the worst moments, but not poor memory recall, partly mediated the relationship between peri-traumatic cognitive processing and re-experiencing symptoms. However, pre-exposure memory updating of negative and neutral material was not related to the development of disjointed memories of the worst moments from the trauma film, or re-experiencing symptoms after analogue trauma. These findings help to explain the development of re-experiencing symptoms in PTSD, and their relationship to memory processes. The findings are in line with studies that show that peri-traumatic dissociation and data-driven processing are associated with the development of PTSD symptoms after analogue trauma (e.g., Sachschal et al., in prep.). It adds to previous findings by showing that cognitive processing during trauma leads to more disjointed trauma memories, which in turn lead to re-experiencing symptoms. The findings therefore may help to better understand the pathways towards the development of PTSD symptoms.

Summary of the Findings

To sum up, this thesis aimed to make a first step in the understanding of the influence of negative information on memory updating and appraisals in low mood and PTSD, and to improve the understanding of the quality of trauma memories in PTSD. It further examined the role of memory processes in PTSD treatment, and how cognitive processes before and during trauma influence the quality of trauma memories. Study 2 and 3 showed that people with PTSD may not only show hypervigilance towards trauma-related threat-related stimuli, but may have biases towards negative information in general, or have an overgeneralised perception of danger. Study 1 and 2 further suggest a relationship between low mood and difficulty with updating mildly negative information, whilst Studies 1, 2 and 3 suggest that anxiety and PTSD were not related to difficulties updating negative information. Study 4 and 5 showed that trauma memories

in PTSD are characterised by difficulties in intentional memory recall and disjointedness of the worst moments, and showed that exposure to a trauma film led to more disjointed trauma film memories in healthy participants, compared to exposure to a neutral film. The findings help clarify previous inconsistent findings (Halligan et al., 2003; Jelinek et al., 2009), and provide support for the study by Halligan and colleagues (2003) who found that trauma memories are associated with more difficulties in recall compared to negative control events. The findings also provide some support for theories suggesting that the worst moments of the trauma are poorly integrated in PTSD and help to explain the 'here and now' quality of re-experiencing symptoms (Ehlers et al., 2004), as the lack of integration may prevent people with PTSD from accessing new information from after the trauma. Study 3 and 4 showed that memory disjointedness and difficulties in recall of the trauma memory decreased with PTSD treatment (Study 4). These findings provide some evidence for the importance of the work on the trauma memory during CT-PTSD (Ehlers et al., 2005; Ehlers & Clark, 2000), and underline the importance of identifying and updating the worst moments of the trauma. Finally, Study 5 showed that peri-traumatic dissociation and data-driven processing during trauma films were related to the development of disorganised trauma film memories, as well as re-experiencing symptoms. Disjointedness of the worst moments of the trauma film but not difficulties in recall played a key role in the development of PTSD symptoms, and partly mediated the relationship between cognitive processing during trauma and the development of re-experiencing symptoms. The findings support literature suggesting that peri-traumatic cognitive processes contribute to the development of disjointed trauma memories and re-experiencing symptoms (e.g., Ehlers et al., 2004).

Potential Implications

Potential Theoretical and Clinical Implications

This thesis combined studies with non-trauma exposed healthy participants, trauma survivors with and without PTSD, and PTSD patients before and after treatment. The studies on information updating were informed by treatment procedures in cognitive therapy for PTSD, and thus aimed to experimentally examine concepts that are directly relevant to PTSD treatment. The studies focusing on autobiographical memory characteristics in PTSD built on theoretical assumptions about the trauma memory and aimed to contribute to a better understanding of the mechanisms underlying re-experiencing symptoms.

