INVESTIGATING THE ROLE OF METACOGNITIVE BELIEFS IN POST-TRAUMATIC STRESS DISORDER (PTSD)

By

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ABSTRACT

Following exposure to a traumatic event, some people will develop a mental health condition called post-traumatic stress disorder (PTSD). One novel approach to the prevention of PTSD explored in this thesis, is the shaping of healthy metacognitive beliefs—which refer to the beliefs we have about our own cognition. The metacognitive model of PTSD proposes that maladaptive metacognitive beliefs heighten vulnerability to PTSD. This thesis explored the role of metacognitive beliefs in the development of PTSD; specifically testing their *causal role*. Second, it examined the relationship between metacognitive beliefs and meta-awareness (i.e., awareness of one's cognition)—a relatively understudied, yet important, topic in PTSD. Third, it investigated the links between voluntary and involuntary memory for analogue trauma, specifically examining how the *details* that people remember about a trauma may link to the development of PTSD symptoms.

Study 1 (pilot), investigated the causal role of healthy metacognitive beliefs in PTSD symptoms, using the cognitive bias modification (CBM) and trauma film paradigms. A novel CBM training protocol, named $CBM_{Metacog}$, was developed in this thesis to test the causal role of healthy metacognitive beliefs in PTSD. The $CBM_{Metacog}$ training was designed to target maladaptive metacognitive beliefs in line with the metacognitive model of PTSD. In Study 1, participants received $CBM_{Metacog}$ training—to increase healthy metacognitive beliefs—*immediately following* analogue trauma and their metacognitive beliefs and PTSD symptoms were measured over time. Study 2 aimed to explore *how* maladaptive metacognitive beliefs increase vulnerability to PTSD. This eye-tracking study investigated whether maladaptive metacognitive beliefs affect the way people encode a traumatic event using the trauma film paradigm. Study 3 assessed the causal role of healthy metacognitive beliefs in the primary prevention of PTSD symptoms. Here, $CBM_{Metacog}$ training was administered *immediately prior to*

analogue trauma. Study 4 was the main CBM study. It replicated and extended Study 3, by examining whether increasing healthy metacognitive beliefs lead participants to become more meta-aware of their intrusions. Chapter 8 combined data from Studies 1, 3 and 4, to investigate the effects of $CBM_{Metacog}$ training on people's *voluntary memory* for analogue trauma—namely, the voluntary recall of central and peripheral details about a distressing event. The associations between these memory details and PTSD symptoms were also explored.

This thesis has demonstrated, for the first time, some early evidence for the causal link between metacognitive beliefs and PTSD symptoms. Overall, these finding have implications for the primary prevention of PTSD and suggest that targeting metacognitive beliefs in the development of preventative approaches to PTSD may be a crucial next step.

I would like to dedicate this thesis to Mary and George, the most loving and supportive grandparents that anyone could ever ask for

I would like to express my deep appreciation and gratitude to my mentor, Heather. I will always remember our meetings from the early days at Leicester. You took me under your wing during my master's degree and I have never looked back! You are the one who made me excited about research—hearing you talk about your findings, the way you approach scientific problems and design complex experiments had me well and truly hooked! I admire your tenacity and integrity and I am in awe of how you manage to juggle so many things! I feel so lucky to have had the opportunity to complete my PhD with you by my side. Thank you for everything you have taught me about research, and most of all, thank you for always believing in me. I hope our collaborations never end!

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The work in Study 2 (Chapter 6) was previously submitted as part of British Psychological Society (BPS) Undergraduate Research Assistantship Scheme. Along with my supervisor, Dr Heather Flowe and Dr Robin Jackson, I co-supervised Mr Matthew Browney during his summer BPS research assistantship project. The study was conceptualised by myself, Dr Heather Flowe and Dr Robin Jackson, and the data were collected by Mr Browney. I re-analysed the data and conducted further analyses. All of the writing presented in this thesis is my own work.

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APA	American Psychiatric Association
ASD	Acute Stress Disorder
BAMQ	Beliefs about Memory Questionnaire
CAS	Cognitive Attentional Syndrome (metacognitive model of PTSD)
CBM	Cognitive Bias Modification
CBT	Cognitive Behavioural Therapy
DASS-21	Depression, Anxiety, Stress Scale-21
DSM	Diagnostic and Statistical Manual of Mental Disorders
EIS	Experience of Intrusions Scale
EMDR	Eye-movement Densensitisation Reprocessing
ERT	Encoding Recognition Task
IES	Impact of Event Scale
IES-R	Impact of Event Scale-Revised
MCQ	Metacognitions Questionnaire
MCT	Metacognitive Therapy
PE	Prolonged Exposure
PTSD	Post-traumatic Stress Disorder
RAP	Recovery adaptation process (metacognitive model of PTSD)
RCT	Randomised Controlled Trial
RIQ	Response to Intrusions Questionnaire
RIQ	Response to Intrusion Questionnaire
S-REF	Self-regulatory Executive Function
TEQ	Traumatic Experiences Questionnaire

CHAPTER 1: INTRODUCTION

Approximately 70% of people worldwide are exposed to at least one traumatic event within their lifetime (Benjet et al., 2016). Following a traumatic event, a small proportion of people will go on to develop a debilitating condition named post-traumatic stress disorder (PTSD). PTSD is associated with significant impairments to one's quality of life (Kessler, 2000) and is co-morbid with a range of mental health disorders, such as depression, anxiety and substance misuse (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). The Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013) defines a traumatic event as "exposure to actual or threatened death, serious injury, or sexual violence" (p. 271). Common examples of traumatic events include road-traffic accidents, natural disasters (e.g., hurricanes) and interpersonal violence (e.g., physical/sexual assault). A more recent example is the Grenfell Tower fire (UK) in 2017, a devastating event that affected the lives of thousands and resulted in mass fatalities. Many, including local people, but also first responders, directly witnessed the fire unfolding and were powerless to help those left inside the tower. Consequently, two-thirds of people affected were assessed as needing treatment for PTSD (Guardian, 2019), although further follow-up is needed to better determine these symptoms over time. Terrorist attacks—which have been on the rise in Western Europe and North America in recent years (Independent, 2018)—are another example of traumatic events that have devastating far-reaching effects on the lives of those affected. This includes those directly exposed, but also those indirectly exposed (i.e., secondary trauma). Clearly, trauma exposure is pervasive across communities worldwide; and as a result, some people will go on to develop PTSD. As PTSD is conditional on trauma exposure, we have the opportunity to help *prevent* the development of PTSD, by delivering timely interventions either prior to or immediately following trauma exposure. Indeed, the

World Health Organisation (2013) regards the prevention of mental illness as a top priority, and more recently, emphasis on the prevention/early intervention following trauma has been discussed in the *Lancet Psychiatry Commission* on the future of psychological treatments (Holmes et al., 2018).

The fact that only a small proportion of people will go on to develop PTSD has sparked investigation into factors that may increase vulnerability to PTSD. One understudied area in the development of PTSD focuses on the role of metacognition, which, broadly speaking, refers to thinking about thinking, and includes the beliefs we hold about our cognition (i.e., metacognitive beliefs). A growing body of research investigating the role of metacognitive beliefs in the development of PTSD (e.g.,Wells & Sembi, 2004) suggests that maladaptive metacognitive beliefs play a role in the development of PTSD symptoms (e.g., Takarangi, Smith, Strange, & Flowe, 2017). However, due to the correlational design of studies to date, it is unclear whether metacognitive beliefs play a *causal* role in the development of PTSD symptoms—a vital research question that this thesis seeks to address.

This thesis explores the role of metacognitive beliefs in PTSD and the aims are threefold: 1) to examine the causal role of metacognitive beliefs in PTSD, using analogue trauma (i.e., trauma film paradigm), 2) to assess the relationship between metacognitive beliefs and meta-awareness (i.e., awareness of one's own cognition) and, 3) to explore the relationship between voluntary and involuntary memory for an analogue trauma event. Chapter 2 provides an overview of PTSD, covering key cognitive theories of PTSD and summarising the literature to date that offers support for the metacognitive model of PTSD. Chapter 3 highlights the use of cognitive bias modification (CBM) training—which is a tool to modify people's thinking styles—drawing specifically on the use of CBM to modify trauma-related appraisals. Chapter 4

outlines the key methodological approaches that are used throughout my empirical research studies. The first research study (Study 1) is described in Chapter 5. Here, participants' metacognitive beliefs were manipulated via a CBM training protocol (that was created as part of this thesis), following analogue trauma, and participants' metacognitive beliefs and PTSD symptoms were measured over time. Chapter 6 (Study 2) explores whether metacognitive beliefs increase vulnerability to PTSD by affecting the way individuals encode a traumatic event. Here, participants' attention to threat and non-threat sources of information were tracked via eye-tracking software, while they watched a trauma film. Chapter 7 (Study 3) adopted a similar design to Study 1; however, it analysed whether training people to adopt healthy metacognitive beliefs, *prior to analogue trauma*, also prevented the development of PTSD symptoms—akin to the primary prevention of PTSD. Chapter 8 (Study 4) replicated Study 3 but extended it to uncover the relationship between metacognitive beliefs and meta-awareness—a relatively understudied concept within PTSD. Lastly, Chapter 9 summarises the voluntary memory recall findings from Studies 1, 3 and 4, all which explored how CBM training (to increase healthy metacognitive beliefs) may affect the recall of one's voluntary memory for an analogue trauma. Chapter 10, the discussion chapter, outlines the key findings from this thesis and considers the clinical implications of the research.

CHAPTER 2: PTSD LITERATURE REVIEW

2.1. Post-traumatic Stress Disorder

Longitudinal research demonstrates that a proportion of people will go on to develop mental health conditions, such as acute stress disorder (ASD) and PTSD following trauma exposure (Santiago et al., 2013). Both ASD and PTSD are recognised as being trauma and stressor-related psychiatric disorders within the DSM-5. ASD is a diagnosis for people who experience symptoms within the first month following trauma, whereas PTSD is for people whose symptoms occur for *at least* one month following trauma (APA, 2013). The DSM-5 outlines five symptom criteria (i.e., A–E) that must be met for a person to be diagnosed with PTSD (see Table 1). The first, and most fundamental part of the PTSD diagnosis, is Criterion A (i.e., stressor), which states that an individual must have been exposed to a traumatic event. As not all stressful events involve trauma, the DSM-5 refers to a traumatic event as "actual or threatened death, serious injury, or sexual violence" (p. 271). As outlined in Table 1, trauma exposure can take many forms. However, according to the DSM-5, it does not include indirect exposure via media (e.g., TV), unless it is work-related. Once criterion A has been established, then individuals must fulfil a specific number of symptoms from each of the four symptom clusters (criterion B–E) to be diagnosed with PTSD—with each symptom being anchored to the traumatic event (as outlined in Table 1).

Table 1

DSM-5 criteria for PTSD

DSM-IV Criterion	
A. Exposure	1) Direct exposure 2) Witnessing the trauma in person 3) Indirectly, by learning that a close friend or family member has been exposed to trauma 4) Repeated indirect exposure to aversive details of the trauma when carrying out work-related duties
B. Intrusion	**1/5 symptoms required for a PTSD diagnosis** 1) Recurrent, involuntary and intrusive recollections (e.g., memories of the event). 2) Nightmares 3) Dissociative reactions (i.e., flashbacks) 4) Intense/prolonged psychological distress to trauma reminders 5) Heightened physiological reactivity to trauma reminders
C. Avoidance	**1/2 symptoms required for a PTSD diagnosis** 1) Avoidance of distressing internal trauma reminders (e.g., thoughts, feelings, memories) 2) Avoidance of distressing external trauma reminders (people, activities, places)
D. Negative cognition and mood	**2/7 symptoms required for a PTSD diagnosis** 1) Inability to voluntarily recall key aspects of the trauma 2) Persistent, exaggerated negative beliefs about self, others, the world 3) Persistent, distorted trauma-related cognitions leading to inappropriate blame of self or others for the event 4) Persistent negative emotional state (e.g. fear, horror and anger) 5) Diminished interest in pleasurable activities

	6) Feeling alienated from others 7) Persistent inability to experience positive emotions
E. Hyperarousal	**2/6 symptoms required for a PTSD diagnosis** 1) Irritable or aggressive behaviour 2) Self-destructive or reckless behaviour 3) Hyper-vigilance 4) Exaggerated startle response 5) Problems with concentration 6) Sleep disturbances

Despite experiencing a traumatic event, not everyone will go on to develop ASD or PTSD. Approximately 10% of people will meet diagnostic criteria for ASD (Bryant, Creamer, O'Donnell, Silove, & MacFarlane, 2012), whereas lifetime prevalence rates for PTSD are estimated to be between 5–12% (Breslau et al., 1998; Kessler et al., 1995). Given that a small minority of people will go on to develop PTSD, a substantial amount of research has investigated factors which may increase one's vulnerability to PTSD (see Brewin et al., 2000 for a meta-analysis review of PTSD risk factors). The ways in which people process and think about the trauma (i.e., thoughts) are known to play an important role in the development of PTSD. Generally, such cognitive models of PTSD posit that dysfunctional appraisals/beliefs surrounding the trauma lead to PTSD (see Brewin & Holmes, 2003 for a review). However, this thesis concentrates on a unique aspect of cognition, named metacognition, which refers to thinking about thinking and focuses on the way that we relate to our own thoughts, as opposed to the content of the thoughts itself.

2.2. Intrusive Memories

Intrusive re-experiencing is a core clinical feature of PTSD. As outlined by Marks, Franklin, and Zoellner (2018), intrusive re-experiencing is an umbrella term that captures the ways in which memories for a previously experienced event can resurface. Terms such as flashbacks, autobiographical memories and intrusive memories all fall under this umbrella term (see Brewin, 2014 and Kvavilashvili, 2014, for a summary of how each my differ from one another). This thesis focuses on intrusive memories, which refer to spontaneous, vivid and often image-based recollections of the trauma, that *persistently* intrude into one's awareness (Brewin, Gregory, Lipton, & Burgess, 2010; James et al., 2016; Marks et al., 2018). They often include strong sensory information (e.g., most emotionally salient sounds) (Conway & Pleydell-Pearce, 2000; Ehlers, Hackmann, & Michael, 2004), for instance, in the form of visual images (e.g., image of a knife coming towards when being attacked). However, they can include other sensory impressions too, such as sounds, tastes and bodily sensations (Ehlers et al., 2004). The main distinction between intrusive memories and other types of trauma memory is that they are *involuntary*, meaning they come to mind without any deliberate retrieval attempt (Berntsen, 1996). Importantly, in the context of trauma, they tend to be experienced as being distressing and often disrupt one's current activities (Brewin et al., 2010). In previous versions of the DSM (i.e., DSM-IV-TR; APA, 1994), intrusive thoughts were also considered to be a re-experiencing symptom. However, the DSM-5 specifically regards intrusive memories (i.e., not intrusive thoughts) as a key symptom (APA, 2013). Accordingly, this thesis will focus on intrusive memories specifically (referred to as *intrusions* from hereon).

Following a traumatic event, it is common for individuals to experience intrusions, which will naturally abate over time (Iyadurai et al., 2019). However, it is

not just the frequency of these intrusions that is important in PTSD development. Both the persistence and the level of distress which the intrusions cause is what, arguably, makes them a hallmark symptom of PTSD (Iyadurai et al., 2019), as clinically, the frequency of intrusions does not predict the onset of psychopathology (Kleim, Ehlers, & Glucksman, 2007) (see Marks et al., 2018 for a systematic review of the predictors to the occurrence of intrusions).

Empirical research investigating the occurrence of intrusions has relied heavily on self-report data (see Chapter 4 Methods, for further information on how intrusions are assessed). In the context of analogue trauma, participants are typically asked to watch a trauma film and then monitor the occurrence of any intrusions they experience. This monitoring period may take place immediately after the film (i.e., within the lab setting), or it may be over a series of days, by recording the occurrence of intrusions via a diary (e.g., Holmes, Brewin, & Hennessy, 2004). Both methods assume that people have accurate awareness of the contents of their consciousness; however, findings from the "mind-wandering" literature indicate that people often fail to notice shifts in their attention and awareness (Smallwood & Schooler, 2006). Consequently, such diary methods, may underestimate the occurrence of intrusions. This issue has sparked investigation into whether individuals can fail to notice the occurrence of trauma-related intrusions. In other words, can individuals experience intrusions that lack meta-awareness? An emerging body of research from the mind-wandering literature would suggest so.

2.3. Meta-awareness

Meta-awareness refers to "the mental state that arises when attention is directed toward explicitly noting the current contents of consciousness" (Smallwood & Schooler, 2015, p. 495). The concept of meta-awareness has been applied to mind-

wandering, which refers to when a person's attention drifts away from their current train of thought (e.g., external task) to a new train of thought often generated from the individual (Smallwood & Schooler, 2015). Indeed, mind-wandering research demonstrates that people can lack meta-awareness that their mind has wondered elsewhere (i.e., off-task) (see Smallwood & Schooler, 2015). For instance, people can mind-wander off-task and notice themselves that they are mind-wandering—known as mind-wandering with awareness. Alternatively, it appears that people can also mind-wander without deliberate attempt. That is, people can often fail to notice that they are mind-wandering off-task—known as mind-wandering without awareness (see Smallwood & Schooler, 2015). Recently, the concept of mind-wandering with and without meta-awareness has been applied to thoughts about negative autobiographical events (Baird, Smallwood, Fishman, Mrazek, & Schooler, 2013) and analogue trauma (Green, Strange, Lindsay, & Takarangi, 2016; Takarangi, Strange, & Lindsay, 2014; Takarangi, Nayda, Strange, & Nixon, 2017). Doing so has helped to distinguish between the frequency with which people *report* intrusions, from the frequency with which they *experience* intrusions (Takarangi et al., 2014). In sum, there is a growing body of research demonstrating that people can often lack meta-awareness of their own trauma-related intrusions. Investigating meta-awareness of intrusions has strong implications for the ways in which trauma intrusions are assessed both clinically and within the lab, as these methods rely on people to accurately be aware and report the contents of their own consciousness.

Baird et al. (2013) demonstrated that people can lack meta-awareness of intrusions related to a negative autobiographical event (i.e., prior romantic relationship). Here, while taking part in an unrelated reading task, participants were asked to monitor the occurrence of intrusive thoughts about a prior relationship, while at the same time,

trying to suppress those thoughts. Using methods from the mind-wandering literature to assess meta-awareness, authors found that participants were frequently (i.e., 14–22% across the three experiments) “caught” experiencing intrusive thoughts about a prior relationship. That is, they were unaware that they were thinking about the prior relationship and were thus caught doing so.

Across two experiments, Takarangi et al. (2014) extended Baird et al.’s (2013) work to show that people can also experience analogue trauma intrusions that lack met-awareness. In Experiment 1, participants (*N* = 74) were asked to watch a trauma film (depicting a road-traffic accident), then immediately after, monitor the occurrence of any film intrusions they had during a reading task. Throughout the reading task, half of the participants were instructed to self-report, by pressing a key, when they noticed themselves experiencing an intrusion about the film. These intrusions were self-caught, and therefore they occurred with meta-awareness (i.e., participants would not have been able to self-capture them, without being meta-aware of them). The remaining participants were additionally exposed to intermittent thought-sampling probes (i.e., self-caught-plus-probes condition) that appeared on the computer screen. These participants were informed that they would experience probes throughout the reading task. The probes asked participants whether they were thinking about the film at that moment, just before the probe appeared on the screen (i.e., “Just now, were you thinking about the film?”). Participants were instructed to press the ‘Y’ key to respond “yes” or the ‘N’ key to respond “no”. Participants who received probes were caught having intrusions about the film 28.86% of the time. Participants self-caught a similar amount of intrusions, regardless of monitoring condition (self-caught only versus self-caught-plus-probes). Based on the probe-caught intrusion finding, this experiment

demonstrated that people can indeed lack meta-awareness for their own trauma-related cognition.

In Experiment 2, Takarangi et al. (2014) replicated the results from Experiment 1, and also showed that the presence of probes did not affect the frequency of probe-caught intrusions. Authors noted that in Experiment 1, it is possible that the presence of multiple probes throughout the monitoring period could lead participants to anticipate probes and thus artificially inflate awareness. This would potentially lead to an increase in the rate of self-caught intrusions, but a decrease in the rate of probe-caught intrusions. To address this, the authors added two new conditions in Experiment 2: a single unexpected probe presented either early (i.e., "single-probe-early") or late (i.e., "single-probe-late") on in the monitoring phase. Should multiple probes affect participants' responses to probes, then participants in the single-probe-late condition should less often report mind-wandering when probed, compared to multiple-probe participants (at the same time point). Similarly, if the presence of multiple probes increases the self-reporting of intrusions, then self-caught intrusions should be higher among the multiple-probe condition versus the single-probe-early/late conditions. Results showed that, like Experiment 1, participants self-caught similar rates of intrusions regardless of monitoring condition, demonstrating that neither the presence nor frequency of probes affected the reporting of intrusions. These two experiments demonstrated that people often lack meta-awareness for their own intrusions.

One limitation of Takarangi et al.'s (2014) experiments is that the probe-caught intrusions could have really been non-reported—but still meta-aware—continuations of a previous self-caught intrusion. If this was the case, then the rate of probe-caught intrusions described in Takarangi et al.'s (2014) experiments would be an overestimation of the true amount of meta-awareness failures (i.e., true probe-caught

intrusions). Green et al. (2016) examined this issue by modifying the probe instructions given to participants. That is, when the probe appeared on the screen, participants could respond by selecting an option stating that the film thought they had in mind was a previous continuation of a previously self-reported intrusion. Overall, participants were caught having intrusions about the film on 35.79% of the probes (rate comparable with Takarangi et al., 2014). Probe-caught film intrusions could then be broken down into either probe-caught thoughts that participants claimed they had previously reported (i.e., continuing-probe-caught thoughts) or "new" probe-caught thoughts. Continuing-probe-caught thoughts were reported on average 18.99% of the probes, and new ones 16.79%. This suggested that care is needed when assessing meta-awareness; as the rate of intrusions may be overestimated if using similar methods to Takarangi et al. (2014). However, and more importantly, it still demonstrates that a significant proportion of intrusions can occur without meta-awareness.

In sum, research shows that people can often lack meta-awareness of their own intrusions. This has strong implications for the ways in which trauma intrusions are assessed both clinically and within the lab, as these methods rely on people to accurately be aware and report the contents of their own consciousness. Second, it also raises the question as to whether intrusions that lack meta-awareness, in addition to meta-aware ones, may also play a key role in the maintenance of PTSD. This emerging line of research may have implications for cognitive models of PTSD and warrants further investigation.

2.4. Psychological Theories of PTSD

Several cognitive theories of PTSD exist, with each offering a different perspective on the ways in which PTSD can develop (see Brewin & Holmes, 2003 for a review). It is not within the scope of this thesis to fully detail them all; however, a brief

overview of two key influential theories will be outlined here, namely, the dual representation theory (DRT; Brewin, Dalgleish, & Joseph, 1996) and Ehlers and Clark's (2000) cognitive model of PTSD. These two cognitive theories have been selected, given the growing body of empirical support that they have each gained to date, and for the strong implications they hold for the psychological treatment of PTSD. Given the focus of this thesis, the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004) will be described in detail, alongside the empirical evidence that supports the model. Importantly, the ways in which the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004) differs from other cognitive theories (i.e., DRT; Brewin et al., 1996, and cognitive model of PTSD; Ehlers and Clark, 2000) will also be discussed.

2.4.1. Dual representation theory (DRT)

The DRT (Brewin et al., 1996) asserts that traumatic events are processed via two memory systems: a verbally accessible memory (VAM) system and a situationally accessible memory (SAM). These memory systems give rise to two distinct representations of the trauma and they work in parallel to one another. The VAM system contains oral or written narrative memories of a trauma, which have been integrated into existing autobiographical memories. Therefore, due to the higher-level conscious processing, VAM memories include rich contextual information about the past, present and future—all information that the individual consciously attended to both before, during and after the trauma. It is thought that due to the higher-level conscious processing, these memories enter long-term memory storage, where they can be deliberately retrieved at a later stage. In contrast, the SAM system contains sensory and image-based memories (i.e., sights, sounds, smells) that received insufficient conscious attention and thus failed to be recorded into the VAM system. Due to lower-level perceptual processing, these memories lack verbal and contextual information and

are thought to be poorly integrated into autobiographical memory. Consequently, these memories are difficult to deliberately retrieve, but are automatically accessed via exposure to cues and reminders about the trauma—which sparks the onset of intrusions. Brewin et al. (1996) propose that PTSD symptoms arise when there is a lack of balance between both VAM and SAM representations; that is, the trauma is being processed via the SAM system more than the VAM. This prevents detailed verbal representations from blocking automatic, unwanted SAM representations from intruding into one's awareness.

More recently, Brewin, Gregory, Lipton, and Burgess (2010) have updated the DRT to account for the recent developments in neuroscience to describe the underlying neural processes that are at play in the development of intrusions. In this revision, Brewin et al. (2010) propose that intrusions arise due to an imbalance between sensory-bound representations (S-reps) (previously referred to as SAMs) and contextual-representations (C-reps) (previously referred to as VAMS), during the encoding of the trauma. S-reps includes sensory details and affective/emotional information about trauma, whereas C-reps refer to the spatial/contextual information from the trauma. It is thought that in healthy memory, the S-rep and C-rep are tightly linked, meaning the S-rep is retrieved via its associated C-rep. The new terminology for C-reps outlines that verbal accessibility is not their only defining characteristic, and similarly with S-reps, here, this new terminology acknowledges that they play a role in healthy memory as well as being a defining feature among PTSD sufferers. This revised DRT model proposes that intrusions arise when: 1) the S-rep is strongly encoded due to its high emotional salience of the trauma and, 2) the C-rep is weakly encoded or encoded without a tight link its corresponding S-rep (possibly due to dissociation). In line with the DRT, recovery from PTSD involves the (re)association between the S-rep and its

corresponding C-rep, thus appropriately contextualising the sensory information about the trauma. This contextualising process is thought allow a person to recognise the difference between the context of the trauma memory and their current personal context and consequently, this is proposed to facilitate the integration of the trauma memory with other autobiographical knowledge; thus, promoting PTSD recovery.

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

Ehlers and Clark's (2000) cognitive model of PTSD (see Figure 1) is viewed as the most detailed account on the maintenance and treatment of PTSD (Brewin & Holmes, 2003). Ehlers and Clark (2000) propose that pathological responses following trauma develop when individuals process the trauma in a way which leads to a *current* sense of threat. This sense of threat may be external (i.e., threat to safety) or internal (e.g., threat to the view of the self and the future), and once activated, the threat drives the emergence of re-experiencing, arousal and anxiety symptoms and other emotional responses. Ehlers and Clark (2000) propose that two key mechanisms are responsible for driving the current sense of threat: 1) excessive negative appraisals of the trauma and/or its sequelae and; 2) the nature of the trauma memory.

Ehlers and Clark (2000) have identified a wide range of negative appraisals surrounding the trauma. These include negative appraisals about oneself and/or own actions during the trauma (e.g., "I am a bad person"; "I deserve bad things to happen to me"; "I could have done more"). Others refer to the sequelae; such as appraisals about one's PTSD symptoms (e.g., "intrusions mean I am losing control"), other people's reactions (e.g., "they think I am too weak to cope on my own"), other people (e.g., "people can't be trusted") and the world (e.g., "the world is a dangerous place"). It is thought that these appraisals, which can occur either during and/or following the trauma, heighten the sense of threat, maintain symptoms and lead to PTSD.

Clinically, those who go on to develop PTSD following a trauma are observed to have great difficulty in *intentionally* recalling the trauma, yet, at the same time, they report experiencing intrusions which spring to mind unbidden. Ehlers and Clark (2000) account for this phenomenon by proposing that PTSD develops as a result of the trauma memory being poorly elaborated and integrated into one's existing autobiographical memory. Typically, autobiographical events are organised into an autobiographical memory knowledge base through contextualising the event with existing autobiographical memory. However, according to Ehlers and Clark (2000), trauma memories are fundamentally different than other memories. Trauma memories are not given a complete context in time and place, and thus remain outside of autobiographical memory base—causing trauma memories to intrude into one's awareness more easily than other types of memories. It is thought that a number of peri-traumatic processes (e.g., dissociation) contribute to the faulty encoding of trauma memory, leading the trauma memory to be incomplete and fragmented, and consequently, difficult to voluntarily recall. Thus, a core component of cognitive-behavioural therapy (CBT) for PTSD—in line with this cognitive model—focuses on increasing the elaboration of the trauma memory, to help reintegrate it with other autobiographical memories. Another key premise to Ehlers and Clark's (2000) model, is that a current sense of threat may lead people to engage in several dysfunctional behavioural and cognitive strategies (e.g., thought suppression, rumination, avoidance) in attempt to manage the perceived threat. These strategies are intended to reduce the perceived threat in the short-term; however, they have the opposing effect, and only serve to perpetuate PTSD symptoms further by preventing cognitive change and the elaboration of trauma memories. In sum, Ehlers and Clark (2000) propose that recovery from PTSD involves changes in three key areas: 1) the trauma memory needs to be elaborated and integrated into an

individual's existing memory; 2) negative appraisals about the trauma and/or its sequelae need to be modified; and 3) dysfunctional behavioural/cognitive strategies that prevent memory elaboration and perpetuate PTSD symptoms need to be reduced.

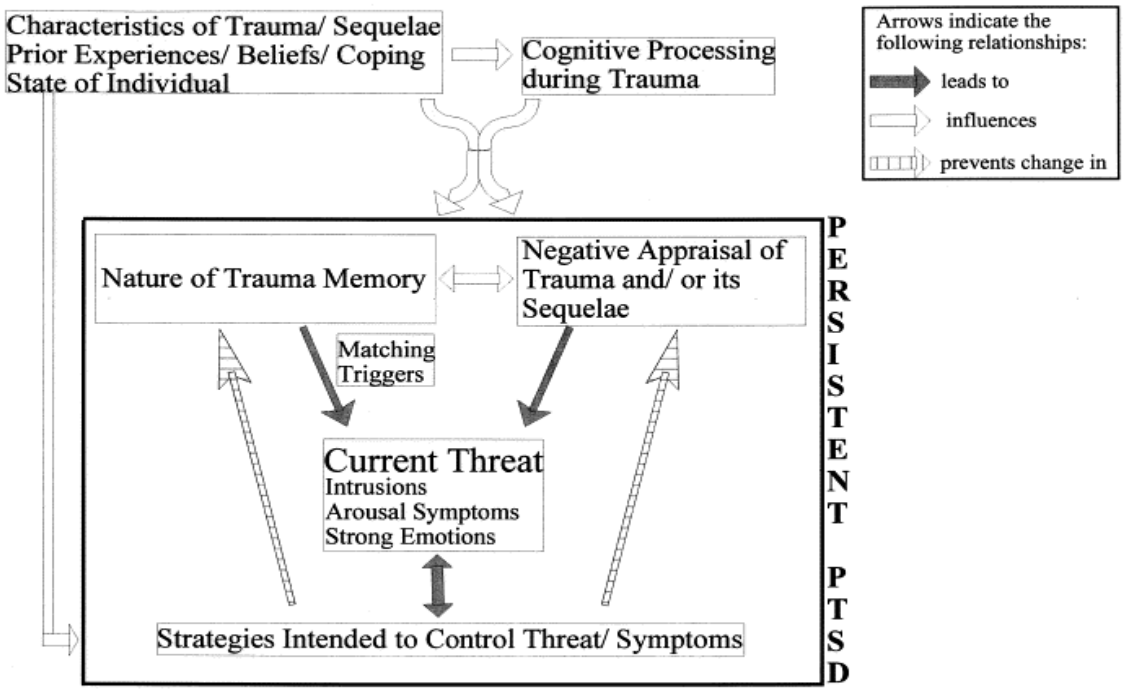


Figure 1 The cognitive model of PTSD (Ehlers & Clark, 2000)

A core component of these cognitive models is the nature of the trauma memory (see Brewin & Holmes, 2003). This is because of the paradoxical relationship that exists between an individual's voluntary memory of the trauma, and their involuntary memory (e.g., intrusions). Thus, in many ways, it can be argued that PTSD symptoms largely hinge on one's memory for the event. Both the DRT (Brewin et al., 1996) and Ehlers and Clark's (2000) cognitive model of PTSD described above, offer accounts as to why PTSD sufferers may experience intrusions. However, experimental research on autobiographical memory also offers another important perspective on the relationship between voluntary and involuntary memory within PTSD that is important to consider.

2.4.3. Involuntary and voluntary trauma memory

Within the PTSD literature, there exists two contrasting views regarding the nature of voluntary and involuntary memory within PTSD (see Rubin, Boals, & Berntsen, 2008 for a detailed account), often termed the "special versus basic mechanisms view". Both viewpoints emphasise the importance of trauma memory, and agree that, following a highly distressing event such as trauma, there should be an increase in the emotional intensity. However, they differ in their views on how trauma affects involuntary versus voluntary memory. Put simply, the special mechanisms view proposes that the increased emotional intensity of the trauma leads to poor encoding of voluntary memory, but enhanced involuntary memory; whereas the basic mechanisms view posits that increased emotional intensity from the trauma leads to enhanced encoding, and thus, increased availability of *both* voluntary and involuntary trauma memory (Rubin et al., 2008).

The special mechanisms view is held by several cognitive theories of PTSD (e.g., DRT; Brewin et al., 1996; Ehlers & Clark, 2000). This account stems from clinical research and proposes that a person's memory for a traumatic event is disorganised and fragmented due to faulty encoding processes. For instance, theories in line with this view suggest that peri-traumatic mechanisms, such as dissociation, may disrupt the encoding of the trauma (e.g., van der Kolk & Fishler, 1995), leading to the trauma memory being poorly elaborated into one's existing autobiographical memory. Consequently, it is proposed that the individual is likely to have *enhanced* involuntary memories of the event (i.e., intrusions), while at the same time, experiencing great difficulty in voluntarily recalling aspects of the trauma (e.g., Ehlers & Clark, 2000). This point is largely supported by clinical observations, despite there being little systematic support. On the other hand, the basic mechanisms view—derived from

experimental memory research—proposes that traumatic events are associated with enhancements (i.e., increased availability) in both voluntary and involuntary memory, and that it is the *availability* of the trauma memory which determines PTSD. That is, the more available the memory, the more PTSD symptoms (e.g., Hall & Berntsen, 2008; Rubin, Berntsen, & Bohni, 2008). Factors such as emotional arousal, intensity and valence are thought to increase the availability of the trauma memory, as well as how central the traumatic event is perceived to be to one's life story (see Berntsen & Rubin, 2006, 2007, 2008). In sum, one of the key differences between these viewpoints is on whether emotional stress (i.e., trauma) differentially effects involuntary versus voluntary memory, with the special mechanisms view claiming it does, and the basic mechanisms arguing that it does not.

Across the cognitive theories of PTSD outlined so far, the one thing they have in common is that they all emphasise—albeit in different ways—the importance of one's *memory* for a traumatic event. As intrusions are a hallmark feature of PTSD, it is understandable why analogue trauma studies have largely focused on measuring this form of involuntary memory. However, understanding how trauma affects one's *voluntary* memory for the trauma is also important; as it allows for a deeper understanding into how these two memory systems may be related. Cognitive theories posit that voluntary trauma memory is fragmented, incoherent and disorganised in its nature (e.g., Ehlers and Clark, 2000). Consequently, several studies have attempted to measure these types of memory characteristics, particularly among those who are exposed to a traumatic event and go on to develop PTSD (or ASD), compared to those who do not develop PTSD (or ASD).

2.4.4. Evidence for fragmented memories in PTSD

Data show that trauma memories are less coherent among individuals with greater symptoms (i.e., ASD/PTSD) compared to those without PTSD/ASD, using both objective and self-report measures (e.g., Amir, Stafford, Freshman, & Foa, 1998; Halligan, Michael, Clark, & Ehlers, 2003; Jones, Harvey, & Brewin, 2007). However, these studies lack a non-traumatic control memory for comparison; thus, it is unclear whether a lack of coherence or increased fragmentation, is evident across other non-trauma memories also. To address this, studies assessed for coherence/fragmentation across PTSD participants' trauma memories and other non-trauma memories. Indeed, research has found that a lack of coherence/increased fragmentation is demonstrated for both types of memories, suggesting that trauma memory is not special or unique in this way (e.g., Gray & Lombardo, 2001; Rubin, 2011). Interestingly, a recent study conducted by Bedard-Gilligan, Zoellner, and Feeny (2017) assessed trauma narrative changes among patients receiving trauma-focused treatment. In line with cognitive theories of PTSD (e.g., Ehlers & Clark, 2000), as a person recovers from PTSD and their symptomology reduces, their trauma narrative should become less fragmented/disorganised and become more coherent. However, this study showed no differences in fragmentation from pre and post-treatment between treatment modalities or response, indicating that fragmentation may not be a crucial mechanism in PTSD recovery; suggesting that other memory mechanisms may be at play.

2.4.5. Event memory details in trauma

Generally, there are mixed findings on the impact of emotion on one's memory for emotional events. Real-life studies show that emotional events are subjectively well remembered; however, lab-based studies report the opposite (see Oulton & Takarangi, 2017). Crucially, not all details of an emotional event are equally well-remembered. One relatively understudied area in voluntary trauma memory is that of event memory

details. Research examining specific details, as opposed to overall coherence/fragmentation qualities of trauma memory, tends to include the assessment of sensory details (e.g., sight, sounds, smells linked to the trauma) (e.g., Brewin et al., 2010), given their importance in cognitive models of PTSD (e.g., Brewin et al., 1996). In the eyewitness memory literature, research shows that memory for central details of an emotional event are better retained at the expense of peripheral details (see Christianson, 1992; Heuer & Reisberg, 1990). Central details refer to the most emotionally salient details of an event (e.g., victim, weapon, perpetrator), whereas peripheral details tend to refer to the background details (e.g., background scenery). High levels of arousal from an event have been found to enhance memory for central details and impair memory for peripheral details (Burke, Heuer, & Reisberg, 1992; Christianson & Loftus, 1991). Further, in a trauma analogue study, Brown, Joscelyne, Dorfman, Marmar, and Bryant (2012) randomly assigned participants to either a high or a low self-efficacy condition. Following the self-efficacy inductions, participants were asked to watch a trauma film and complete several follow-up measures (e.g., Impact of Event Scale; IES; Horowitz, Wilner, & Alvarez, 1979, to measure PTSD symptoms). Researchers were interested in whether enhancing self-efficacy *prior* to a stressful event would impact subsequent voluntary memory for the film; namely central and peripheral details. Results showed that participants in the low self-efficacy condition reported more central details compared to the high self-efficacy condition. Secondly, high self-efficacy participants reported fewer intrusions overall compared to the low self-efficacy group. These results suggest that that having lower self-efficacy prior to a distressing event, leads one to interpret that event as being *more* distressing. It also suggests that, low self-efficacy may lead one to preferentially encode central details of an event more than people with high self-efficacy.

In sum, assessing central and peripheral details of analogue trauma may be an interesting avenue for future trauma research. Focusing on what event memory details people remember may help shed light into the memory mechanisms behind cognitive processes/tasks thought to attenuate PTSD symptoms. A cognitive intervention, named cognitive bias modification (CBM) is used throughout this thesis to modify people's metacognitive beliefs and analogue PTSD symptoms. Throughout the upcoming thesis studies, participants were asked to freely recall what they can remember about a trauma film (i.e., analogue trauma) and their free memory recall was then coded for central and peripheral memory details. This research will uncover whether CBM training—designed to increase healthy metacognitive beliefs—leads to the heightened recall of certain memory details (central and peripheral) of a trauma film, compared to a control condition.

In this literature review thus far, key cognitive theories of PTSD have been outlined, as well as critical accounts explaining the relationship between voluntary versus involuntary trauma memory (i.e., special versus basic mechanisms). However, these cognitive theories are, arguably, limited because they fail to consider the role of metacognition—a specific type of cognition—which is thought to play a central role in the development of PTSD. Unlike previous cognitive theories (see Brewin & Holmes, 2003 for a review), which focus on an array of beliefs about the self, the traumatic event and others, the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004) focuses specifically on a person's *metacognitive* beliefs as being central to the development of PTSD.

2.5. Metacognition

Metacognition refers to thinking about thinking; cognition applied to cognition. Flavell (1979) defines metacognition as ones "knowledge and cognition about cognitive

phenomena" (p. 906) and according to Wells (2009), metacognition "monitors, controls and appraises the products and process of awareness" (p. 1). The role of metacognition has been implicated in the development of several psychological disorders, including PTSD (Wells & Mathews, 1994; Wells, 2000; Wells & Sembi, 2004). Unlike other cognitive models of PTSD (e.g., Ehlers & Clark, 2000), which view the content of thoughts/beliefs (e.g., about the self, the world, other people) as being central to the development of symptoms, the metacognitive model views metacognitive beliefs—the beliefs we have about our own thinking—as being chiefly responsible for the development of PTSD. Put simply, ordinary cognition focuses on the content of thoughts (i.e., what a person is thinking), whereas metacognition is more concerned with *how* a person thinks, that is, *how a person relates to their thoughts.* Two areas of metacognition, metacognitive knowledge and metacognitive strategies (Flavell, 1979, Wells, 2009) are central to this thesis and will be discussed in turn.