Firstly, the finding that memory characteristics changed with PTSD treatment (Study 4) provides evidence that the cognitive work on the trauma memory in trauma-focused CT helps to change memory characteristics that are assumed to lead to re-experiencing symptoms and contribute to the maintenance of negative trauma appraisals. The fact that integration of the worst moments of the trauma but not improvement in memory recall was associated with PTSD recovery, provides empirical support for the updating memory procedure in trauma-focused CT-PTSD, which focuses on the worst moments of the trauma and the parts that are re-experienced. Furthermore, it was found that trauma film exposure led to more memory disjointedness of the worst moments of the film but not poor memory recall. Memory disjointedness after film exposure was also more strongly related to the development of PTSD-like symptoms than poor memory recall. This suggests that disjointedness of the worst moments plays a role in the development of PTSD symptoms after trauma. The findings also support the procedure of trauma-focused CT-PTSD (Ehlers et al., 2005; Ehlers & Clark, 2000) to identify the worst moments of the trauma, and identify and update the dysfunctional appraisals

related to them. Previous studies have shown that the content of re-experiencing symptoms is related to the worst moments of the trauma (Ehlers et al., 2004), supporting the focus of the memory work on these parts of the memory in treatment. This may be particularly relevant for trauma survivors with multiple traumas when it is not possible to work through all traumatic experiences. Secondly, it was found that PTSD patients tended to have difficulties updating neutral rather than negative information, and tended to respond with more negative appraisals after receiving negative information about other people, compared to controls. Again, this underlines the role of hyperarousal and increased attention to threat in PTSD, and its relationship to memory functioning and appraisals in PTSD. It is conceivable that they contribute to the maintenance of negative appraisals of experiences after the trauma. This supports cognitive theories that suggest that the reduction of the sense of current threat is an important aim in treating PTSD (Ehlers et al., 2005). Reducing the sense of current threat may then allow patients to better focus on relevant information in treatment, and integrate relevant new and non-threatening information that help change the meaning of the trauma.

Potential Methodological Implications

This thesis combined paradigms from experimental and neuroscience research with clinical research with PTSD patients. To examine memory and appraisal updating, experimental paradigms were selected for the DPhil that have been validated in healthy samples. It was therefore difficult to predict how PTSD patients would respond to them. Findings from Study 2 and 3 show that hypervigilance and arousal in PTSD may affect responses in the paradigms that were used, and Study 1 suggested that low mood may play a role in updating associative memories. It is conceivable that people with PTSD respond differently to stimuli related to locations and people, or to changes in associations, as they may be experienced as particularly threatening in PTSD due to a

hypervigilance towards information perceived as threatening. It remains unclear how low mood and hypervigilance interact in response to the paradigms used in these studies. Future studies should address the question of threat-related attention biases in PTSD, and further examine what kind of stimuli may evoke fear in PTSD. A better understanding of hypervigilance, the sense of current threat in PTSD, and memory biases may help to design paradigms that can examine memory and appraisal updating unrelated to arousal, which may have impacted the results of these studies. Furthermore, future studies should also include measures of hypervigilance to better understand its relationship to memory processes, and the development of PTSD symptoms. Findings of Studies 4 and 5 further suggest that research should differentiate between general memory disorganisation of the trauma memory and disjointedness of the worst moments. Studies should clearly distinguish between the worst moments of the trauma memory and the overall trauma narrative when discussing memory disorganisation, and use more specific terminology when referring to memory disorganisation.

Strength, Limitations and Future Directions

This thesis has several strengths and weaknesses that will be outlined.

Strength of the Thesis

One of the main strengths of this thesis is that it assessed information updating and memory characteristics in trauma survivors with PTSD, as well as traumatised and non-traumatised controls. It used experimental research paradigms developed with healthy participants, and applied these to a clinical population, to further the understanding of processes that cannot be easily examined in PTSD patients. It therefore assures high ecological validity in some studies, and high experimental control in others. This DPhil project further provides data from treatment studies, as it examined PTSD

patients before and after treatment, and related cognitive processes measured before treatment to treatment outcomes. It therefore applied the experimental research directly to clinical practice, and may help to understand cognitive processes that contribute to successful PTSD recovery with PTSD treatment. Another main strength is that it derived research questions from effective clinical procedures, and contributes to an under-researched area in clinical as well as basic research. The questions were derived from theoretical models of PTSD that inform clinical practice. This thesis aimed to bring together knowledge from different - and usually unconnected - research fields in order to examine clinical phenomena. It used a variety of experimental paradigms from basic research and applied them to clinical research of PTSD. It is hoped that the findings will contribute to PTSD research by combining studies on relevant aspects of PTSD, and examining them with a range of different methods and from different perspectives.