Metacognitive knowledge refers to the knowledge and beliefs people have about their own thinking—*that is, their metacognitive beliefs*. For example, a person with PTSD may hold beliefs that certain thoughts are harmful. Understandably, holding this type of belief will affect the way they respond to thoughts (e.g., attempt to control harmful thoughts). In line with metacognitive theory, there are two types of metacognitive knowledge (Wells & Mathews, 1994; Wells, 2000): explicit and implicit knowledge. Explicit knowledge refers to those beliefs that can be verbally expressed (e.g., "worrying is uncontrollable"; "worrying can cause a heart attack"; "if I focus on danger, I will avoid getting hurt"). Whereas, implicit knowledge refers to the rules that guide ones thinking, and unlike explicit knowledge, these cannot be verbally expressed (e.g., the allocation of attention) (Wells & Matthews, 1994). Additionally, there are two forms of metacognitive beliefs: positive and negative. Positive metacognitive beliefs are

linked to the *usefulness or advantages* of engaging in worry or other unhelpful coping strategies (e.g., “worrying helps me cope”), whereas negative metacognitive beliefs are concerned with the *importance, uncontrollability and dangerousness of thoughts* (e.g., “it is bad to think certain thoughts”). Metacognitive strategies can be defined as the responses one makes in attempt to control or change one’s thinking. These strategies can either aid the down-regulation of distress or amplify it. Metacognitive theory proposes that people suffering with psychological disorders experience a feeling of being out of control. Therefore, the metacognitive strategies typically implemented are ones that attempt to *control the nature of thinking* (e.g., suppressing unwanted thoughts or using worry as a coping strategy to deal with anxious thoughts). However, the problem with these strategies is that they serve to ultimately maintain psychological distress as opposed to reduce it. It is thought that metacognitive knowledge and metacognitive strategies are linked. That is, the strategies people use to respond/relate to their thoughts is dependent on the metacognitive knowledge (metacognitive beliefs) they endorse.

In sum, metacognitive theory proposes that psychological disorders develop because one’s metacognitive knowledge leads people to respond to their inner experiences in a way that *maintains* negative emotion and distress (Wells, 2009).

2.6. Metacognitive model of PTSD

The self-regulatory executive function model (S-REF) proposed by Wells and Matthews (1994) is a transdiagnostic model of psychological disorders. The S-REF model outlines the cognitive and metacognitive factors that are proposed to be involved in the top-down control or maintenance of psychological disorders (see Wells & Matthews, 1994, for a detailed account of the S-REF model). In sum, the S-REF model proposes that emotional suffering can be prolonged by the strategies that people use in

response to perceived threat. Thus, people will go on to develop psychological disorders when their style of thinking or coping *strengthens* emotional distress; a style of thinking named the cognitive attentional syndrome (CAS). The CAS is comprised of maladaptive coping strategies such as worry, rumination and threat monitoring that people employ in attempt to control and manage their distressing thoughts and feelings. The S-REF model acknowledges that people may have distressing and negative thoughts, *but it is the way in which people respond to these thoughts* (e.g., engaging in repetitive thinking styles such as worry/rumination) that prolongs distress and maintains symptoms. Put simply, this model suggests that the ways in which a person relates to their thoughts is more important than the actual content of their thoughts—an important distinction compared to other cognitive models of PTSD (e.g., Ehlers & Clark, 2000). The metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004) is based on the S-REF model and will now be explained in detail.

The metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004) (see Figure 2) views the occurrence of symptoms such as intrusions and increased arousal as normal responses in the aftermath of trauma, all which stem from an automatic, in-built, reflexive adaptation process (RAP). According to the model, the RAP is responsible for guiding our emotional processing and it is where plans are devised to help guide our thinking and coping. The RAP will run its course uninterrupted for most people. However, if people hold maladaptive metacognitive beliefs—as is proposed to be the case among those who go on to develop PTSD—then this will trigger the CAS, which disrupts the RAP. The CAS fuels the processing of threat. For instance, the use of worry about future threats maintains anxiety and rumination about the traumatic event leads to the preoccupation of the trauma memory. Further, the use of other unhelpful coping responses such as threat monitoring (e.g., hyper-vigilance) also maintain anxiety and

prevent cognition from re-tuning to a threat-free mode of processing. Wells and Sembi (2004) outline that the CAS is driven by one's metacognitive beliefs.

Metacognitive beliefs are central to the metacognitive model as they are thought to form the implicit plans that guide our thinking/coping. Metacognitive beliefs refer to the specific beliefs we have about our own thinking and cognition (e.g., "worrying helps me to cope"). Other cognitive models of PTSD (e.g., Ehlers & Clark, 2000) focus on *cognitive* beliefs/appraisals (e.g., "I am to blame"); which are different to metacognitive beliefs and instead focus more on the *content of the thought* rather than how one relates to their thoughts. For example, to aid PTSD recovery, the metacognitive approach would focus more on changing the way person relates to their thoughts (e.g., understanding that worry is an unhelpful coping strategy), thus changing their metacognitive beliefs. Whereas a pure cognitive approach (e.g., Ehlers & Clark, 2000) would focus more on tackling the content of a person's negative/dysfunctional appraisal/thought (e.g., via thought challenging/reality testing).

Two forms of maladaptive metacognitive beliefs are proposed; positive beliefs about the need to engage in aspects of the CAS and negative beliefs about importance or dangerousness of thoughts. Positive metacognitive beliefs relevant to PTSD include positive beliefs about worry (e.g., "worrying helps me cope"; "I must worry in order to be prepared") and rumination (e.g., "I must go over the event to make sense of it"). Whereas, negative metacognitive beliefs include beliefs about the uncontrollability/danger of thoughts (e.g., "my worrying is dangerous for me") and beliefs about the meaning of intrusions (e.g., "intrusions mean my life is ruined"). Further, a specific type of metacognition, named metamemory, refers to how people evaluate the contents of their trauma memory. Again, there are positive metamemory beliefs about the need to have a complete trauma memory (e.g., "I must have a complete

memory to feel normal") and negative beliefs about the consequences of not having a complete trauma memory ("gaps in my memory are preventing me from getting over it"). Metacognitive and metamemory beliefs are thought to drive perseveration, which is the persistent and repetitive thinking about the trauma, threat and one's own reaction to it. Perseveration can take shape in several cognitive and behavioural strategies (i.e., worry/rumination, threat monitoring, thought-control) and is maladaptive, as it only serves to strengthen and maintain perceptions of threat and blocks the RAP. In sum, the metacognitive model proposes that dysfunctional metacognitive beliefs, alongside poor coping strategies (i.e., avoidance; thought suppression) maintain a current sense of threat and perpetuate PTSD symptoms.

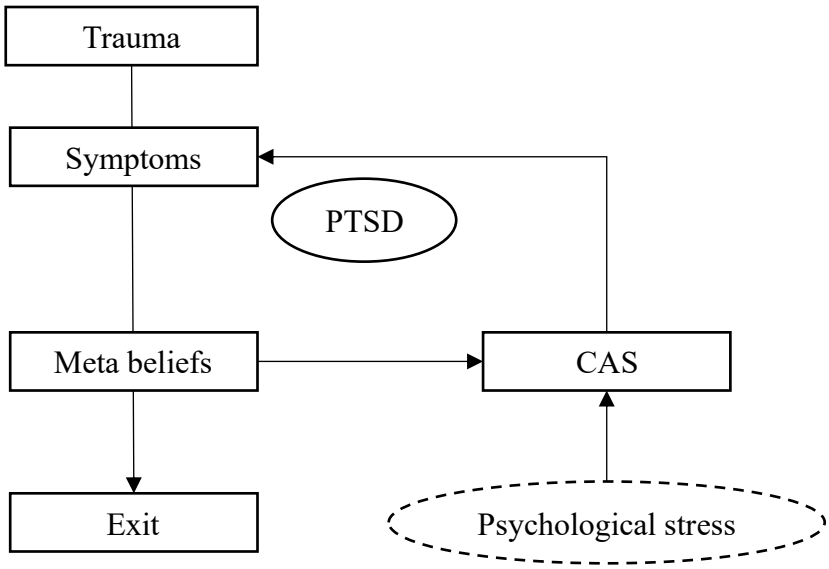


Figure 2 The metacognitive model of PTSD as cited in Wells (2009, p. 129).

Importantly, the metacognitive model differs from other cognitive models of PTSD (e.g., Ehlers & Clark, 2000), as it does not place special emphasis on the nature of the trauma memory as being responsible for the development of PTSD. For example, Ehlers and Clark's (2000) cognitive model of PTSD proposes that PTSD develops as a result of a disorganised/fragmented trauma memory—which lacks integration into one's

existing autobiographical memory. However, instead, the metacognitive model proposes that it is *how* people view the contents of their trauma memory, and *how* they engage with such thoughts (e.g., worry/ruminate about having gaps in their memory) that is crucial to PTSD development. That is, fragmented memory is only important when it becomes the focus of people's maladaptive thinking (Bennett & Wells, 2010). For instance, interpreting the fact that one has gaps in their memory for the trauma as a bad thing (e.g., "gaps mean that I did something wrong") (i.e., metamemory beliefs), could cause a person to become focused on the trauma by constantly checking their memory, ruminating over the event or even engaging in "gap-filling" (Wells, 2008). These dysfunctional strategies are thought to prevent the normal adaptation process and prolong symptoms, leading to PTSD. Thus, it is not the nature of the trauma memory that is thought to be responsible for symptom development, but *the beliefs one has about the need to have a complete memory/consequence of not having a complete memory* (i.e., metamemory beliefs). The theoretical insight regarding metacognitive beliefs is important for this thesis because metacognitive beliefs are thought to maintain the CAS, which is ultimately responsible for the development of PTSD—in line with metacognitive theory. To date, evidence for the metacognitive model of PTSD stems from: 1) clinical trial research comparing metacognitive therapy (MCT)—where metacognitive belief change is thought to play an integral part of recovery—to other gold standard treatments for PTSD (e.g., prolonged exposure); and 2) systematic research (e.g., experimental/correlational studies among healthy participant samples).

2.6.1. Evidence for the metacognitive model of PTSD

There is growing evidence demonstrating that MCT is an effective treatment for PTSD (see Normann & Morina, 2018 for a systematic review). For instance, a recent randomised controlled trial (RCT) compared MCT with prolonged exposure (PE) in

patients with chronic PTSD. Results showed that while both treatments proved effective at reducing self-reported PTSD symptoms compared to a waiting list control, treatment effects for PTSD were more rapid for MCT compared with PE (Wells, Walton, Lovell, & Proctor, 2015). This is consistent with an earlier controlled clinical trial assessing the efficacy of MCT for PTSD (e.g., Wells & Colbear, 2012). An RCT comparing MCT versus eye movement desensitisation reprocessing therapy (EMDR) for PTSD is currently underway (ClinicalTrials.gov, NCT01955590), further demonstrating the growing interest in metacognitive versus traditional, cognitive approaches for the treatment of PTSD.

Although valuable, these clinical trial studies provide limited knowledge as to how such treatments work, that is, the mechanisms behind MCT. As outlined by Holmes et al. (2018), focusing on the mechanisms of psychological treatments allows researchers to develop new methods to improve interventions, for example by targeting certain variables known to directly influence symptoms. Thus, experimental and correlational studies examining the role of maladaptive metacognitive coping strategies and/or metacognitive beliefs with the onset of stress symptoms (e.g., PTSD symptoms), have also demonstrated growing support for the metacognitive model of PTSD.

Wells and Papageorgiou (1995) found that experimentally induced worry and rumination about a distressing film lead to a greater number of intrusions. Here, researchers investigated post-event processing (e.g., worry) on the frequency of intrusions following a stressor (i.e., 8-minute silent colour film depicting a workshop accident). Following the film, participants (N = 70) would engage in a post-event processing task that lasted 4 minutes and were randomly allocated to a post-event processing group (14 per group): 1) control group (i.e., settled down); 2) imagery (i.e., imaged the film and its implications); 3) distraction (i.e., distraction task consisting of

letter cancellation); 4) usual worry (i.e., worried about thing's they usually worried about); and 5) film worry (i.e., worried about the film and its implications in verbal form). Following the film and post-event processing task, participants were given a diary to record any film intrusions they experienced over the next 3 days. Results showed that participants who used worry as a coping strategy to manage their thoughts about the film, reported significantly more intrusions over the next 3 days compared to the control condition. This finding suggests that the use of repetitive thinking styles such as worry, post-trauma, are maladaptive and lead to a greater reporting of PTSD symptoms; offering support for the metacognitive model.

Warda and Bryant (1998) investigated thought control strategies in motor vehicle accident survivors with (N = 20) and without (N = 20) ASD. Individuals with ASD were found to engage in punishment (e.g., "I punish myself for thinking the thought") and worry as thought control strategies, more than ASD accident survivors. Thus, engaging in repetitive thinking strategies such as worry, or strategies to try and control one's thoughts (e.g., punishment) are dysfunctional, and likely serve to perpetuate stress symptoms. These findings are consistent with the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004), which proposes that strategies such as worry and thought control form part of the CAS—the style of thinking/coping thought to be responsible for the development of PTSD following trauma exposure.

Roussis and Wells (2006) found that maladaptive metacognitive beliefs and coping strategies maintained stress symptoms. This cross-sectional study asked participants (student sample N = 171) to identify a recent significant stressor in their life (e.g., bereavement, health problems, relationship difficulties) and then complete several questionnaires assessing their metacognitive beliefs, thought control strategies and stress symptoms (linked to the stressor) that they experienced over the past 7-days (via

the IES). Negative metacognitive beliefs regarding the uncontrollability/danger of thoughts and using worry as a coping strategy, were both linked to increased stress symptoms—supporting previous research (Matthews, Hillyard, & Campbell, 1999). Similarly, Roussis and Wells (2008) also found that the use of worry as a coping strategy predicted PTSD symptoms, three months following a stressor. Here, participants (student sample N = 110) were assessed at two time points, one-week following exposure to a self-reported stressor (e.g., academic, relationship, health, financial difficulties) and again three months later. Overall, both studies (i.e., Roussis & Wells 2006, 2008) offer some support for the metacognitive model of PTSD, by highlighting the association between worry as a coping strategy and increased stress symptoms.

Importantly, the studies outlined so far appear offer more support for the metacognitive model as opposed to other cognitive models (e.g., Ehlers & Clark, 2000), as they highlight the detrimental role of negative repetitive thinking strategies (e.g., worry and rumination—i.e., CAS) and metacognitive beliefs in maintaining stress symptoms. That is, the way a person *relates to their thoughts (metacognitive beliefs)*, as opposed to the content of their thoughts alone, plays an important role in the development of symptoms. Take the following example: two people go through the exact same trauma and have the exact same negative appraisals (e.g., “it was my fault” “I could have done more”). However, only one goes on to develop PTSD, and the other does not. How so? According to other cognitive models (Ehlers & Clark, 2000), *both* of these individuals are likely to go on to develop PTSD, because they are both endorsing dysfunctional trauma appraisals which are thought to maintain a current sense of threat and lead to PTSD. However, the metacognitive model of PTSD offers and explanation for this outcome; proposing that the one who does go on to develop PTSD, does so,

because of the way they are relating to their thoughts. That is, they are engaging in excessive negative thinking styles (e.g., worrying about future threat, ruminating over what happened) and/or attending to danger in their environment, which ultimately locks them into a current sense of threat, strengthening their negative emotional processing of the trauma and leading to PTSD. Thus, metacognitive beliefs are proposed to be the mechanism at play here, and not the type of thought/appraisal they have (as would be explained by Ehlers & Clark, 2000). Notably, Ehlers and Clark (2000) do identify rumination as being as maladaptive coping response following trauma, and one that will heighten PTSD risk; however, they do not explain how, and do not identify metacognitive beliefs as playing a central role.

Bennett and Wells (2010) were the first to demonstrate that people's beliefs about their trauma memory—but not memory disorganisation for the trauma narrative—predicted PTSD symptoms. In this study, student nurses and midwives (N = 95) narrated their most distressing placement-related memory that they had experienced and completed several questionnaires including the Beliefs about Memory Questionnaire (BAMQ; Bennett & Wells, 2010). Additionally, each distressing narrative was objectively assessed for memory disorganisation qualities using Foa, Molnar, & Cashman's (1995) memory disorganisation coding template. Positive and negative metamemory beliefs, along with negative beliefs about the uncontrollability/danger of thoughts, rumination and the need to control thoughts, all had a significant positive correlation with PTSD symptoms. Specifically, negative metamemory beliefs (e.g., "having gaps in my memory means I am not normal") were better at predicting PTSD symptoms than an objective memory disorganisation measure. In terms of theory, this study tells us that the way people evaluate the contents of their trauma memory plays a fundamental role in the development of PTSD symptoms. This has clinical implications

for the treatment of PTSD. Namely, efforts to modify people's metamemory beliefs about the trauma event may be more important for reducing symptoms than the use of memory elaboration techniques commonly advocated in cognitive models of PTSD (e.g., Ehlers and Clark, 2000).

Cook et al. (2015) found that, within individuals recently diagnosed with cancer, endorsing maladaptive metacognitive beliefs predicted PTSD symptoms. Participants (*N* = 229) completed several self-report questionnaires assessing their emotional distress in relation to their diagnosis, their level of worry and their metacognitive beliefs. Specifically, two types of metacognitive beliefs about worry were assessed; positive beliefs about the need to engage in worry (e.g., "worrying helps me to cope") and negative beliefs about the danger or uncontrollability of worry (e.g., "my worrying is dangerous for me"), and their association with emotional distress. Regression analysis showed that metacognitive beliefs predicted PTSD symptoms, with negative metacognitive beliefs specifically making the biggest contribution. Structural equation modelling showed direct effects between negative metacognitive beliefs and PTSD symptoms, but not from positive metacognitive beliefs. Similar results were reported more recently by Fisher et al. (2018) who investigated the link between metacognitive beliefs and emotional distress in a sample of adolescent and young adult survivors of cancer. Again, metacognitive beliefs were positively correlated with PTSD symptoms, with *negative* metacognitive beliefs demonstrating the strongest association with PTSD. Collectively, these results suggest that modifying maladaptive metacognitive beliefs is key to reducing one's vulnerability to developing PTSD in response to traumatic events.

More recently, Takarangi, Smith et al. (2017) outlined the detrimental role of pre-existing maladaptive metacognitive beliefs (i.e., *pre-trauma)* in the development and maintenance of PTSD symptoms. In this study, participants' (*N* = 664) pre-existing

trauma-related cognition (Post-traumatic Cognitions Inventory; PTCI; Foa et al., 1999), metacognitive and metamemory beliefs, PTSD symptoms (PTSD Checklist; PCL; Weathers, Litz, Herman, Huska, & Keane, 1993) and trauma history were all measured at baseline (i.e., Time 1). As the PTCI, metacognitive/metamemory belief scales are usually tied to a specific event, participants completed these scales at baseline in relation to their worst nominated life event (identified in the trauma history questionnaire). 12-weeks later, participants (final sample *n* = 300) were contacted again and asked to complete the same measures once more, only now in relation to a new traumatic event that had may have experienced within the 12-week period (i.e., Time 2). Similar to previous studies (e.g., Frazier et al., 2009), the majority of participants had reported experiencing at least one traumatic event within their lifetime at baseline (*n* = 633). Further, at Time 2, 107 participants reported experiencing a new traumatic event within the 12-week period. The main results showed that pre-existing metacognitive beliefs about the uncontrollability/danger of thoughts (e.g., "when I start worrying, I cannot stop") and negative inferences about the meaning of intrusions (e.g., "my life is ruined") independently predicted PTSD symptoms in relation to a novel trauma. This result was the first to demonstrate how pre-existing maladaptive metacognitive beliefs can increase vulnerability to PTSD, following trauma exposure.

Next, Takarangi, Smith et al. (2017) assessed whether maladaptive metacognition would *maintain* PTSD symptoms. To determine this, only participants whose symptoms were classified as persistent (i.e., elevated PCL scores > 44 at Time 1 and Time 2) or recovered (i.e., participants who had elevated scores at Time 1, but not at Time 2) (*n* = 78) were included in the analysis. Result showed that negative metamemory beliefs and negative inferences about the meaning of intrusions significantly predicted the persistence of PTSD symptoms. This demonstrates that

maladaptive metacognitive beliefs can not only predict an individual's risk of developing PTSD, but they can also maintain symptoms over time. This prospective study was the first to pinpoint the detrimental role of pre-existing maladaptive beliefs in the development of PTSD in response to a new trauma and suggests that targeting and retraining individuals to adopt healthier metacognitive beliefs may be a crucial preventative measure to guard against PTSD following trauma exposure.

Capobianco, Morrison, and Wells (2018) demonstrated the causal role of negative metacognitive beliefs (i.e., metacognitive beliefs of thought importance) in stress recovery, specifically affect. Here, negative metacognitive beliefs were manipulated using a fake electroencephalography (EEG) paradigm used by Myers and Wells (2013) along with the Trier Social Stress Test (TSST: Kirschbaum, Pirke, & Helhammer, 1993). Seventy-five students were randomly allocated to either the experimental condition (negative metacognitive belief manipulation) or the control condition (no manipulation). Participants were told that they would complete a stressful task while their brain-wave activity was measured via EEG. After being fitted with EEG electrodes, participants were shown a pre-recorded film of real EEG waves. They were told that the EEG waves visible in the film were their own brain waves being detected; however, in fact, the EEG was not turned on and the film was not showing their brain wave activity, but just a pre-recorded film. Participants received different instructions dependant on the condition they were assigned to. In both conditions, participants were instructed that the EEG measures their mental reactions to negative thoughts. However, in the experimental condition, in addition to this, participants were told that when these reactions have been detected, a loud noise may be played. In the control condition, participants were told that the loud noise might be played at random (i.e., not in response to the detection of mental reactions to negative thoughts). While fitted with

EEG, participants took part in a stressful task (i.e., a recorded oral presentation reviewed by a panel of judges and a 5-minute mental arithmetic task while the experimenter gave negative feedback). Following the stress induction participants rated their mood once more. Results showed group differences in self-report measures of positive and negative affect, with participants in the negative metacognitive belief experimental condition reporting greater levels of negative affect and lower levels of positive affect than the control condition. Overall, these results offer some support for the metacognitive model, and add to the literature showing that metacognitive beliefs affect positive and negative affect reactions following stress exposure.

In sum, the metacognitive model of PTSD (Well, 2000; Wells & Sembi, 2004) outlines that metacognitive beliefs are a central determinant in the development of PTSD. To date, there is growing evidence for the role of metacognitive beliefs in the development of PTSD. Specifically, research highlights the *positiv*e association between maladaptive metacognitive beliefs and coping strategies on the development of stress symptoms. In the context of trauma, these findings indicate that targeting maladaptive metacognitive beliefs may help reduce individuals' vulnerability to PTSD following exposure to trauma. However, questions remain; as it is unclear whether metacognitive beliefs play a *causal* role in PTSD. This thesis aims to target people's metacognitive beliefs and test whether they play a *causal* role in the development of PTSD symptoms.

CHAPTER 3: COGNITIVE BIAS MODIFICATION LITERATURE REVIEW

Cognitive models of anxiety propose that anxiety arises due to maladaptive patterns of selective information processing, known as cognitive biases (see MacLeod & Mathews, 2012). In brief, cognitive bias refers to the tendency of people to systematically process information in a way that favours one type of information over another, and these biases are thought to play a causal role in people's vulnerability to anxiety. Several types of cognitive biases exist; however, this thesis will focus on one type called interpretation bias, which has gathered a strong evidence base among cognitive models of anxiety. Interpretation bias refers to the tendency of a person to interpret ambiguous information in one particular way. For instance, people with anxiety may interpret ambiguous information in a negative fashion (Richards, 2004). Thus, cognitive biases can play a damaging role in people's day-to-day life, casting a negative spin on the situations that one experiences and exacerbating anxiety symptoms. To examine these biases experimentally, researchers have developed a procedure known as cognitive bias modification (CBM) to directly manipulate cognitive biases and assess their effect on anxiety/stress vulnerability. This thesis will focus specifically on the research and methods behind CBM for interpretation bias (CBM-I).

3.1. Cognitive Bias Modification (CBM)

CBM refers to the direct manipulation of a cognitive bias by exposing people to tasks that favour one predetermined way of processing information (MacLeod & Mathews, 2012). Put simply, CBM-I trains people to adopt specific way of interpreting information, to ascertain whether such biases are characteristic of heightened anxiety vulnerability. Typically, CBM-I adopts a computerised training protocol to systematically guide people to respond to information in a certain way. CBM-I involves people being exposed to several trials of ambiguous information, after which, participants are then required to respond to and resolve the ambiguity in a

predetermined way (usually either positively or negatively). Mathews and Mackintosh (2000) developed a CBM-I training procedure, which involved trials of textual descriptions of an ambiguous situation, for example, “your partner asks you to go to an anniversary dinner that their company is holding. You have not met any of their colleagues before. Getting ready to go, you think that the new people you will meet will find you ____” (friendly/boring). Next, participants were required to complete the final word fragment to resolve the ambiguity, and thus provide a meaningful ending to the sentence. The study included two CBM-I conditions, one that trained people to interpret information in a negative way and thus only yielded word fragments that were consistent with a negative interpretation (e.g., word fragment “bo---g”, resolved as boring), and a positive condition, that trained people to adopt positive interpretations of the word fragment (e.g., word fragment “fri----y”, resolved as friendly). After participants completed over 100 trials in this manner, their interpretation bias towards new ambiguous situations was assessed via Eysenck, Mogg, May, & Richard’s (1991) recognition procedure. Results across five studies demonstrated that participants had adopted an interpretation bias consistent with the training protocol they received, thus demonstrating that people’s interpretation biases can successfully be manipulated in the lab and consequently affect the way people then process novel information.

Research employing CBM techniques has grown exponentially over the last two decades. As outlined by MacLeod and Mathews (2012), CBM research has three key objectives: 1) to determine the causal role of a cognitive bias; 2) to evaluate the therapeutic benefits of CBM; and 3) to explore the nature of cognitive bias mechanisms. As several cognitive models highlight the role of dysfunctional thinking patterns in the development of anxiety, it is perhaps unsurprising that CBM has proven to be a highly useful tool assess to the causal role of these thinking habits. More recently, researchers

have extended the CBM-I training procedure to target dysfunctional appraisals known to play a key role in the onset and development of psychological disorders such as depression and PTSD.

Cognitive models of PTSD (e.g., Ehlers & Clark, 2000) propose that people who go on to develop PTSD do so because of the dysfunctional appraisals they hold in relation to the trauma (see Chapter 2). In brief, it is thought that these dysfunctional appraisals maintain a current sense of threat, thus maintaining their symptoms and leading to the development of PTSD. Targeting and modifying such dysfunctional appraisals is thus of high clinical importance. Consequently, CBM training to target dysfunctional appraisals (known as CBM-App from hereon), has been developed and used to successfully modify participants' appraisals. For instance, Lang, Moulds, and Holmes (2009) developed a new CBM-App training protocol to target dysfunctional appraisals about the meaning of depressive intrusions. Participants were randomly allocated to either a positive (i.e., trained to adopt positive appraisals of depressive intrusions, e.g., "intrusive memories mean that I am coping well") or negative CBM condition (i.e., trained to adopt negative appraisals of depressive intrusions, such as "intrusive memories mean that I am coping badly"). After completing the CBM training, participants were asked to watch a depressing film (i.e., to induce depressive intrusions) and were asked to keep track of any intrusions they had experienced in relation to the film, over the following week via an intrusion diary. One-week later, participants returned to the lab and completed follow-up measures including the IES (to assess PTSD symptoms in relation to the film). Participants who received the positive CBM training demonstrated a positive appraisal bias immediately following the training and reported fewer film intrusions and lower IES scores at one-week follow-up, compared to the negative CBM condition. These results offer evidence for the causal

role of dysfunctional intrusion appraisals in the development of depressive intrusions and provide support for the use of CBM-App to successfully target appraisals. These results have sparked research into the efficacy of CBM-App training to modify trauma-related appraisals associated with the development of PTSD symptoms (e.g., Woud, Holmes, Postma, Dalgleish, & Mackintosh, 2012).

3.1.1. CBM in PTSD

There is now a growing body of evidence for the role of cognitive biases in PTSD. To date, seven published studies exist for the use of CBM-I/CBM-App in PTSD research (see Woud, Verwoerd, & Krans, 2017 for a review).

The first is a series of four studies conducted by Schartau, Dalgleish, and Dunn (2009), who trained participants to adopt functional appraisals centred around four main themes: 1) every cloud has a silver lining (i.e., the idea that just because you experience a negative event, does not mean everything about it is negative; 2) broader perspective (i.e., the idea that there are still positive aspects to life, even when you experience a negative event); 3) time heals (i.e., the idea that things will appear better once the acute distress from a negative experience passes); and 4) bad thing (i.e., the idea that it is best to sometimes accept negative events that occur). The studies utilised the trauma film paradigm (Studies 1–3) and autobiographical memory (Study 4) to determine the efficacy of the reappraisal training. Overall, the results showed that training individuals, via CBM, to adopt functional appraisal styles helped to reduce emotional reactivity related to negative distressing events.

The second study, conducted by Woud et al. (2012) (N = 74), used a CBM-App procedure to target self-efficacy appraisals. Woud et al. (2012) developed a new CBM training protocol that targeted and modified negative self-efficacy appraisals associated with the development of PTSD (e.g., “the event happened to me because of the sort of

person I am”). This stemmed from the prospective work by Bryant and Guthrie (2005, 2007) who assessed trainee fire fighters’ appraisals about the self, world and self-blame (PTCI; Foa et al., 1999) both pre-trauma exposure and at follow-up four years later. Bryant and Guthrie (2005, 2007) found that pre-trauma appraisals related to the self (e.g., “the event happened because of the way I acted”), rather than negative appraisals about the world (e.g., “the world is a dangerous place”) predicted later PTSD. These results suggest that targeting negative self-efficacy appraisals either before or immediately after trauma exposure may help guard against the development of PTSD. CBM training offers a novel approach to modifying unhelpful thinking styles, thus it has promising potential to be used as a tool to manipulate beliefs or thinking styles within experimental research.

Woud et al.’s (2012) CBM-App training targeted self-efficacy appraisals and was comprised of a series of scripted vignettes that appeared to participants as a sentence completion task. In line with previous CBM studies (see MacLeod & Mathews, 2012), participants were not explicitly made aware of the training contingency. Woud et al. (2012) had two training conditions, a positive CBM-App (i.e., trained participants to adopt a positive appraisal style) and a negative CBM-App (i.e., trained participants to adopt a negative appraisal style). Each vignette ended in an incomplete word-fragment, which, when resolved by participants, would be consistent with either a positive or negative reappraisal style (dependant on the training condition they were assigned to). All word fragments were designed so that only one possible solution would complete the word fragment. The training sentences were developed based on items from the PTCI (Foa et al., 1999) (e.g., “If I think about the event, I will not be able to handle it”). An example training sentence is “In a crisis I predict my

responses will be h-lpf-l/u-el-ss" (resolved as helpful in the positive condition and useless in the negative condition).

A total of 72 training sentences were created, and to encourage thorough processing of the sentences, comprehension questions that required either a yes or no response, were included throughout (e.g., "do you believe you will be able to respond in a useful way when there is a crisis"). Yes/No responses occurred equally often, and error feedback messages were displayed for incorrect responses. For each trial sequence, participants firstly read the sentence without the missing word fragment. They then pressed the advance key to move to the next stage, where the word fragment was displayed. Participants were instructed to resolve the word fragment by typing the first missing letter from the word as quickly as possible. Then the completed word was displayed on the screen and either the next training sentence was displayed, or a comprehension question. Similar to previous CBM training studies, Woud et al. (2012) used a two-phase procedure to determine induced reappraisal bias. This included an encoding phase followed by a recognition phase (see Mathews & Mackintosh, 2000). The encoding phase randomly presented participants with 10 novel ambiguous sentences related to items on the PTCI. Importantly, each of these novel sentences was introduced with a distinctive title, and always remained ambiguous. After participants read each of the sentences, they were asked to imagine themselves vividly in the situation using a 10-point scale. Immediately following the encoding phase came the recognition phase. Here, the original 10 encoding phase sentence titles were presented, followed by four statements. Out of these four statements, one represented a positive interpretation of the original sentence (positive target) and one represented a negative interpretation (negative target). The remaining two acted as foil items; that is, they had a general positive/negative meaning, but they did not actually resolve the ambiguity. To

determine induced bias, the data were converted to obtain an index bias score, which was achieved by subtracting the mean ratings of the negative targets from the positive targets.

Woud et al. (2012) assessed the efficacy of the CBM-app training using the trauma film paradigm, whereby participants were asked to watch a 20-minute distressing film, comprised of 1–3 minute clips which have previously been used to elicit acute distress in healthy participants (see Holmes & Bourne, 2008; James et al., 2016). Following the film, participants were randomly assigned to a CBM training condition (positive versus negative). The procedure for the study was as follows: in session 1, participants firstly completed several self-report measures (i.e., trauma history, depression and anxiety). Next, participants watch the film alone in a darkened room. After the film, they completed the CBM-App training (either positive or negative) and immediately after, completed the encoding and recognition task to measure induced bias. Session 1 ended with participants being given an intrusion diary to complete, which involved participants keeping a diary of any film-related intrusions they experienced over the following 7-days. Session 2 occurred one-week later, where participants handed in their intrusion diaries and completed several follow-up self–report questionnaires, including the PTCI and Impact of Event Scale–Revised (IES–R; Weiss & Marmar, 1997) (to assess analogue PTSD symptoms).

The study assessed, firstly, whether the CBM-App would induce reappraisals congruent with the training condition, and secondly whether the positive CBM condition would lead to fewer intrusions and PTSD symptoms over one-week, compared to the negative CBM condition. As predicted, CBM-app training successfully modified appraisal styles congruent to the training participants received as measured via the index bias score, and via the PTCI scores (i.e., the positive CBM group

demonstrated significantly lower PTCI scores both post-training and at one-week follow-up compared to baseline). Secondly, and more importantly, results demonstrated that participants who received the positive training also reported significantly fewer intrusions over the week and lower scores on IES-R compared to the negative group. Indicating that training individuals to adopt healthy appraisals immediately following a stressful event, may help mitigate against the development of PTSD symptoms.

Due to the promising findings from Woud et al. (2012), Woud, Postma, Holmes, & Mackintosh (2013) conducted another study using the CBM-App, to investigate whether delivering the CBM-App training *prior* to analogue trauma, also lead to fewer PTSD symptoms. Using the exact same CBM training groups as outlined in Woud et al. (2012), Woud et al. (2013) instructed participants (N = 47) to complete the CBM-App training first, then watch the distressing film. Participants then completed follow-up measures and were instructed to keep a 7-day diary recording the frequency and distress associated with any intrusions they experienced. Although, no significant training group differences were found for the frequency of intrusions, participants who received the positive training, compared to the negative, reported less distress associated with their intrusions. When analysing changes in the PTCI, results showed a significant CBM group x time interaction effect. Post-hoc analyses revealed that the positive CBM group demonstrated a healthier PTCI score (i.e., lower scores) when comparing baseline to one-week follow-up. However, no improvement in PTCI scores was found between baseline and post-training assessment. These results offer support for Woud et al.'s (2012) previous findings, suggesting that training people to adopt positive self-efficacy appraisals, prior to analogue trauma, can help to reduce PTSD development—namely, intrusion distress.

More recently, Woud, Cwick et al. (2018) extended their previous work (i.e., Woud et al., 2012; 2013) by examining whether sleep—due to its memory consolidation effects (e.g., Wagner, Gais, & Born, 2001)—could enhance the effects of CBM-App training. One-hundred and five participants watched a trauma film and were randomly allocated to a CBM training group; positive or negative. After that, within each CBM group, half of the participants had a 90-minute nap and the other half were asked to watch a neutral film (i.e., to stay awake). CBM appraisals were measured both before and after the sleep/wake manipulation and participants were instructed to keep a 7-day diary to record the occurrence of any intrusions. This study replicated previous findings, demonstrating that the CBM training induced training congruent appraisals. However, sleep did not appear to enhance the efficacy of the CBM training. Interestingly, results found a main effect for sleep/wake group, showing that overall, participants who slept reported fewer intrusions compared to those who watched the neutral film. Thus, this study also highlighted an important factor, sleep, which may help to prevent the development of intrusions post-trauma.

So far, the three studies by Woud and colleagues (2012; 2013; Woud, Cwik et al., 2018) demonstrate that CBM-App training can reduce PTSD symptoms associated with analogue trauma. However, one unanswered and important clinical question is whether CBM-App training can also reduce PTSD symptoms associated with a personally experienced negative event (i.e., negative autobiographical memory). Although the trauma film paradigm is a reliable method to investigate analogue PTSD symptoms (James et al., 2016), it does have limitations. The main being that it is an analogue trauma, meaning that watching a trauma film is unlikely to evoke the same sense of distress and threat that is associated with real-life trauma. These are all important factors which ultimately limit the external validity of the trauma film

paradigm. Alternatively, utilising a person's distressing autobiographical memory event to act as an analogue trauma may help to address some of the trauma-film limitations. Assessing the efficacy of CBM-App training on distressing autobiographical events, that arguably hold greater emotional intensity and personal relevance compared to witnessing simulated trauma happen to others (trauma film), allows for greater generalisability of CBM-App in the context of real-world psychological trauma. Woud, Zlomuzica et al. (2018) extended previous work in two ways: 1) by using autobiographical memory recall of a distressing event, as opposed to the trauma film, to represent analogue trauma; and 2) by measuring implicit appraisals. Typically, appraisals are measured explicitly via self-report questionnaires. However, Woud, Zlomuzica et al. (2018) argue that dysfunctional appraisals may be activated on an automatic level—meaning that individuals may lack awareness of any triggers for their dysfunctional appraisals. Thus, implicit appraisals were measured via the Implicit Association Task (IAT; Greenwald, McGhee, & Schwartz, 1998), which is thought to capture implicit appraisals by assessing the strength of associations between concepts (e.g., race) and evaluations/stereotypes (e.g., good, bad, athletic etc.). The notion behind IAT is that making a response is easier when closely related items share the same response key; thus, faster reaction times during a specific target-attribute indicate a strong association between the two.

The procedure was as follows; healthy participants (N = 65) who reported experiencing a distressing or traumatic life event were selected for the study. These participants were instructed to describe a maximum of three negative events they had experienced, and to detail their age at the time of each event. Next, participants rated each event for the distress they felt at the time and the distress they experienced right then in the moment for the events, using an 11-point scale (0 = *not at all distressing* to

100 = *very distressing*). Additionally, for each event, participants stated how frequently they thought about or appraised the event using a 6-point scale (0 = *not appraised at all*, to 5 = *everyday*) and completed the Posttraumatic Stress Disorder Checklist for DSM 5 (PCL-5; German version Krüger Gottschalk et al., 2017). The autobiographical event that received the highest rating for current distress was selected for the session. Next, participants' autobiographical memories were re-activated at three time points during the session, the first being pre CBM-App training. Based on previous studies using reactivation of autobiographical memories (Santa Maria, Reichert, Hummel, & Ehring, 2012), participants were instructed to "think back on the negative life event and provide a brief written description of that moment for 30 seconds" (Woud, Zlomuzica et al., 2018, p. 28). They were told to "close their eyes and to imagine the moment as vividly as possible, as if they were experiencing again, with all the associated images and emotions" (Woud, Zlomuzica et al., 2018, p. 28). Participants completed several questionnaires, the pre-training ERT and the CBM-App training (in reference to the negative event) and the post-training ERT. After this came the second reactivation of the negative life event. Here, instead of writing down a summary of the negative event, they were required to read over the summary they had previously written (i.e., pre CBM-App) and then imagine the event once more for 30 seconds alongside several questionnaires. Session 1 ended with all participants being given instructions on how to complete the 7-day intrusion diary. One-week later, participants returned to the lab to hand in their intrusion diaries and completed the PTCI (4) and the PCL to measure PTSD symptoms over the past 7-days.

Although there were mixed findings, the results generally supported Woud, Zlomuzica et al.'s (2018) predictions, that CBM-App training can modify PTSD symptoms connected with an autobiographical event. The main results showed that

participants who received the positive training reported more functional appraisals post-training, whereas the negative grouped showed no improvement in appraisals pre-to-post-training. Analysing between group differences post-training and at one-week follow-up, revealed no significant difference in PTCI scores. No significant training group differences for the frequency of intrusions, although there were significant differences between intrusion distress ratings. That is, participants who received the positive training reported less distress associated with their intrusions compared to the negative training group. Further, participants who received the positive CBM training reported fewer PTSD symptoms (PCL) compared to the negative training group. Lastly, contrary to prediction, IAT analysis revealed no significant differences over time between the two training groups for automatic trauma associations. This suggests that implicit appraisals measured via the IAT were not affected by the CBM training. Generally, these results support previous findings (e.g., Woud et al., 2012), demonstrating that appraisals have a causal effect on PTSD symptoms and that CBM-App training can successfully be used as a tool to manipulate trauma-related appraisals.

To date, one study has tested out CBM-App training using a clinical sample. De Kleine et al. (2019) assessed whether an adapted version of Woud et al.'s (2012) CBM-App training could also decrease dysfunctional appraisal style and reduce PTSD symptoms, among a chronic PTSD sample, compared to a control group. Participants were randomly allocated to either the CBM-App active (positive) condition (i.e., to train people to adopt healthy appraisals; n = 49) or the control condition (n = 57). Participants completed four sessions of CBM training online within one week, and here the active CBM-App condition was comprised of 40 training vignettes, as opposed to 72 in Woud et al. (2012). Participants' appraisal bias was measured at baseline, and immediately prior to and after each training session, as well as at post-training (1-week after) and

follow-up sessions (1-month and 6-month post-training). Lower appraisal bias scores in this study indicated *healthier* appraisal bias. In line with Woud et al. (2012), participants in the active condition in this study completed the word-fragment task, which when resolved, was consistent with a healthy appraisal style. However, for the control condition, here, when participants completed the word fragment the meaning of the sentence remained neutral. For instance, a training sentence for the control condition included, "you never know what the future will bring. I believe the future holds d-ff-r-nt things for me" (resolved as different). Contrary to prediction, there were no significant differences between appraisal bias or PTSD symptoms between CBM groups. However, across both CBM groups, a reduction in appraisal bias (i.e., healthy appraisal style) during training predicted lower PTSD symptom scores at post-training and follow-up sessions.

Taken together, de Kleine et al.'s (2019) findings are not in keeping with earlier CBM analogue studies (e.g., Woud et al., 2012; 2013; Woud, Cwik et al., 2018). Unlike previous studies, de Kleine et al. (2019) included a control condition for comparison with a negative CBM condition. They propose these results may be down to the type of control condition used. Perhaps the control condition was not a truly neutral training condition, but rather a milder (and therefore less effective) version of Would and colleagues' positive training condition. Additionally, they acknowledge the lack of no intervention wait-list control group, which would have allowed them to assess whether CBM training is more effective than no training/natural passage of time condition. This study is key, as it is the first to test out the effects of CBM-App training on a clinical PTSD sample. The transition from testing out novel psychological interventions in the lab to testing them in a clinical setting is vital, and like this study, provides rich insights into the complexities of piloting new interventions among clinical samples. Thus,

despite the results suggesting that CBM-App training was ineffective at reducing PTSD symptoms—unlike previous analogue trauma studies—further clinical studies are warranted before firm conclusions can be made, for instance, a replication using a different type of control condition is needed.