Limitations

This thesis also has several weaknesses. Firstly, the sample sizes in the PTSD patient studies were small, especially for the post-treatment sessions. This is due to drop-outs, and data loss from trauma survivors with PTSD. Therefore, the findings need to be interpreted with caution. Future studies should assess larger patient samples, as the effects of PTSD treatment on memory performance measured in the experimental paradigms may be small. Secondly, it is conceivable that there may be a recruitment bias in the studies. More than half of PTSD patients that went through the services did not agree to take part in the study. The study was time-consuming and it is possible that the PTSD patients who agreed to take part in the research were not representative. PTSD patients and traumatised controls stated that they were interested in advancing the research in this field or reported that they wanted to give something back. Therefore, it is conceivable that non-traumatised participants in Studies 2, 3 and 4 may have been less

invested in the research due to motivational differences between groups. It is unclear though how this would have led to systematic differences in the dependent variables. In Study 5, participants were screened for past trauma and mental health problems, and it was made clear at the time of recruitment that participants would see a distressing film. Therefore, a selection bias may apply in this study, as participants able to tolerate a traumatic film may have been more likely to sign up. Thirdly, PTSD patients and traumatised and non-traumatised controls differed in some of the demographic variables. It is not surprising that non-traumatised controls had different demographics, as epidemiological studies suggest that up to 80% of people experience a trauma at some point in their life (e.g., Kilpatrick et al., 2013), even though studies in Europe have found lower rates of trauma prevalence (e.g., Hepp et al., 2006). More research is needed to test whether differences in motivation, or group demographics may have influenced performance in the experimental tasks. Fourthly, the study relied on self-report of the traumatic experience with the stressful life events checklist (Foa et al., 1997). It may be that some people have experienced a traumatic event but did not indicate it on the scale, or did not remember the event at that time. This may be particularly relevant for the trauma criterion according to the DSM-5 (APA, 2013), which no longer involves the subjective experience of fear, horror or helplessness. Traumatic experiences that did not evoke those feelings may be less likely to be remembered. Fifthly, there was no wait list group to compare PTSD patients over the course of treatment. It is therefore not clear whether cognitive processes and PTSD symptomatology may have changed independently of PTSD treatment, although this is unlikely as patients had chronic PTSD and several randomised controlled trials found very little change during wait list conditions (e.g., Ehlers et al., 2014, 2005). Furthermore, Study 2 and 3 used a traumatised control group to assess natural changes over time and re-test effects as a

comparison. Sixthly, information updating and memory processes were assessed with self-report measures, or with experimental paradigms, and mainly focused on group comparisons. It is therefore difficult to say whether processes are a result of concentration difficulties and self-perception in PTSD, or whether they actively play a role in the development and maintenance of PTSD symptoms. Seventhly, multiple testing may have inflated the alpha error for correlations in Chapter 3 and 6. It was not Bonferroni corrected as part of the analyses were control analyses that were not meant to be significant. However, it is still possible that correlations may have become significant due to an inflated alpha error rate and results should be interpreted carefully when multiple testing occurred. Finally, several studies did not meet their recruitment aims, or have overestimated the expected effect sizes. Therefore, some studies did not have enough power to detect existing effects, and non-significant findings should to be interpreted carefully. Post-hoc power analyses showed that Study 1 (Chapter 2) did not have enough power to detect the potentially differences of small effect sizes between mildly negative and neutral material, and to detect the small relationship between low mood, anxiety and updating error rates. They further revealed that Study 3 (Chapter 4) was underpowered to detect the medium sized interaction effects between interpersonal events. This may explain why statistical trends may not have reached significance. Finally, they revealed that Study 5 (Chapter 6) did not have the power to detect small correlations between poor memory recall and the development of intrusions in the trauma film group. Therefore, the differential findings between poor memory recall and memory disjointedness have to be interpreted carefully, and it is not possible to draw final conclusions with regards to them. More research with greater sample sizes is needed to further address these questions.