Lastly, the use of CBM-App training has been applied to modify event centrality appraisals linked to PTSD (Vermeulen, Brown, Raes, & Krans, 2018). According to Berntsen and Rubin (2007), event centrality refers to when a traumatic experience is: 1) appraised as being a reference point in one's life for other events (e.g., a person may overestimate the general frequency of such events happening, as well as the likelihood that it will happen again); 2) viewed as a turning point in one's life-story (e.g., feeling that the traumatic event has changed one's life); and 3) affects one's personal identity (e.g., viewing the self as a victim of trauma). Such event centrality appraisals (e.g., "I have changed for the worse") are found to be predictive of PTSD symptoms (Boals & Ruggero, 2016) and are typically measured via the Centrality of Events Scale (CES; Berntsen & Rubin, 2006, 2007). Thus, Vermeulen et al. (2018) developed a new CBM-App training protocol to manipulate event centrality appraisals to causally modulate event centrality and PTSD symptoms.

Vermeulen and colleagues (2018) asked participants to write down their most stressful negative/traumatic memory and keep this memory in mind throughout the session. Participants were randomly allocated to a training group, either the CBM-App training to decrease event centrality or a control condition. The control condition consisted over neutral training sentences that were unrelated to event centrality (e.g., daily events). Following recall of their worst/traumatic memory and the completion of several questionnaires (e.g., pre-bias assessment), participants completed the CBM training. Next, participants completed the post-bias assessment and follow-up measures

(e.g., CES). Three days later, participants were contacted via email to complete an online follow-up session, consisting of several questionnaires (e.g., IES, CES). Results showed that participants who received the CBM event centrality training, to reduce event centrality appraisals reported lower event centrality compared to the control. However, no changes in PTSD symptoms were found between CBM groups. This study adds to the growing literature on the use of CBM-App to modify trauma-related appraisals.

Overall, based on the studies conducted to date, it appears that the use of CBM-App training to modify dysfunctional thinking styles is promising. Generally, it appears that training healthy individuals to adopt functional appraisals, either before or after analogue trauma, may lead to a reduction in PTSD symptomology (i.e., intrusion frequency and distress). These studies have all focused on modifying ordinary cognition (i.e., appraisals/beliefs). In review of the literature to date, there appears to be one study by Krans, Moulds, Grisham, Lang, and Denson (2014) that manipulated people's *metacognitive* beliefs using CBM training; however, they focused on beliefs about angry rumination linked to depression, not PTSD. Nevertheless, Krans et al. (2014) found evidence that CBM training successfully biased participants' metacognitive beliefs in the intended direction. This suggests that CBM training may be an effective tool to causally modulate metacognitive beliefs associated with PTSD. This thesis employs a novel CBM protocol to modify metacognitive beliefs, to study their causal impacts on PTSD. Importantly, the efficacy of this CBM training has been compared against a control condition—which previous CBM studies have failed to include. The next section considers control group composition within CBM studies.

3.2. Control Groups used in CBM-I

One outstanding issue that arises within the CBM literature is, what constitutes a suitable control group? It is common to observe CBM studies whereby two "active" conditions (i.e., positive versus negative CBM training) are included, however, to best determine how different CBM training conditions affect the dependent variable (e.g., clinical symptoms), perhaps a study should ideally compare the effects observed in the active condition(s) with the effects observed in a control condition. This allows for the control group to act as a benchmark for comparison. Woud and colleagues (Woud et al., 2012; Woud et al., 2013; Woud, Cwik et al., 2018; Woud, Zlomuzica et al., 2018) recognised the lack of control group in their studies as a potential limitation, noting that without a suitable control group, it is hard to know what produced the observed effects. For instance, did the negative CBM training lead participants to more intrusions, or did the positive training reduce the intrusions, or did both occur (Woud et al., 2012)?

Indeed, as outlined by Blackwell, Woud, and MacLeod (2017), deciding what control group to use in CBM research is challenging and must be determined on the basis the research question at hand. Blackwell and colleagues (2017) describe two key research questions at the heart of CBM research: 1) the causal role of a specific cognitive bias/appraisal on symptoms of interest; and 2) examining whether attenuating dysfunctional biases has therapeutic benefits in clinical populations (e.g., does training clinical populations to adopt healthier biases lead to reduced clinical symptoms?).

In CBM research, several types of control conditions have been utilised; however, one type is more common—namely, the use of a "sham training" control. This control condition is very closely matched to the active condition, but it does not contain the specific contingency thought to bring about the reduction in the target cognitive bias. For example, in CBM-I research, an active condition is a task that presents

participants with ambiguous sentences and participants are systematically steered via the training to resolve the ambiguity in a positive/benign way. Ideally then, a suitable control condition is one that would look identical to the active condition, except that the training contingency is removed. A commonly used control condition is one where participants are equally required to resolve the ambiguity in either a positive or a negative manner (e.g., Salemink, van den Hout, & Kindt, 2009) (i.e., 50% of sentences are resolved in a positive way and 50% in a negative way). This is an attempt to not fully bias participants in either a positive or negative direction; however, problems remain with this choice of control group, as participants in this type of control condition may attend more to one type of sentences than others. For example, some people may still attend to the sentences that are resolved positively rather than the ones resolved negatively—thus *still* biasing participants thinking. It is thought that these sham training conditions may not be appropriate if the research question is one regarding the therapeutic efficacy of CBM training on clinical symptoms. Reasons for this include: 1) sham training is not a placebo condition—for instance, sham controls that deliver contingencies of 50/50 positive and negative resolution are not inert, they could still be biasing people depending on what information people attend to more; 2) participant expectancies of training may influence its effectiveness—for instance, in cases where participants know they have a 50% chance of either receiving the sham training or the active one. This may interfere with how they process the training and what information they attend to; and 3) it does not compare well to standards used to determine the efficacy of new treatments/interventions. Typically, new interventions are compared against other existing evidence-based treatments/interventions, that then act as a clinically meaningful benchmark for comparison (e.g., CBT therapy versus EMDR) (see Blackwell et al., 2017 for a full discussion).

Should the research question be whether a specific cognitive bias/appraisal plays a causal role in emotional vulnerability (e.g., symptom development), then the sham training control conditions offer an appropriate and beneficial comparison to address this question. Here, it is essential that the CBM training induces a group difference in the target bias. Only then can it be "determine[d] whether this gives rise to a concomitant group difference in the emotional vulnerability of interest" (Blackwell et al., 2017, p. 8). Thus, to assess the causal effects of changes in emotional vulnerability (e.g., symptoms), group differences in the target bias following the CBM training must be established (MacLeod & Grafton, 2016). If no group difference in target bias is found post-training, then no conclusions can be drawn about the effects of induced bias on the symptoms of interest (MacLeod & Grafton 2016). However, if a group difference in the target cognitive bias is found, then this is evidence for the causal role of that cognitive bias on the type of symptom reported. One way to maximise the desired group difference is to have two CBM training conditions that induce oppose biases (e.g., positive bias versus negative bias training), as in Woud and colleagues (Woud et al., 2012; Woud et al., 2013; Woud, Cwik et al., 2018; Woud, Zlomuzica et al., 2018).

One aim of this thesis is to investigate the causal role of metacognitive beliefs in the development of PTSD symptoms. This is important, as the literature so far highlights a positive association between metacognitive beliefs/strategies and the reporting of PTSD symptoms, yet it remains unclear whether metacognitive beliefs play a *causal* role in PTSD. CBM, due to its systematic nature and growing evidence base for targeting trauma-related appraisals, offers the ideal platform to causally modulate metacognitive beliefs and assess their effect on PTSD symptoms. Chapter 4 outlines the development of a novel CBM training paradigm ($CBM_{Metacog}$) to manipulate metacognitive beliefs. Further, as outlined in this chapter, the use of control conditions

within CBM-I research is invaluable, thus, a sham control condition was also developed to act as a benchmark for comparison against the $CBM_{Metacog}$ condition. This control condition allows for stronger conclusions to be made about the observed effects on PTSD symptoms.

CHAPTER 4: METHODS

This section will address the experimental approaches used throughout this thesis. It will cover the use of cognitive bias modification training as a tool to manipulate metacognitive beliefs (as it was used in Studies 1, 3 and 4) in relation to analogue trauma, using the trauma film paradigm.

4.1. Cognitive Bias Modification (CBM)

As described in Chapter 3, CBM-App training has repeatedly been found to successfully induce training congruent appraisal styles and attenuate the development of analogue PTSD symptoms (e.g., Woud et al., 2012; 2013). Thus, CBM proves a useful tool to effectively investigate the causal role of trauma-related dysfunctional appraisals/beliefs in the development of PTSD symptoms.

To recap, research to date has highlighted the positive association between maladaptive metacognitive beliefs and PTSD symptoms (e.g., Takarangi, Smith et al., 2017). Importantly, the reviewed studies to date are correlational in design, thus, it remains unclear whether metacognitive beliefs play a causal role in PTSD. Secondly, research to date is vulnerable to confirmation bias; as evidence for maladaptive metacognitive beliefs/coping strategies is interpreted as evidence for the metacognitive model. It can be argued that science progresses primarily through falsification (Popper, 1959); that is, by designing experiments that set conditions for disconfirmation rather than confirmation. Consequently, Studies 1, 3 and 4 in this thesis tested a novel CBM training protocol ($CBM_{Metacog}$ from hereon) to causally modulate metacognitive beliefs by training participants to adopt healthy metacognitive beliefs in line with the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004). To address limitations of previous CBM studies, the effects of $CBM_{Metacog}$ were compared to a newly developed control group condition (i.e., $CBM_{Control}$ from hereon). The efficacy of $CBM_{Metacog}$ versus $CBM_{Control}$, was assessed using the trauma film paradigm, to measure

participants' analogue PTSD symptoms in relation to the film, both following and prior to the CBM training.

4.2. Development of $CBM_{Metacog}$ Training

The $CBM_{Metacog}$ training was developed in line with previous CBM-App training studies (e.g., Woud et al., 2012) and was based on methods within the CBM-I literature (e.g., Mathews & Mackintosh, 2000). The $CBM_{Metacog}$ training was delivered via Qualtrics software, an online survey platform program. The $CBM_{Metacog}$ training protocol appeared to participants as a sentence completion task. Each sentence ended in a to-be-completed word fragment, so that the meaning of the sentence remained ambiguous until the final word fragment was resolved. For example, "experiencing intrusive memories following a negative event is *com-on*" (resolved as common). Participants were required to complete the word fragment (i.e., resolve the ambiguity) by correctly selecting the *first* missing letter from the word fragment (e.g., selecting the letter 'm' in the example above). Participants were presented with three letter options to solve the ambiguity of the final word. Participants were required to select one letter option, and then click the next button. When participants selected the correct missing letter, the completed word was then displayed on the computer screen. However, if/when participants selected an incorrect letter, they received the following message "Incorrect answer. Please press the back button and try again". Therefore, only when participants selected the correct first missing letter to complete the word fragment, were they able to proceed. Each training sentence is designed so that only one possible solution can complete the sentences' meaning; and these completed word fragments/sentences are consistent with a healthy metacognitive belief—in line with the metacognitive model (Wells, 2000; Wells & Sembi, 2004).

To encourage thorough processing of the sentences' meaning, a comprehension question was included after every three training sentences (e.g., in the previous example above, "Is it the case that experiencing intrusive memories is an abnormal reaction to a negative/traumatic event?"). Here, participants were required to select either the Yes or No option. Again, should the participant answer this comprehension question incorrectly, they received the incorrect error message. This was to further reinforce the desired thinking style i.e. healthy metacognitive beliefs. The comprehension questions were designed such that Yes/No answers occurred equally often. Importantly, as in previous CBM studies (e.g., Woud et al., 2012), participants *were not* given explicit instructions regarding the true aim of the CBM training throughout the task (i.e., to bias their thinking), nor were they instructed to play close attention to the content of the sentences. Therefore, participants were ostensibly unaware that they were being trained to adopt healthier metacognitive beliefs when completing the training.

The $CBM_{Metacog}$ condition was based around four themes of maladaptive metacognitive beliefs: 1) positive beliefs about worry and rumination; 2) the uncontrollability/danger of thoughts; 3) positive and negative beliefs about the need to have a complete memory (i.e., metamemory beliefs); and 4) beliefs about the meaning of intrusions (see Table 2 for example sentences from each theme). These themes were chosen due to their association with PTSD symptoms (e.g., Roussis & Wells, 2006; Takarangi, Smith et al., 2017). The $CBM_{Metacog}$ training consisted of 72 training sentences and 24 comprehension questions, resulting in a total of 96 trials.

Table 2

Examples of CBM$_{Metacog}$ training sentences by each theme

Theme	Example sentence
1) Positive beliefs about worry and rumination	*"worrying excessively about the/a negative event is cou-terpro-uctive*" (solved as counterproductive)
2) Uncontrollability/danger of thoughts	"*no matter how upsetting my worries are, about the/a negative event, they are mana-eable*" (solved as manageable)
3) Positive and negative beliefs about the need to have a complete trauma memory	"*gaps in my memory for the/a negative event, show that I am ad–ust-n g*" (solved as adjusting)
4) Beliefs about the meaning of intrusions	"*intrusive memories following the/a negative event are nor–al*" (solved as normal)

4.3. Development of CBM$_{Control}$ Training

The CBM$_{Control}$ training was developed to act as a sham control condition. In sum, CBM$_{Control}$ required participants to engage in the same type of sentence completion task as outlined for the CBM$_{Metacog}$ condition, however, instead of the training sentences being geared towards healthy metacognitive beliefs, they were instead neutral sentences about daily activities. Examples sentences used included: "your morning routine involves you having a coffee and reading the n-wspa-er" (resolved as newspaper); "recycling your used plastics, glass and cardboard is good for the e-viron-ent" (resolved as environment). The control condition was designed in this way to act as a placebo condition. Interestingly, since the design and data collection for Studies 1, 3 and 5, a similar control condition (i.e., neutral sentences) has been published by Vermeulen et al.

(2018). Again, as in the $CBM_{Metacog}$ condition, comprehension questions about the content of the training sentences were included throughout. The $CBM_{Control}$ training was made up of 104 neutral sentences and 32 comprehension questions, giving a total of 136 trials. Eight of the neutral sentences in $CBM_{Metacog}$ were taken from Woud et al.'s (2012) CBM-App training (whereby neutral filler sentences were used throughout). We found in our pilot testing (below) and Study 1, that both training groups had similar task completion times on average, despite there being a greater number of trials in the $CBM_{Control}$ condition compared to the $CBM_{Metacog}$. However, in Study 4 we adapted the $CBM_{Control}$ condition to have the same amount of training sentences as $CBM_{Metacog}$ (i.e., 72). See Appendix 1 for the full list of the $CBM_{Metacog}$ training sentences) and Appendix 2 for the list of $CBM_{Control}$ training sentences.

The typical procedure was as follows: participants were randomly allocated to a CBM condition ($CBM_{Metacog}$ versus $CBM_{Control}$). Participants either completed the CBM training immediately after the trauma film (Study 1) or immediately prior to the trauma film (Studies 3 and 4). Across all studies, all participants took part in the same practice trial first (i.e., three neutral training sentences) to familiarise themselves with the task prior to the main CBM training (i.e., either $CBM_{Metacog}$ versus $CBM_{Control}$).

4.3.1. Assessing biased metacognitive appraisals: encoding and recognition task (ERT)

To assess whether the $CBM_{Metacog}$ training successfully induced a bias in thinking (i.e., healthier metacognitive beliefs), similar to past research (Woud et al., 2012) a two-phase procedure was used, which entailed an initial encoding phase followed by a surprise recognition phase (i.e., encoding recognition task; ERT). The ERT was adapted to assess induced bias for both $CBM_{Metacog}$ and $CBM_{Control}$ training conditions. During the encoding phase, all participants were presented with 10 novel

ambiguous sentences that were based around items on the RIQ (Clohessy & Ehlers, 1999), BAMQ (Bennett & Wells, 2010) and the three MCQ-30 subscales (i.e., positive beliefs about worry; beliefs about the uncontrollability and danger of thoughts; beliefs about the need to control thoughts) (Wells & Cartwright–Hatton, 2004). Each sentence was introduced with a specific title (e.g., "memory beliefs"), followed by a sentence (e.g., "my beliefs about what it means to have gaps in my memory have changed since taking part in this study"); which unlike the training sentences, remained ambiguous. Here, participants were asked to rate the extent to which this sentence described them, at that moment, in time using a 5-point scale; 1 (*does not describe me at all*) to 5 (*describes me perfectly*). This rating scale was adapted from Woud et al.'s (2012) instructions, whereby they asked participants to "imagine themselves vividly in the situation" using a 10-point scale.

For the surprise recognition phase, which followed immediately after the encoding phase, participants were only shown the 10 original encoding titles (e.g., "memory beliefs"). Underneath these titles were four related sentences. Participants were required to read each sentence and rate how similar in meaning each sentence was to the original encoding phase sentence that was presented previously, using a 5-point scale; 1 (*not similar at all*) to 5 (*extremely similar*). Two of the four sentences were a positive and negative target sentence (i.e., they were congruent with either a positive or negative interpretation of the original sentence). For instance, "as a result of this study session, I now understand that having gaps in my memory [for the event] shows I am psychologically healthy" (positive target) or "psychologically unhealthy" (negative target). The remaining two sentences had content similar in meaning to the original encoding sentence, but did not resolve the ambiguity (e.g., "as a result of this study session, I now understand that I can remember better if I try harder"), these were known

as the foil items (see Table 3; for examples and Appendix 3 for the full list of items). Only the raw data from the recognition phase was converted into an index bias score; the degree to which the sentences had been interpreted as having a positive (or negative) meaning, by subtracting the mean ratings for the negative targets from the positive targets. Thus, as predicted, the $CBM_{Metacog}$ training should yield a positive index bias score—indicating that participants have interpreted the original encoding sentences in a healthy manner, in line with healthy metacognitive beliefs. As the control condition used in these studies was not designed to bias participants' thinking in either direction (i.e., neither positive nor negative), it was predicted that the $CBM_{Control}$ condition should yield an index bias score close to zero, indicating no bias.

Table 3

Example of encoding and recognition stimuli used to determine index bias scores

Title	"Memory Beliefs"
Encoding Sentence	"My beliefs about what it means to have gaps in my memory have changed since taking part in this study session"
Recognition Sentences	
Negative Target	"As a result of this study session, I now understand that having gaps in my memory shows I am psychologically unhealthy"
Positive Target	"As a result of this study session, I now understand that having gaps in my memory shows I am psychologically healthy"
Negative Foil	"As a result of this study session, I now understand that I can remember less if I am tired"
Positive Foil	"As a result of this study session, I now understand that I can remember better if I try harder"

4.4. $CBM_{Metacog}$ Pilot Study to assess induced bias

A brief pilot study was conducted to determine whether the $CBM_{Metacog}$ training protocol could successfully induce training congruent bias in participants. To determine induced bias the two-phase ERT was employed. The hypothesis was that the $CBM_{Metacog}$ group would yield a significantly higher positive index bias score compared to the $CBM_{Control}$.

Method

Participants. Twenty participants (age *M* = 34.55, *SD* = 10.50, *R* = 24–62) (*n* = 9 female) were recruited online via Amazon's Mechanical Turk (MTurk) in return for payment (i.e., $10.80). The study was advertised as the "investigating cognitive processing" study. Participants were told that the study was investigating the different ways in which people process information. All participants resided in the United States and were predominantly Caucasian (*n* = 15). The pilot study was conducted following Loughborough University ethical approval.

Procedure. This pilot study involved three online sessions, spaced over three consecutive days. Informed consent was gained online, prior to the study. All participants firstly completed several demographic questions (i.e., age, ethnicity, gender, highest level of education achieved) then completed the CBM training task only. Participants did not watch any trauma films or complete any self-report questionnaires in this pilot, as the purpose of this pilot was to assess whether the CBM training can induce a group difference in index bias scores, congruent with CBM group. At session 1, participants were randomly allocated to either the $CBM_{Metacog}$ (*n* = 9) or $CBM_{Control}$ training (*n* = 11). All participants completed the training, which was immediately followed by the ERT to determine index bias. Participants were contacted again 24-hours later (session 2) and 48-hours later (session 3) and invited to take part in

two shorter follow-up studies in return for bonus payment. Both session 2 and 3 were identical, and only required participants to complete the ERT again in relation to the training. This allowed the induced cognitive bias assessment to be measured across time (i.e., 3-days). However, not all participants from session 1 completed the voluntary follow-up sessions. Seven participants completed session 2 (24-hours later) (n = 5 $CBM_{Metacog}$; n = 2 $CBM_{Control}$), and five completed session 3 (48-hours later) (n = 5 $CBM_{Metacog}$).