Future Directions

Future research could address several points. Firstly, this thesis explored the role of mood, anxiety and hypervigilance in information updating. Memory flexibility and the ability to integrate new information may not be specific to PTSD, but could be seen as a trans-diagnostic process, associated with other disorders or general well-being. More research is needed to explore these processes in different psychiatric conditions, as well as in healthy participants. Secondly, this DPhil project used experimental paradigms and self-report measures to examine information updating and autobiographical memory in PTSD. Different measures and approaches were used to assess a variety of constructs relating to autobiographical memory and information updating. Future research should combine experimental measures with self-report measures of the same constructs to gain a better understanding of the phenomenology. For example, the Autobiographical Memory Test (AMT; Williams & Broadbent, 1986) could be used to assess general autobiographical processes in PTSD, and relate them to self-report measures, as well as objective measures of memory and learning. Thirdly, experimental paradigms mainly focused on updating location associations, and impressions about people. As previously described, these are potentially threatening in PTSD, as locations and people are often closely bound to trauma. For example, a trauma survivor with PTSD who was assaulted close to a parking lot is very likely to have re-experiencing symptoms when returning to the same location, or going other places that remind them of the parking lot. It would therefore be interesting to investigate how other associations can be updated, to see whether hypervigilance is related to the overall arousal in PTSD, or may be related to the subjective sense of threat that is evoked by the stimuli. It would also be interesting to assess physiological measures of general arousal to better understand the relationship of attention, arousal and memory updating in PTSD. Fourthly, information updating is time

dependent, and studies on memory reconsolidation showed that consolidated memories can be reactivated and changed (e.g., Hupbach et al., 2007). It would be interesting to examine whether memory flexibility changes after the consolidation process has taken place and whether hypervigilance processes may be particularly relevant in updating processes related to short term memory.

Conclusion

To sum up, this thesis presented a series of five studies that examined information updating and autobiographical memory in PTSD. More specifically, it examined memory updating of negative and neutral associative memories in low mood and PTSD, appraisals about strangers in PTSD and after distressing interpersonal events, memory disorganisation of trauma and negative control memories, and the relationship between cognitive processes before and during trauma and memory disorganisation and re-experiencing symptoms after analogue trauma. Study 2 found that relative to a control group without PTSD, trauma survivors with PTSD tended to have more difficulties in memory updating of neutral compared to negative associative memories. In a subsample of PTSD patients, difficulties in updating neutral memories was related to less change in trauma memory disjointedness and PTSD recovery after trauma-focused CBT. Study 3 found that trauma survivors with PTSD showed more negative change in appraisals about strangers when receiving negative information, than positive change when receiving positive information, compared to a group of non-traumatised controls. Interpersonal distressing experiences (regardless of whether they were traumatic) were associated with less change in person appraisals with incongruent information, and more change with congruent information about strangers, regardless of the valence of the information. Study 4 found that trauma survivors with PTSD reported poorer recall and more

disjointedness of the worst moments for the memory of their traumatic experience, compared to a memory of a negative control event. They also reported poorer recall and more memory disjointedness compared to traumatised and non-traumatised control groups. Trauma-focused CBT was associated with improvements in trauma memory recall and a decrease in trauma memory disjointedness. The decrease in trauma memory disjointedness, but not the improvement in memory recall, was related to PTSD recovery. Finally, Study 5 found that the exposure to an analogue trauma led to more memory disjointedness but not poorer recall at follow-up. Memory disjointedness but not poor recall partly mediated the relationship between cognitive processing during trauma and the development of re-experiencing symptoms. The findings provide support for cognitive models of PTSD (e.g., Ehlers & Clark, 2000), suggesting that the characteristics of trauma memories may contribute to the development and maintenance of PTSD symptomatology. They further underline the importance of memory and appraisal processes in PTSD, but more research is needed to better understand the role of memory updating of negative and neutral material and person appraisals in PTSD. Finally, the findings provide support for the rationale of memory work in trauma-focused CBT, and suggest that memory updating is an important procedure during PTSD treatment. It can be speculated that a modification of attention biases in PTSD (e.g., Beard et al., 2012; Hakamata et al., 2010) may help reduce the focus on negative information which maintains negative appraisals. This could potentially help trauma survivors to focus on less salient information that may however be relevant to update negative appraisals in PTSD. More research is needed to better understand these phenomena.

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