Results

Metacognitive appraisal bias session 1. Firstly, index bias scores at post-training session 1 were analysed using an independent samples t-test. Results showed a significant difference for index bias scores between training groups, $t(10.79) = 5.33$, $p < .001$, $d = 2.47$ ($CBM_{Metacog}$ $M = 3.01$, $SD = 1.46$; $CBM_{Control}$ $M = .20$, $SD = .68$), with the $CBM_{Metacog}$ group yielding a significantly higher index bias score, as predicted, compared to the $CBM_{Control}$. Further analysis using a one-sample t-test, also verified that the $CBM_{Metacog}$ group demonstrated a mean bias significantly different from zero, in the intended direction $t(8) = 6.18$, $p < .001$ (mean difference = 3.01). However, the $CBM_{Control}$ failed to demonstrate a significant difference in bias from zero (as predicted), $t(10) = .98$, $p = .35$ (mean difference = 0.20).

Metacognitive appraisal bias over time. Next, only the participants (n = 5) who completed the bias assessment measure across all 3 days were analysed. This was to ascertain whether the bias was maintained over time. Interestingly, all five participants who completed all three sessions were all from the $CBM_{Metacog}$ training group. A repeated measures ANOVA, using session (1, 2, 3) as the within-subjects variable was conducted. Results found a non-significant main effect for session, $F(2,8) = 1.40$, $p = .30$, $\eta_p^2 = .26$ (session 1 $M = 2.94$, $SD = 1.41$; session 2 $M = 3.44$, $SD = .88$; session 3 M

= 3.28, *SD* = 1.03), indicating that the index bias was maintained, and interestingly, descriptively speaking, it appeared to increase over time.

In sum, results from the pilot study indicated that the $CBM_{Metacog}$ training protocol successfully induced a positive bias in appraisal style, with healthier metacognitive beliefs being reported more so in the $CBM_{Metacog}$ group compared to the $CBM_{Control}$ group. However, it is important to note that in this pilot study there was no specific reference (e.g., analogue trauma) for participants to complete the CBM training. This may limit the extent to which these pilot results can generalise to the other CBM studies which do include an analogue trauma (i.e., Studies 1, 3 and 4). To conclude, the two CBM training conditions outlined here were used in Studies 1, 3 and 4 to assess the efficacy of the training on the development of PTSD symptoms, using the trauma film paradigm.

4.5. Trauma Film Paradigm

The trauma film paradigm involves showing non-clinical participants a short film that contains scenes depicting stressful or traumatic events, in an attempt to mimic real-life trauma exposure in the laboratory (see James et al., 2016 for a full review). There is a wide variety of trauma films used within research; however, typically, a trauma film consists of several clips being edited together (e.g., car crash footage, interpersonal violence, medical injuries), resulting in a film that is approximately 20–30 minutes in total (e.g., Woud et al., 2012). However, some studies only use a single film clip of a traumatic event (e.g., road-traffic accident) lasting 4–20 minutes (e.g., Takarangi et al., 2014). Both types of trauma films reliably been shown to induce analogue intrusions in healthy participants, which usually subside within a week (James et al., 2016). Indeed, reviews assessing the use of the trauma film paradigm indicate that it is an invaluable tool that offers a reliable and controlled way to measure people's

responses to distressing material (Holmes & Bourne, 2008; James et al., 2016) and holds several advantages as an experimental psychopathology model.

First, the content of the films used are in line with the type of traumatic events described in the DSM-5 (APA, 2013); that is, events which involve actual or perceived threat and serious injury. Interestingly, to recap, the DSM-5 now recognises that trauma exposure can include the repeated exposure via media resources (e.g., television, movies, pictures), when occurring as part of one's work-related duties (e.g., police officer repeatedly viewing pictures of dead bodies). However, it is important to note that the trauma film paradigm is not designed to mimic this type of work-related trauma exposure, as the trauma film paradigm typically involves a one-time exposure. Second, research consistently demonstrates that the trauma film paradigm can elicit reactions linked with real-life PTSD. For example, watching analogue trauma can lead to the onset of analogue PTSD symptoms, such as intrusions, physiological reactions (e.g., heart rate), mood (e.g., fear, disgust, horror) and negative cognitions. As outlined by, Lau-Zhu, Holmes, and Porcheret (2018), an ideal experimental psychopathology model would be able to stimulate both exposure to trauma and the hallmark symptom—intrusive memories of the traumatic event. This allows researchers to evaluate proof-of-concept interventions, examine risk factors for the development of symptoms (e.g., intrusive memories) and investigate mechanisms that may exacerbate or mitigate symptoms. To date, research has focused on a range of factors that can be manipulated either before the film (i.e., pre-trauma), during the film (i.e., peri-trauma) or after the film (i.e., post-trauma) to determine how they affect intrusion development (see Figure 3). Third, it uses a prospective design to assess intrusion development following trauma exposure, thus avoiding memory biases associated with retrospective reporting (James et al., 2016).

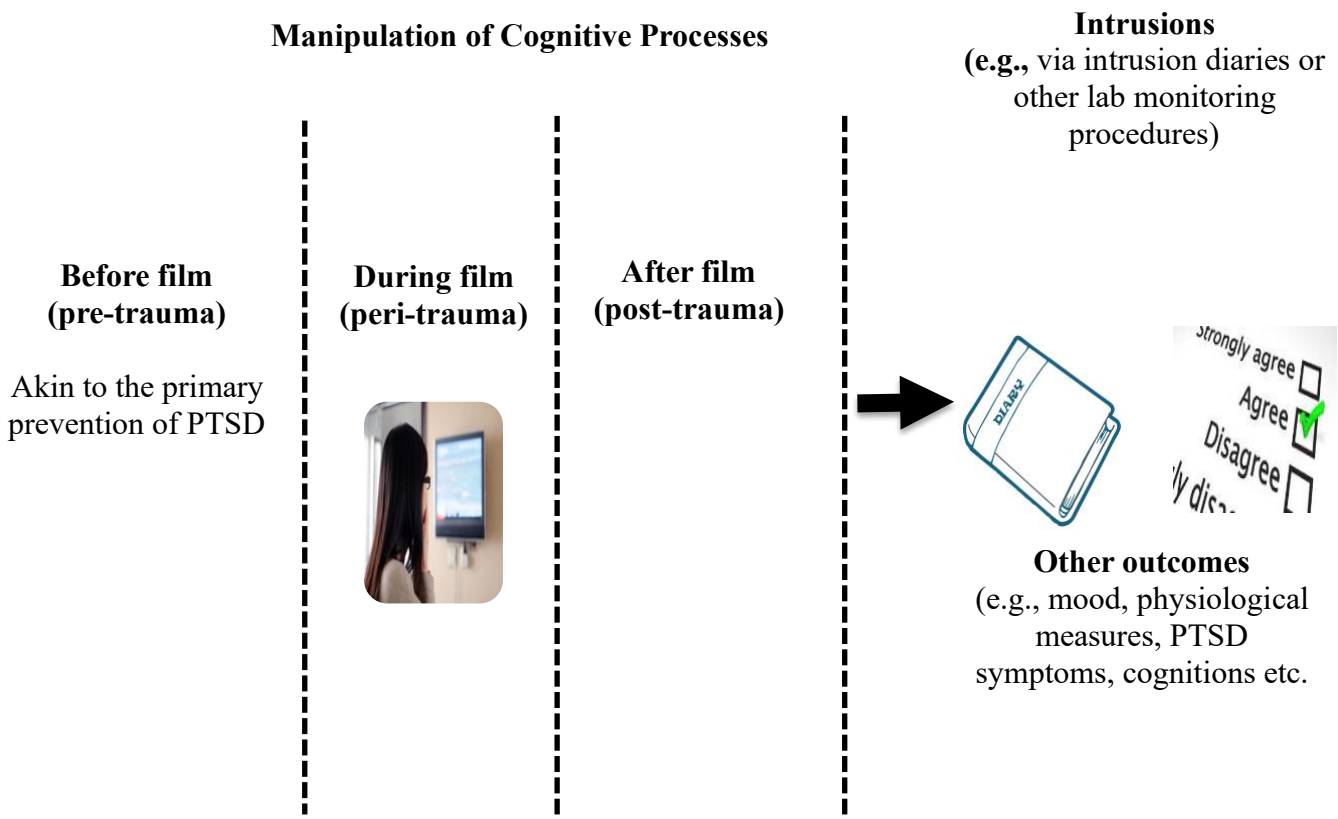


Figure 3 Outline of the trauma film paradigm as an experimental psychopathology model, adapted from James et al., 2016

Of course, it is unethical to expose research participants to real trauma; thus, the main limitation of the trauma film paradigm is that watching a distressing film is not entirely akin to experiencing a real-life trauma and may therefore lack external validity. For example, participants watch the film in a controlled experimental environment, and the film is viewed remotely and is often shown from an observer's perspective (James et al., 2016)—all of which are important limitations to consider. Further, trauma films will lack the same sense of distress and threat associated with real-life trauma, as there is no immediate threat to one's life and the films often lack personal relevance (Marks et al., 2018). These limitations are important to note, as real-life traumatic experiences may capture all these factors; therefore, findings from analogue trauma experiments are

limited in their level of generalisability to real-life trauma. Second, as part of the ethical approval process for the study, researchers will need to inform potential participants about the fact that they will be asked to watch an emotional/distressing film as part of the study. Again, this is unlike real-life trauma, which often occurs unexpectedly. Third, by informing participants prior to the study that they will be asked to watch a distressing film, participants can choose whether or not they take part in the study. This self-selection to studies is unavoidable, and for ethical reasons, researchers must be transparent about the nature of the study and what is involved. However, it is possible that individuals who choose not to take part in the study may be different in some meaningful way (e.g., personality characteristics) (Marks et al., 2018). Despite these drawbacks, the trauma film paradigm is an invaluable, reliable and widely used experimental tool used to assess trauma reactions. It offers a controlled method to study factors which may mitigate/exacerbate PTSD symptoms and is thus a reliable experimental psychopathology model.

In this thesis, Studies 1–4 used the trauma film paradigm to assess the efficacy of $CBM_{Metacog}$ versus $CBM_{Control}$. Specifically, the same (single) trauma film was chosen throughout all the studies for consistency. This film has been used in previous research (e.g., Strange & Takarangi, 2012; Takarangi et al., 2014) and known to reliably induce (short-lived) intrusions.

4.6. Involuntary Memory: Assessment of Intrusions

4.6.1. Intrusion diaries

Accurately capturing the occurrence of intrusions is an important challenge faced by clinicians and researchers worldwide. Although studies are limited, clinical studies largely use a retrospective summary assessment, whereby individuals are asked

to enter the amount of intrusions they have had after a couple of days/1-week, which is potentially subject to memory biases (James et al., 2016). One common method for recording intrusions, in both clinical practice and lab-based research, is via intrusion diaries. Here, following exposure to a trauma film, participants are asked to keep track of any intrusions they experience in their day-to-day lives, for a set period of time (e.g., 7-days). These intrusion diaries can be in pen-and-paper format (e.g., Morina, Leibold, & Ehring, 2013) or electronic diaries (e.g., Bisby, Brewin, Leitz, & Curran, 2009). Typically, participants are required to record the number of intrusions they experience, the distress or vividness associated with these intrusions, and the type of intrusion (e.g., image, thought etc.) they experienced within the diaries (e.g., Holmes et al., 2004). Intrusions arising from a trauma film can vary between two and six intrusions per week (e.g., Deeprose, Zhang, Dejong, Dalgleish, & Holmes, 2012; Zetche, Ehring, & Ehlers, 2009). The main strength of intrusion diaries is the ecological validity of real-life monitoring (James et al., 2016). However, there are several limitations to their use. Firstly, there is an issue of non-compliance with completion (Lau-Zhu et al., 2018). Second, the variability in the context in which individuals complete the diaries. Third, the diaries do still require individuals to retrospectively self-report the occurrence of intrusions, leaving the diaries vulnerable to memory biases and possibly demand characteristics—however, this is still the case with real-life clinical cases of ASD/PTSD. Fourth, this retrospective reporting relies heavily upon individuals having accurate awareness of their own cognition, and research from the mind-wandering literature reports that people do not always accurately track the contents of their consciousness (see Smallwood & Schooler, 2006). Despite these limitations, intrusion diaries remain to be a useful and ecologically valid tool to assess the development of intrusions.

4.6.2. Measuring meta-awareness of intrusions

As outlined in Chapter 2, there is a growing body of research demonstrating that people can lack meta-awareness for their own intrusions. Researchers have prospectively measured intrusions that occur both with and without meta-awareness, by adopting methods used within the mind-wandering literature. This stems from research investigating whether people can lack meta-awareness that they are mind-wandering. Based on Schooler (2002), mind-wandering with and without meta-awareness has been measured via experience sampling techniques, which include self-caught and probe-caught methods, respectively. Participants are asked to engage in a low cognitive load task (e.g., reading task). Throughout the reading task, participants are instructed to self-report (e.g., by pressing a key on the computer) when they notice that their mind has wandered off-task (i.e., mind-wandering with awareness). Probe-caught methods involve participants receiving intermittent probes that ask whether their attention was off-task just before the probe appeared (e.g., Schooler et al., 2004). When these probes appear, they attempt to capture instances of off-task thinking that the participant was unaware of (i.e., mind-wandering without awareness). It is deemed to be mind-wandering without awareness because the participant would have self-reported that they were off-task, if they were aware of it. Thus, the mind-wandering literature highlights an important distinction between *having an experience* and *having an experience and knowing you are having that experience* (i.e., meta-awareness of your own cognition) (e.g., Schooler, 2002).

Accordingly, researchers have sought to apply these methods to the experience of unwanted negative thoughts (i.e., intrusions). For example, Takarangi et al. (2014) asked participants to watch a trauma film of a road-traffic accident. Next, participants were asked to read three articles about science topics (e.g., a cell) while being instructed

to press a computer key every time, they noticed themselves experiencing an intrusion about the film (i.e., self-caught only condition). In addition to these instructions, half of the participants were also told that a probe screen would appear on the computer, asking them if they were thinking about the film at that particular moment in time—immediately before the probe appeared (i.e., while they were engaged in the reading task). Participants would be asked to respond to the probe by pressing 'Y' for "yes" and 'N' for "no". The probes would appear independently of self-caught intrusions. A "yes" response to the probe is regarded as an intrusion lacking meta-awareness; because if participants were aware of their intrusion, they would have self-caught it and not responded "yes" to the probe. By adopting these methods, Takarangi et al. (2014) found that people can often be caught experiencing intrusions that they were not necessarily aware of—highlighting the interesting and potentially important role of intrusion awareness in the development of PTSD.

Studies have attempted to assess the frequency of intrusions that occur with and without meta-awareness. Takarangi, Nayda et al. (2017) investigated whether people's metacognitive beliefs affect meta-awareness of their intrusions. One-hundred and fifty-one participants were allocated to a weak versus strong metacognitive belief group, depending on participants scores from the 9-item control subscale of the Interpretation of Intrusions Inventory (III-31; Obsessive Compulsive Cognitions Working Group [OCCWG], 2003) (weak group = if scores fell into the lower third; strong group = if scores fell into the higher third). Next, participants were randomly allocated to an intrusion monitoring condition (either self-caught only or self-caught-plus-probes) prior to the film and reading task. Participants were then asked to watch a trauma film, which depicted a fictional gang rape taken from the move *The Accused* (1998). Following the film, participants were required to read one article, and similar to Takarangi et al.

(2014), all participants were instructed to press a computer key every time they noticed themselves having an intrusion. However, participants in the self-caught-plus-probes condition received a different probe screen to the one outlined in Takarangi et al. (2014). Here, the probe screen appeared asking “Just now what were you thinking about?”. Participants could respond by pressing one of three keys: (1) “if you were thinking about the film”; (2) “if you were thinking only about the article you were reading”; or (3) “if you were thinking about something else”. As predicted, participants were caught thinking about the film. Specifically, participants were caught thinking about the film 25.89% of the time and about “other things” 9.61% of the time; demonstrating once more that people can lack meta-awareness of their intrusions. Interestingly, results showed that people with strong metacognitive beliefs (i.e., more maladaptive) were more likely to notice their intrusions, both with and without meta-awareness, compared to those with weak beliefs.

Accordingly, this thesis uses both pen-and-paper and electronic diaries to assess trauma intrusions (Study 1, 3 and 4). Also, Study 4, investigated the role of meta-awareness of intrusions, and in addition to the pen-and-paper format, also used self-caught and probe-caught methods to determine the frequency of intrusions that occur with and without meta-awareness.

4.7. Voluntary Memory

The idea that trauma differentially effects involuntary memory versus voluntary memory remains a contentious issue that has strong implications for clinical theories of PTSD. Despite this, studies assessing voluntary memory associated with a trauma film have received little attention. Assessing voluntary memory, as well as involuntary memory of a trauma film is important, as it allows the relationship between PTSD symptoms and voluntary memory, as well as the relationship between voluntary

memory and involuntary memory to be explored. Additionally, it also allows for the potential memory mechanisms that may underpin cognitive processing tasks (e.g., CBM) to be investigated. For instance, does receiving $CBM_{Metacog}$ affect one's voluntary memory for an analogue trauma, that is, the memory details recalled? To recap, the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004) differs from other cognitive models of PTSD (e.g., Ehlers & Clark, 2000) as it does not give special emphasis to the nature of the trauma memory. It does not support the idea that trauma memory is fragmented or disorganised as a result of the trauma. Instead, it argues that most people hold incomplete memories of the trauma, and that it is *one's beliefs* about the need to have a complete memory of the trauma (metamemory beliefs) that leads to the development of symptoms. Thus, it does not make specific predictions about how one's metacognitive beliefs may affect what details (i.e., central and peripheral) people remember about a trauma. Voluntary memory of the analogue trauma film was assessed via free-recall in Studies 1, 3 and 4 to determine whether: 1) the mechanisms behind the efficacy of $CBM_{Metacog}$ are due to changes in the way the event is voluntarily remembered (i.e., details); and 2) to examine whether metacognitive beliefs are associated with the recall of specific event memory details (Study 2).

Specifically, two event memory details were assessed in this thesis; central and peripheral details. In general, central details often refer to the most emotionally salient aspects of an event, whereas peripheral details refer to more background details (see Chapter 9 for a detailed outline). Broadly speaking, events that elicit negative emotional reactions, such as fear, heighten memory for thematically central details, and impair memory for peripheral details about the event (Edelstein, Alexander, Goodman, & Newton, 2004; Reisberg & Heuer, 2004, 2007). Thus, examining the types of memory details voluntarily recalled, may provide better insight into what drives the development

of intrusions. For example, it is possible that a psychological intervention is effective at reducing intrusions because it reduces the amount of *central details* a person *voluntarily* remembers. This question is explored in Chapter 9, firstly though, the efficacy of $CBM_{Metacog}$ training is explored.

In sum, due to the correlational design of previous studies, it remains unclear whether metacognitive beliefs play a causal role in PTSD. This is important to know because, if they do play a causal role, then tailored preventative interventions can be developed. A first step to addressing this question is outlined in Chapter 5 (Study 1). Here, participants were randomly allocated to a CBM group ($CBM_{Metacog}$ versus $CBM_{Control}$) following exposure to analogue trauma (similar to the design used in Woud et al., 2012) and metacognitive beliefs and PTSD symptoms were measured over time.

CHAPTER 5: RETROSPECTIVE PILOT ANALYSIS OF $CBM_{METACOG}$ TRAINING FOR AN ANALOGUE TRAUMA (STUDY 1)

5.1. Study overview

To date, research investigating the role of metacognitive beliefs in PTSD has been correlational, demonstrating that maladaptive metacognitive beliefs are associated with the development of PTSD symptoms (e.g., Takarangi, Smith et al., 2017). However, it remains unclear whether metacognitive beliefs play a causal role in the development of PTSD. To address this research question, in the present pilot study, participants' metacognitive beliefs were causally modulated—via a new CBM training protocol (i.e., $CBM_{Metacog}$)—to assess whether receiving the $CBM_{Metacog}$ training, immediately after analogue trauma, would lead to healthier metacognitive beliefs post-training and fewer PTSD symptoms in relation to analogue trauma, compared to a control condition (i.e., $CBM_{Control}$).

5.2. Method

Participants

Eighty-six participants were recruited from the university campus via the online participation scheme/fliers on campus. Data for twelve participants were excluded; ten participants failed to fully complete the study (i.e., they did not complete session 2 at all/on time) and two were removed due to technical problems during session 1 in the lab. Thus, the final sample used in the analysis was 74 participants (n = 61 female; age M = 22.15, SD = 5.92, R = 18–54 years). [1] The study was pre-registered on Open Science Framework (OSF) prior to data collection. An a priori sample size calculation,

[1] Data for twenty-nine participants from this sample (n = 15 $CBM_{Metacog}$; n = 14 $CBM_{Control}$) was collected separately as part as another study (see Study 2; Chapter 6) and combined with a new dataset for analysis (n = 45). However, taking part in a separate study did not appear to significantly affect how participants experienced the trauma film (i.e., mood and film ratings) (ps > .12), therefore we combined the datasets together for analysis here.

using a large effect size (obtained from analysis of the index bias scores in the pilot study), indicated this was a large enough sample (at 80% power, with alpha set to .05).

All participants were informed that the study would involve watching a brief emotional film depicting a multi-fatality car accident and they were told not to take part in the study if they felt they would be adversely affected by watching the film. They were reminded that they could withdraw from the study at any point, by informing the researcher.

Design

A 2 CBM group ($CBM_{Metacog}$ versus $CBM_{Control}$) x 2 session (session 1 and session 2) mixed experimental design was employed. CBM group was the between-subjects factor and session was the within-subjects factor. Ethical approval was obtained from Birmingham University's Science, Technology, Engineering and Mathematics Ethical Review Committee (Ref: ERN_17-1155A).

Materials

Trauma film. A 4-minute film depicting a multi-fatality car accident was used as the analogue trauma. This film has been used in past research (e.g., Takarangi et al., 2014) with no reported long-term adverse effects. Immediately prior to the film, participants rated their current mood via the Visual Analogue Scale (VAS; Davies & Clark, 1998) (happiness, anxiety, anger and depression) using an 11-point scale of 0 (*not at all*) to 10 (*extremely*). An overall mood score was calculated both pre and post-film by calculating an average across the four scales (with happiness reverse scored). Similar to Woud et al. (2012), all participants were instructed to watch the film, as if they were, "a bystander at the scene of the events, and to pay attention to the film, as later there may be questions about the film content" (p. 780), to enhance self-relevance. Immediately following the film, participants rated their mood once more (i.e., VAS

mood ratings). Additionally, they rated how much attention they paid to the film and how distressing they found it, using an 11-point scale of 0 (*not at all*) to 10 (*extremely*).

CBM Training. Participants were randomly allocated to a CBM training group, either the $CBM_{Metacog}$ or the $CBM_{Control}$. A more detailed description of each of these conditions can be found in Chapter 4. Briefly, like previous CBM studies (e.g., Woud et al., 2012), the CBM training involved participants processing a series of vignettes that appeared to them as a sentence completion task. Each sentence ended in a to-be-completed word fragment, wherein the meaning of the sentence remained ambiguous until the final word fragment was resolved. The $CBM_{Metacog}$ condition was based around four themes of maladaptive metacognition: 1) positive beliefs about worry and rumination; 2) beliefs about the uncontrollability/danger of thoughts; 3) positive and negative beliefs about the need to have a complete memory (i.e., metamemory); and 4) beliefs about the meaning of intrusions. In this study, the CBM training sentences were designed to be linked to the trauma film where applicable (e.g., “having gaps in my memory for the event [film] is understandable”).

The $CBM_{Control}$ training was comprised of neutral training sentences that were unrelated to metacognitive beliefs and referred to daily life activities (a similar control condition has been used more recently by Vermeulen et al., 2018). An example sentence is “your morning routine involves you having a coffee and reading the n-wspa-er” (resolved as newspaper). Thus, the $CBM_{Control}$ condition was designed in this way to act as a placebo condition, whereby participants engaged a similar task (i.e., word completion task) as those in the $CBM_{Metacog}$ group, however the content was unrelated to metacognitive beliefs. In both conditions, participants would receive comprehension questions throughout to encourage thorough processing of the training sentences’ content.

In this study, the $CBM_{Metacog}$ training consisted of 72 training sentences (plus 24 comprehension questions), giving a total of 96 sentences. Whereas, the $CBM_{Control}$ training was made up of 104 neutral sentences (plus 32 comprehension questions), giving a total of 136 sentences.

Measures

Measuring induced appraisal style. Based on previous CBM studies (e.g., Mathews & Mackintosh, 2000; Woud et al., 2012; Woud et al., 2013), metacognitive appraisal style (i.e., induced bias) was assessed using a two-phase procedure; the ERT (see Chapter 4). All participants received the same ERT immediately following the training, regardless of CBM condition. Only the raw data from the recognition phase was converted into an index bias score, which is the degree to which the ambiguous sentences had been interpreted in either a positive or negative way. The bias score was calculated by subtracting the mean ratings for the negative targets from the positive targets. Therefore, a positive score indicated a positive bias (i.e., healthy metacognitive belief styles), a negative score a negative bias (i.e., less healthy metacognitive belief styles, and a score close to zero indicated no bias. For the current study, it was predicted that the $CBM_{Metacog}$ group would yield a positive bias index score, because these participants would be more likely to rate the positive recognition test items as being more similar in meaning to what they had learned in the session, compared to the negative test items. Whereas, in the $CBM_{Control}$ group, these participants would yield a score closer to zero, to indicate no bias, as the $CBM_{Control}$ training did not aim to bias their metacognitive beliefs. We assessed participants' metacognitive appraisal style both immediately post-training and at session 2, the following day. At session 2, the recognition items from the ERT were still worded to refer to what participants had

learned from the CBM training session (e.g., "by completing session 1 of this study, I now understand that having gaps in my memory shows I am psychologically healthy").

Metacognitive and metamemory beliefs. Explicit metacognitive beliefs were assessed using self-report questionnaires; three subscales from the MCQ-30 (Wells & Cartwright-Hatton, 2004) (18 items in total) and an adapted version of the RIQ (Clohessy & Ehlers, 1999). The three MCQ-30 subscales included positive beliefs about worry (e.g., "I need to worry in order to work well") (i.e., MCQ 1), beliefs about the uncontrollability/danger of thoughts (e.g., "my worrying could make me go mad") (i.e., MCQ 2) and beliefs about the need to control thoughts (e.g., "not being able to control my thoughts is a sign of weakness") (i.e., MCQ 3). These three MCQ subscales were chosen due to their association with PTSD (Roussis & Wells, 2006; Takarangi, Smith et al., 2017). Participants rated their agreement with each MCQ statement using a 4-point scale, 1 (*do not agree)* to 4 (*agree very much*), with higher scores representing higher agreement with maladaptive thinking. The MCQ subscales were administered at pre-screen, post-training session 1 and at session 2. We calculated Cronbach's alpha for each subscale at each time point; baseline (MCQ 1 α = .91; MCQ 2 α = .90; MCQ 3 α = .62), session 1 post-training (MCQ 1 α = .90; MCQ 2 α = .90; MCQ 3 α = .70), session 2 (MCQ 1 α = .87; MCQ 2 α = .90; MCQ 3 α = .67). The MCQ 3 at session 2 was just below acceptable reliability levels, however it was kept in the analysis to compare changes in MCQ 3 scores, between CBM groups.

An adapted version of the RIQ (Clohessy & Ehlers, 1999) was used to measure negative inferences about the meaning of intrusions (e.g., "something is wrong with me"). Participants were asked to read each statement and rate, on a 7-point scale of 1 (*totally disagree*) to 7 (*totally agree*), how much they agreed with the statement in relation to the intrusions that they had experienced. Positive inference items (e.g.,

"nothing- it is a normal reaction") were reverse coded and RIQ scores were calculated by summing up the individual items. Due to the design of the study, only participants who reported experiencing intrusions (either in relation to their self-nominated worst event at pre-screen or in relation to the film at post-training session 1 and session 2) completed the RIQ. Cronbach's alpha was calculated for each time point; pre-screen (n = 31) α = .85; post-training session 1 (n = 13) α = .90, session 2 (n = 15) α = .84 and session 3 (n = 6) α = .81.

The BAMQ (Bennett & Wells, 2010) assesses metamemory, a specific type of metacognition referring to how people evaluate the contents of their trauma memory. The BAMQ is a 15-item scale that measures positive beliefs about the need to have a complete memory for an event (e.g., "I must try to remember all the details of the event so that I can understand why it happened") and negative beliefs about the consequences of not having a complete memory for an event (e.g., "gaps in my memory for the event are preventing me from getting over it"). Therefore, the BAMQ is always anchored to a specific event. Here, the BAMQ was administered at baseline—as part of the pre-screen questionnaires administered prior to the CBM session—in relation to participants' self-nominated life event. Whereas, at session 1 post-training and session 2 it was completed in relation to the film. Participants rated the extent to which they agreed with each item using a 4-point scale (1 – *do not agree* to 4 – *agree very much*), with lower scores representing healthier metamemory beliefs. Cronbach's alpha scores for the positive belief subscales demonstrated strong internal validity, with scores ranging from α = .84 –.87. However, the BAMQ negative subscale yielded poor internal reliability (α = .28 – –.61) and consequently it was removed from the analysis.

PTSD symptoms. The IES-R (Weiss & Marmar, 1997) is a self-report assessment of stress reaction symptoms that a person may experience following a

distressing/ traumatic event. The IES-R is a 22-item measure that contains three subscales: 1) intrusions (e.g., “I thought about it when I didn’t mean to”); 2) avoidance (e.g., “I tried not to think about it”); and 3) hyper-arousal (e.g., “I was jumpy and easily startled”), which are key symptom clusters associated with PTSD. The IES-R was administered at session 2 and participants were asked to read each item and rate on a scale of 0 (*not at all*) to 5 (*extremely*) how distressing each symptom had been for them in the past 24 hours in relation to the film they watched at session 1. Higher scores for the total IES-R represent greater self-reported analogue PTSD symptoms in relation to the film. The IES-R total score and IES intrusion subscale were our primary outcome variables, and both demonstrated strong internal reliability (α= .75 – .83).

We also measured intrusions via a 1-day intrusion diary. At the end of session 1, all participants were given instructions on how to keep a 1-day intrusion diary in relation to the film they watched in session 1. In line with previous research, (see Holmes et al., 2004; Holmes, James, Coode-Bate, & Deeprose, 2009), intrusions were defined as “any memory of the negative event [film clip] that appeared spontaneously in your mind over the past 24 hours. This does not include any memories of the event that you have deliberately or consciously brought to mind”. For the diary, participants were asked to record all intrusions as soon as they occurred (where possible). For each intrusion experienced, they were asked to record what type of intrusion it was (i.e., thought, image or combination of both), briefly report what the intrusion was about (i.e., to verify it was in relation to the film) and to rate the distress associated with each reported intrusion, using a scale of 0 (*no distress*) to 10 (*extremely distressing*). Participants were told that they would be asked to enter this information during the online follow-up session the following day, similar to other study procedures (e.g. Das et al., 2016). Unlike some analogue trauma studies (e.g., Siegesleitner, Strohm,

Wittekind, Ehring, & Kunze, 2019), participants did not receive daily prompts to remind them to complete the diary, as it is possible that prompts may trigger intrusions, thus over-estimating the true frequency of intrusions (e.g., Shiffman, Stone, & Hufford, 2008; Rattel et al., 2019). After participants entered their intrusion data at session 2, they were asked to rate on a scale of 0 (*not at all*) to 10 (*extremely*), how accurate they were at recording their experience of intrusions in the diary.

Past versions of the DSM (i.e., DSM-IV-TR; American Psychiatric Association, 2000) included intrusive thoughts as a re-experiencing symptom. However, the most recent DSM version for PTSD (i.e., DSM-5; APA, 2013), specifically refers to intrusive memories, which often take the form of sensory-perceptual impressions such as visual images that come to mind spontaneously. Therefore, in line with the DSM-5, and other studies (e.g., Asselbergs et al., 2018; Krans, Brown, & Moulds, 2018) only image-based intrusions were considered intrusions and thus included in the analysis. Additionally, like previous studies (e.g., Rombold et al., 2016), only intrusions that were experienced as being distressing (i.e., distress rating > 0) were considered intrusive—akin to real-life PTSD intrusions—and included in the final analysis. All intrusion diaries were scored by DH, who was blinded to CBM group allocation. The number of intrusions per participant, over the 1-day period, were summed to give a total intrusion frequency score. Further, since all participants experienced a different number of intrusions, the proportion of intrusions that were distressing was calculated for each participant by summing the distress ratings and dividing by the number of intrusions reported per participant), similar to Porcheret et al. (2019).

Psychological resilience. The Ecological Systems model of Resilience (EEA; Maltby, Day, & Hall, 2015) is a 12-item self-report measure that assesses three components of resilience; engineering, ecological and adaptive. Engineering resilience

refers to the ability of a person to bounce back following adversity (e.g., “I recover from difficult situations with ease”), ecological resilience refers to the ability of a person to remain robust and keep going despite adversity (e.g., “I am always able to give all I can regardless of what may happen”) and adaptive resilience refers to a person’s ability to accommodate change and adapt (e.g., “I enjoy it when there are changes to my routine”). Participants were asked to read each statement and rate on a scale of 1 (*strongly disagree*) to 5 (*strongly agree*) how much they agreed with the statement at that present moment. The EEA was administered at baseline (pre-screen survey) and again at session 2. An overall total score (i.e., total sum of all three subscales) was obtained and used for analysis. Reliability analyses of all subscales and total scores demonstrated that the EEA had strong internal validity across both sessions (α = .84 – .90).

Depression, anxiety and stress symptoms. The 21-item Depression Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995) equally assessed symptoms of depression, anxiety, and stress. In this study, the DASS-21 was administered at baseline (pre-screen survey prior to session 1) and at session 2. Participants were asked to read each statement (e.g., “I found it hard to wind down”), and rate the extent to which this statement applied to them over the past week (baseline) or past 24 hours (session 2) using a 4-point scale (0 = *never* to 3 = *almost always*). The higher the score on the DASS-21, the more self-reported depression, anxiety and stress symptoms experienced. Within our sample, all the DASS-21 subscales demonstrated internal consistency with scores ranging from α=. 74 – .91, except for the DASS anxiety subscale at session 2, which yielded a Cronbach’s alpha score of α=. 49, and it was therefore removed from the analysis.

Film ratings. Participants were asked to rate their mood both immediately prior to and following the film using the VAS (Davies & Clark, 1998). The VAS included ratings for happiness, anxiety, anger and depression and participants were asked to rate their mood for each using an 11-point scale of 0 (*not at all*) to 10 (*extremely*). An overall combined mood score was calculated both pre and post-film by calculating an average across the four scales (with happiness reverse scored). Additionally, after the film, participants were asked to rate how much attention they had paid to the film using the same 11-point scale.

Procedure

The procedural overview of Study 1 can be found in Appendix 4. The present study involved one online pre-screen survey prior to session 1. The main experiment involved two sessions (session 1 lab-based and session 2 online), which took place over two consecutive days. The study was advertised as a "processing emotional events" study and participants signed up by selecting the lab-based session that they could attend. Once dates for sessions 1 and 2 were confirmed, participants were sent the online link to the pre-screen survey and they were required to complete this within 7-days of their pre-booked session 1.

The pre-screen required participants to read through the participant information sheet and provide their informed consent online. Next, participants completed several demographic questions (e.g., age[2], gender, occupation) including the Traumatic Experiences Questionnaire (TEQ; adapted from Foa, Ehlers, Clark, Tolin, & Orsillo, 1999)—a brief measure of trauma history. The TEQ asked participants to read a series of statements depicting examples of traumatic experiences (e.g., "a serious accident, fire, or explosion?") and respond with either "yes" or "no" if they had ever experienced

[2] Age data for one participant was missing

or witnessed any of these events during their lives. This 11-item scale included statements on exposure to sexual and physical assault, as well as military war exposure. Each "yes" response was awarded one point; therefore, a TEQ score was calculated by summing up the total number of "yes" responses (i.e., max score = 11). Next, based on previous studies (Takarangi, Smith et al., 2017) participants were asked to nominate the worst event that they had experienced within their lifetime (e.g., physical assault, life threatening illness, car accident). They were told to describe this briefly in a few words and not to recall it in detail. Next, participants were asked to retrospectively rate how emotionally distressed they were at the time of this event, using a scale of 1 (*not at all*) to 5 (*very much*). Next, participants completed the DASS-21 in relation to the past 7-days and the EEA. Following this, participants completed the BAMQ, MCQ-30 subscales and RIQ (where applicable), all in relation the nominated historic event from the TEQ. This was to obtain an estimate of participants' pre-existing metacognitive/metamemory beliefs (in relation to a personally experienced event).

In session 1 (lab-based), all participants participated individually. Here, following study information and informed consent verifications, participants were asked to rate their mood, watch the trauma film and complete the post-film mood and film rating questions. Next, participants were randomly allocated to a CBM training group, either $CBM_{Metacog}$ or $CBM_{Control}$. Immediately following the training, all participants completed the same ERT to determine index bias scores. Next, participants completed the MCQ subscales and BAMQ (in relation to the film). Lastly, participants were asked a dichotomous yes/no question of whether they had experienced any intrusions about the film since watching it. Only participants who responded "yes" completed the RIQ in relation to the film. At the end of session 1, there was an open-ended question to determine whether participants in the $CBM_{Metacog}$ were aware that we were trying to bias

their thinking. The question was "please provide your best guess as to what the purpose of today's session was". Seventeen participants, all from the $CBM_{Metacog}$ group (i.e., 45% of the total $CBM_{Metacog}$ sample), gave a response that was closely aligned with the true aim of the session (i.e., CBM to bias thinking/beliefs). Example responses included "to make me realise that memory blanks are not a sign of weakness or my fault"; "to understand that worrying and memory loss regarding traumatic events is normal"; "to help people realise that no matter how they recall a negative event, it is normal and not concerning". This demonstrates that, despite participants not being explicitly told that the computerised task was aimed to modify their thinking, nearly half of the participants in the $CBM_{Metacog}$ group were explicitly aware of what the CBM training was trying to do. This puts into question the level of demand characteristics that may be at play within this study.

Session 2 was the following day. Here, all participants were emailed the online link to session 2, and they were advised to complete the link as close as possible to the time that they took part in session 1, to ensure at least 24 hours had passed. At session 2, participants firstly entered their intrusion diary data, including their diary compliance rating.[3] Next, they completed the second ERT, free memory recall task, post-training metacognitive/metamemory beliefs, DASS-21 and the IES-R. Upon completion of session 2, participants received a written debrief online and were given contact information should they have any further questions about the study.

5.3. Hypotheses

1) The $CBM_{Metacog}$ group compared, to the $CBM_{Control}$ group, will demonstrate significantly healthier metacognitive beliefs, as measured by index bias scores

[3] Diary compliance data for twenty-nine participants was missing (these were the participants who completed another study as outlined in Chapter 5).

and the standardised scales (i.e., lower scores on BAMQ, MCQ subscales and RIQ) at each session.

2) The $CBM_{Metacog}$ group, compared to the $CBM_{Control}$ group, will report fewer PTSD symptoms. Specifically, the $CBM_{Metacog}$ group, compared to the $CBM_{Control}$ group, will report lower IES-R scores, lower intrusion frequency scores (intrusion diary), and lower overall intrusion distress.
3) The $CBM_{Metacog}$ group, compared to the $CBM_{Control}$ group, will demonstrate greater levels (i.e., higher scores) of self-reported psychological resilience.
4) The $CBM_{Metacog}$ group, compared to the $CBM_{Control}$ group, will demonstrate fewer self-reported depression and stress symptoms.

5.4. Data analysis

All data were analysed with the General Linear Model, with alpha set to .05. The study's hypotheses and analysis plan were also pre-registered via Open Science Framework (https://osf.io/48wpg/?view_only=39f98c74df8b40efa79c9504f8c7198a), prior to data collection. Thus, all prior hypotheses tests were one-tailed and the post-hoc comparisons were Holm-Bonferroni corrected (Holm, 1979) to control family-wise error rates. In line with the pre-registration, outliers were kept in the final data set for analysis (N = 74). However, when extreme multivariate outliers were identified and removed from the dataset (n = 5), the pattern of results remained the same, thus they were kept in the final analysis. [4] As a reminder, due to the poor reliability of the anxiety subscale of the DASS-21 and the BAMQ negative, they are not included in the results section below.

[4] Extreme outliers were determined via boxplots on SPSS. Any data point that was three times the interquartile range was deemed to be a significant extreme outlier.

5.5. Results

Participant characteristics and baseline measures

Independent *t*-tests revealed no significant group differences ($CBM_{Metacog}$ versus $CBM_{Control}$) on demographic questions or baseline measures (two-tailed): age $t(71) = .34$, $p = .74$; TEQ $t(72) = .55$, $p = .58$; depression $t(72) = .36$, $p = .72$; and stress symptoms $t(72) = .30$, $p = .08$. Additionally, there were no significant group differences on gender $\chi^2 (1) = .02$, $p = .90$, metacognitive/metamemory beliefs (MCQ 1, 2, 3 & BAMQ) (*p*s > .07) or psychological resilience (*p*s > .26) (see Table 4).

Film impact

The combined mood scores pre and post-film were analysed with a mixed ANOVA. Here, time was the within-subjects factor and CBM group as the between-subjects factor. The ANOVA revealed a significant main effect for time $F(1, 72) = 104.78$, $p < .001$, $\eta_p^2 = .59$, with greater scores (i.e., worse mood) being reported post film ($M = 3.46$, $SEM = .19$) compared to pre film ($M = 1.75$, $SEM = .14$), as predicted. There were no other significant main or interaction effects (*F*s<. 72, *p*s >. 40). Further, separate independent *t*-tests revealed no significant group differences in distress ratings towards the film ($p = .72$) or attention paid to the film ($p = .91$). These results demonstrate that, participants in both CBM groups, experienced similar increases in their negative mood and levels of distress in response to the film.

Table 4

Participants' demographic data, baseline metacognitive/metamemory beliefs, mood scores and film ratings by CBM group (Study 1)

Measure	$CBM_{Metacog}$ (*n* = 38, 29 female) *M* (*SD*)	$CBM_{Control}$ (*n* = 36, 27 female) *M* (*SD*)	*t*-test
Age	21.92 (5.86)	22.39 (6.07)	$t(71) = .34$, $p = .74$
TEQ	0.61 (0.79)	0.75 (1.40)	$t(72) = .55$, $p = .58$
DASS-21-D	6.21 (7.45)	6.89 (8.89)	$t(72) = .36$, $p = .72$
DASS-21-A	5.68 (4.93)	6.11 (6.07)	$t(72) = .33$, $p = .74$
DASS-21-S	7.74 (7.05)	10.72 (7.28)	$t(72) = 1.79$, $p = .08$
MCQ-1	10.11 (4.26)	11.53 (4.14)	$t(72) = 1.46$, $p = .15$
MCQ-2	10.11 (3.91)	9.97 (4.80)	$t(72) = .13$, $p = .90$
MCQ-3	10.53 (3.14)	10.97 (2.84)	$t(72) = .64$, $p = .53$
BAMQ-Negative	9.39 (2.24)	8.47 (1.98)	$t(72) = 1.87$, $p = .07$
BAMQ-Positive	13.37 (4.91)	13.67 (4.81)	$t(72) = .26$, $p = .79$
RIQ	28.12 (10.14)	27.53 (13.01)	$t(32) = .15$, $p = .88$
EEA (total score)	37.32 (11.27)	36.69 (10.05)	$t(72) = .25$, $p = .80$
Attention to film	9.05 (0.98)	9.03 (0.94)	$t(72) = .11$, $p = .91$
Distress to film	6.87 (1.74)	6.72 (1.72)	$t(72) = .36$, $p = .72$
Diary compliance	9.00 (1.00)	8.91 (0.92)	$t(43) = .32$, $p = .75$

Note. TEQ = Traumatic Experiences Questionnaire; DASS-21-D/A/S = Depression Anxiety, Stress-21 subscales; BAMQ = Beliefs about Memory Questionnaire; MCQ-1/2/3 = Metacognitions Questionnaire subscales; RIQ = Response to Intrusions Questionnaire; EEA = Ecological Systems Model of Resilience

Metacognitive appraisals and beliefs

Participants' index bias scores from post-training session 1 and session 2 were analysed separately using a one-way ANOVA with CBM group as the between-subjects factor. Analysis of session 1 revealed a significant main effect for CBM group $F(1, 72) = 43.37$, $p < .001$, $\eta_p^2 = .38$, with significantly higher index bias scores (i.e., positive) reported for the $CBM_{Metacog}$ group ($M = 2.38$, $SD = .90$) compared to the $CBM_{Control}$ ($M = .96$, $SD = .94$) as predicted. Similarly, there was also a significant main effect for CBM group at session 2, $F(1, 72) = 19.10$, $p < .001$, $\eta_p^2 = .21$, with a higher positive bias demonstrated in the $CBM_{Metacog}$ group (M = 2.35, SD = 1.12) vs the $CBM_{Control}$ group ($M = 1.23$, $SD = 1.07$). These results demonstrate that the $CBM_{Metacog}$ training was successful in inducing a positive—i.e. healthy metacognitive belief—bias in participants, compared to the $CBM_{Control}$.

It was expected that the $CBM_{Control}$ group would yield an index bias score close to zero (i.e., no bias). However, contrary to prediction, the $CBM_{Control}$ group also yielded a positive index bias score. To investigate this further, the index bias scores for each CBM group, at each session were analysed separately using a one sample *t*-test. As expected, the index bias scores at both sessions for the $CBM_{Metacog}$ group were significantly different than zero, as predicted (i.e., positive) (*p*s <. 001). However, the $CBM_{Control}$ also demonstrated index bias scores that were significantly different from zero, in session 1, $t(35) = 6.13$ $p < .001$, $d = 1.02$ ($M = .96$, $SD = .94$) and in session 2, $t(35) = 6.89$ $p < .001$, $d = 1.15$ ($M = 1.23$, $SD = 1.07$). Therefore, it appears that the $CBM_{Control}$ group also yielded a positive bias score at both sessions.

Next, the positive metamemory beliefs were analysed using a 2 x 2 mixed ANOVA, using session (post-training session 1 and session 2) as the within-subjects factor and CBM group as the between-subjects factor. Results found a significant main

effect for CBM group, $F(1, 72) = 4.25$, $p = .04$, $\eta_p^2 = .06$, with healthier metamemory beliefs being reported by the $CBM_{Metacog}$ group ($M = 10.32$, $SEM = .58$), compared to the $CBM_{Control}$ group ($M = 12.04$, $SEM = .60$). No other effects were found (Fs < .31 ps >.24).

Next, changes in participants' self-reported metacognitive beliefs were assessed. Analysis of the MCQ 1 (i.e., positive beliefs about worry), MCQ 2 (i.e., beliefs about the uncontrollability/danger of thoughts) and MCQ 3 (i.e., (i.e., beliefs about the need to control thoughts) were analysed together at each session with a MANOVA. At post-training session 1, the MANOVA revealed a significant CBM group effect, $F(3, 70) = 8.89$, $p < .0005$; Wilk's $\Lambda = .72$, $\eta_p^2 = .28$. Post-hoc univariate tests revealed a significant difference in both MCQ 1 $F(1, 72) = 9.38$, $p = .003$, $\eta_p^2 = .12$ and MCQ 3 $F(1, 72) = 12.44$, $p = .001$, $\eta_p^2 = .15$, scores between CBM groups (Bonferroni corrected). Healthier scores for both the MCQ 1 and MCQ 3 were reported by the $CBM_{Metacog}$ group (MCQ1 $M = 9.53$, $SEM = .63$; MCQ3: $M = 8.55$, $SEM = .47$) vs the $CBM_{Control}$ group (MCQ1 $M = 12.28$, $SEM = .64$; MCQ3: $M = 10.92$, $SEM = .47$).

Analysis of MCQ scores at session 2 revealed a significant CBM group effect, $F(3, 70) = 4.04$, $p = .01$; Wilk's $\Lambda = .85$, $\eta_p^2 = .15$. Post-hoc univariate tests revealed a significant difference between CBM groups in MCQ 3 scores only $F(1, 72) = 7.13$, $p = .009$, $\eta_p^2 = .09$ (Bonferroni corrected); with healthier scores being reported by the $CBM_{Metacog}$ group ($M = 8.00$, $SEM = .42$) vs the $CBM_{Control}$ group ($M = 9.61$, $SEM = .43$). The MCQ 3 results should be interpreted with caution, as the session 2 MCQ 3 score demonstrated a Cronbach's alpha score of .67, which is just under acceptable limits. Additionally, these analyses were conducted again, using participants' baseline metacognitive/metamemory belief score as a covariate, to assess whether participants' pre-existing metacognitive beliefs affected the results. However, including participants'

pre-existing baseline scores as a covariate did not change the pattern of results for most analyses.

Lastly, independent *t*-tests were used to analyse the RIQ total score at post-training session 1 and session 2. At session 1 post-training, 31 participants reported experiencing intrusions since watching the film and completed the RIQ ($CBM_{Control}$ n = 15; $CBM_{Metacog}$ n = 16), however there were no significant differences in RIQ scores between CBM groups, $t(29) = .17$, $p = .87$, $d = .06$ (CBM_{Metcog} $M = 19.38$, $SD = 4.15$; $CBM_{Control}$ $M = 19.00$, $SD = 7.73$). Similarly, at session 2, only 24 participants completed the RIQ ($CBM_{Control}$ $n = 9$; $CBM_{Metacog}$ $n = 15$) and no significant differences were found in RIQ scores, between CBM groups $t(22) = .50$, $p = .62$, $d = .06$ (CBM_{Metcog} $M = 19.20$, $SD = 4.09$; $CBM_{Control}$ $M = 18.11$, $SD = 6.57$).

PTSD symptoms

In line with the pre-registration analysis plan, a one-tailed independent samples *t*-test revealed no significant differences in IES-R total scores between CBM groups, $t(72) = .61$, $p = .27$, $d = .14$ (one-tailed). However, inspection of the mean scores revealed that the IES-R total scores were lower in the $CBM_{Metacog}$ group compared to the $CBM_{Control}$ group, as predicted. Similarly, no significant differences were found between CBM groups on the IES-R intrusion subscale scores, $t(72) = .23$, $p = .82$, $d = .03$ (one-tailed). However, descriptively speaking, intrusion scores were higher for the $CBM_{Metacog}$ group compared to the $CBM_{Control}$ (see Figure 4 and Table 5).

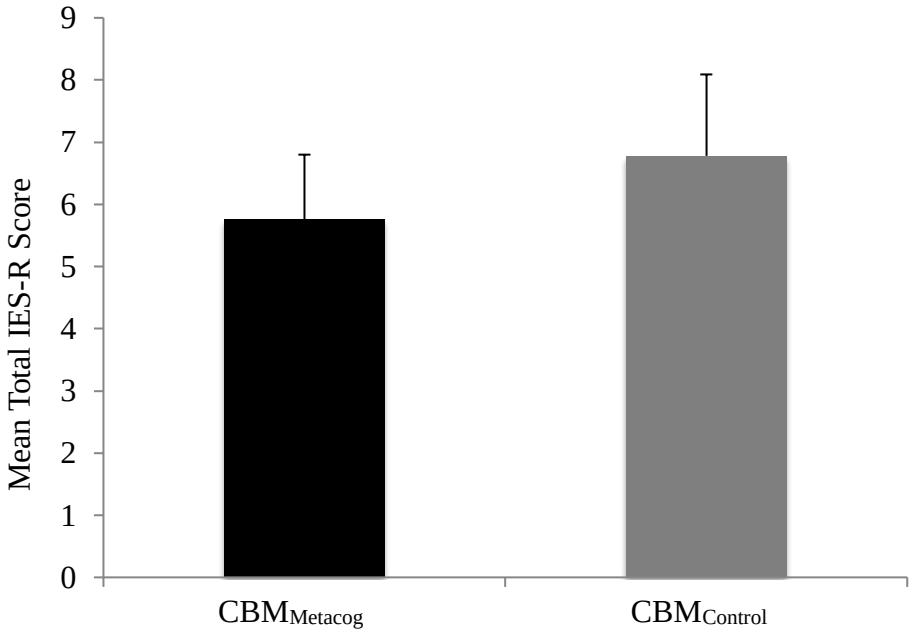


Figure 4 Mean (+1SEM) total IES-R scores by CBM group (Study 1)

Table 5

Mean (SD) of IES-R by CBM group (Study 1)

	$CBM_{Metacog}$	$CBM_{Control}$
Measure	*M(SD)*	*M (SD)*
IES-R: Total Score	5.76 (6.40)	6.78 (7.88)
IES-R: Intrusions	2.50 (3.37)	2.33 (3.37)

Next, the intrusion diary scores were analysed. Firstly, there was no significant difference in diary compliance ratings between CBM groups, $t(43) = .32$, $p = .75$, $d = .10$ (see Table 4). Only 24 participants reported intrusions at session 2 (only 32% of the total sample), (n = 9 $CBM_{Control}$; n = 15 $CBM_{Metacog}$). In line with the pre-registration analysis plan, separate independent-samples t-tests (one-tailed) were conducted to analyse the total intrusion frequency and intrusion distress scores between CBM groups.

There was no significant difference in intrusion frequency between CBM groups, $t(72) = 1.36$, $p = .09$, $d = .31$ (one-tailed) ($CBM_{Metacog}$ $M = .71$, $SD = 1.01$; $CBM_{Control}$ $M = .42$, $SD = .84$). The next analysis was confined to only the sample of participants ($n = 24$) who reported intrusions. Again, it appeared that both CBM groups reported a similar number of intrusions ($CBM_{Metacog}$ $M = 1.80$, $SD = .75$; $CBM_{Control}$ $M = 1.67$, $SD = .87$), $t(22) = .39$ $p = .35$, $d = .16$ (one-tailed). Although non-significant, descriptively speaking, both results show that the $CBM_{Metacog}$ group displayed higher intrusion means than the $CBM_{Control}$ group, opposite to the direction predicted.

Participants from the $CBM_{Metacog}$ group reported greater intrusion distress compared to the $CBM_{Control}$ condition, $t(22) = 1.83$, $p = .04$, $d = .78$ (one-tailed), $CBM_{Control}$ $M = 2.54$, $SD = 1.73$ versus $CBM_{Metacog}$ $M = 3.98$, $SD = 1.94$, ; note that the direction of the effect was opposite to that predicted. Overall, these results do not support hypothesis 2. Importantly, given that only a small proportion of participants reported experiencing intrusions, these results need to be interpreted with caution.

Psychological resilience

Next, participants total psychological resilience scores were analysed with a 2 x 2 mixed ANOVA, with session (baseline and session 2) as the within-subjects factor and CBM group as the between-subjects factor. The ANOVA revealed a main effect for time, with higher resilience scores being reported at session 2 ($M = 39.91$, $SEM = .97$) compared to session 1 ($M = 37.01$, $SEM = 1.24$), $F(1, 72) = 5.28$, $p = .02$, $\eta_p^2 = .07$. No other main effects or interaction effects were found (Fs < .07, ps >. 80).

Depression and stress symptoms

Separate mixed ANOVAs, for both depression and stress DASS subscales, were conducted, using CBM group as the between-subjects factor. The analyses indicated that depression and stress symptoms were all significantly higher at baseline (i.e., pre-

screen) compared to session 2; depression: $F(1, 72) = 9.43$, $p = .003$, $\eta_p^2 = .12$, baseline ($M = 6.55$, $SEM = .95$), session 2 ($M = 4.28$, $SEM = .70$); and stress: $F(1, 72) = 25.15$, $p < .001$, $\eta_p^2 = .26$, baseline ($M = 9.23$, $SEM = .83$), session 2 ($M = 5.81$, $SEM = .66$). No other effects were found (Fs < 3.07, ps > .08). These results suggest that, contrary to prediction (hypothesis 4), $CBM_{Metacog}$ training does not appear to reduce depression or stress symptoms.

5.6. Discussion

Study 1 was a pilot study that aimed to examine the causal role of healthy metacognitive beliefs in PTSD, using the trauma film paradigm. To examine this, two novel CBM training protocols were developed: one to train people to adopt healthy metacognitive/metamemory beliefs ($CBM_{Metacog}$), and one composed of neutral training sentences to act as a suitable control group ($CBM_{Control}$). The CBM training was tested using the trauma film paradigm to determine whether receiving the $CBM_{Metacog}$ training immediately following exposure to an analogue trauma, led participants to report healthier metacognitive/metamemory beliefs and fewer analogue PTSD symptoms post-training compared to participants in the $CBM_{Control}$ group. Although there was evidence that the $CBM_{Metacog}$ training lead to healthier metacognitive beliefs compared to the $CBM_{Control}$ group, the data did not show differences in PTSD symptoms between CBM groups. These results will be discussed in turn below.

Firstly, the results demonstrated that the $CBM_{Metacog}$ training did bias participants' thinking styles in the intended direction, as represented by the positive index bias scores that were significantly higher than those found in the $CBM_{Control}$ group. However, interestingly, it appeared that the $CBM_{Control}$ group also yielded a positive index bias score. This may be due to the sample chosen in this study. For instance, here we used a sample of healthy participants, whom arguably hold relatively

healthy metacognitive beliefs compared to clinical/sub-clinical PTSD samples. Thus, it is possible that when completing the ERT ratings, participants in the $CBM_{Control}$ group were interpreting the meaning of the sentences as if it were asking them what they think personally overall, and not specifically in relation to what they had learned from the CBM training. This is despite the ERT items asking participants specifically to rate them in relation to what they had learned as a result of "this training session". However, it is clear that the $CBM_{Metacog}$ did enhance participants' healthy bias in metacognitive beliefs, as demonstrated by the significantly higher positive bias score in the $CBM_{Metacog}$ group compared to the $CBM_{Control}$ group, thus offering support for hypothesis 1.

Secondly, in line with hypothesis 1, there was evidence that the $CBM_{Metacog}$ training lead participants to report healthier explicit self-reported metacognitive/metamemory beliefs, compared to the $CBM_{Control}$ group. Specifically, the $CBM_{Metacog}$ training appeared to have increased healthy metamemory beliefs about the trauma film. Likewise, participants who received the $CBM_{Metacog}$ training reported healthier metacognitive beliefs compared to $CBM_{Control}$, such as lower scores on the MC1 (i.e., positive beliefs about worry) and the MCQ 3 (i.e., beliefs about the need to control thoughts). However, as the MCQ 3 session 2 score was borderline significant, these results should be interpreted with caution. Overall, these results offer further support for hypothesis 1, suggesting that the $CBM_{Metacog}$ training did lead to some significant transfer effects by increasing healthy self-reported metacognitive/metamemory beliefs among participants, compared to $CBM_{Control}$.

Importantly, hypothesis 2 was not supported in this study. No significant differences in analogue PTSD symptoms were found between CBM groups. Here, participants were asked to keep a 1-day intrusion diary and to enter their intrusion data at session 2, when they were sent the online link. Overall, only a small proportion of

participants reported experiencing intrusions via the diary in this study. Thus, the numbers are too low to make reliable inferences about the intrusion diary data between CBM groups. Indeed, previous analogue trauma studies have also reported low intrusion frequencies obtained from intrusion diaries (e.g., Bisby et al., 2009; Das et al., 2016; Holmes et al., 2009), or no intrusions at all (Verwoerd, Wessel, de Jong, Nieuwenhuis, & Huntjens, 2011). However, it is possible that the 24-hour follow-up used in this study did not provide enough time to capture the development of participants' intrusions. It is likely that the impact of the $CBM_{Metacog}$ training may need more time to take effect. For instance, in real-time monitoring of intrusions, an individual needs to first notice the occurrence of an intrusion and then be able to apply what they have learned from the training (whether this is implicitly or explicitly). Thus, it is possible that a longer follow-up period between CBM training and the measurement of intrusions is required to better assess the frequency and distress ratings of intrusions over time. Although there were no significant differences between total IES-R scores or any of the IES subscales, the means for the total score appeared to be in the anticipated direction, that is, higher in the $CBM_{Control}$ versus the $CBM_{Metacog}$ group. The exception being for the intrusion subscale; here, the mean was slightly higher in the $CBM_{Metacog}$ group compared to the $CBM_{Control}$ group. As approximately half of the participants in the $CBM_{Metacog}$ group detected the true aim of the study to some extent (i.e., to change their thinking patterns), it may be that $CBM_{Metacog}$ participants detected the demand to possibly report lower intrusions and, consequently, did not report them. However, when data from the 17 participants (who guessed the aim of the experiment) were removed, the overall pattern of results remained the same (i.e., metacognitive belief/ PTSD symptom results). Another possibility for this unexpected finding is that the trauma film used in this study did not evoke a strong enough emotional response in

participants to trigger the development of intrusions. It is clear that replication of this study is needed, and once replicated, it would be worthwhile testing the $CBM_{Metacog}$ training out using another analogue trauma stimulus, such as a mixture of compiled trauma film clips. Using a compilation of trauma clips could help to maximise the chances of participants experiencing intrusions, as the content of the trauma films is more varied and consequently, may evoke an emotional reaction among more participants.

Lastly, this study failed to support hypotheses 3 and 4; as no significant differences were found in depression and stress scores, or psychological resilience, between CBM groups.

Overall, the results of Study 1 offer some promising findings. It is the first study to test out a novel CBM training protocol designed to target maladaptive metacognitive beliefs associated with the development of PTSD. Although no significant differences in PTSD symptoms were found, these results suggest that metacognitive beliefs can be targeted using the $CBM_{Metacog}$ training protocol, however replication is needed, and key questions remain. For example, would training people to adopt healthy metacognitive beliefs, *prior* to analogue trauma, lead to healthier metacognitive beliefs and fewer PTSD symptoms, compared to the $CBM_{Control}$ group? This design would be more in line with the primary prevention of PTSD, which focuses on administering preventive interventions prior to trauma exposure; a concept that is pertinent to first responder communities whom are routinely exposed to trauma in their day-to-day jobs.

However, before addressing this research question it is important to consider whether people's pre-existing metacognitive beliefs affect the way they encode distressing/threatening situations. For instance, are maladaptive metacognitive beliefs associated with increased vulnerability to PTSD, as they affect how people encode a

distressing event? Specifically, are maladaptive metacognitive beliefs associated with an increased attentional bias towards threat-related versus non-threat information? Exploring this research question will help shed light on whether training people to adopt healthier metacognitive beliefs changes the way the way they encode distressing information, or whether it changes the way they process and recover from a distressing event.

CHAPTER 6: AN EYE-TRACKING STUDY TO INVESTIGATE THE LINK BETWEEN METACOGNITIVE BELIEFS AND ATTENTION TO THREAT (STUDY 2)

6.1. Study overview

Research demonstrates that endorsing maladaptive metacognitive beliefs, prior to trauma exposure, can render one vulnerable to developing PTSD (Takarangi, Smith et al., 2017). Study 1 examined whether increasing people's healthy metacognitive beliefs *post* analogue trauma had a protective effect on reducing PTSD symptoms, compared to a control group. The next step is to test whether training people to adopt healthy metacognition can prevent the development of PTSD symptoms. If $CBM_{Metacog}$ is delivered *prior* to analogue trauma will the adoption of healthier metacognitive beliefs lead to fewer PTSD symptoms compared to a control group (see Chapter 7; Study 3)? Before we can answer this question, however, one understudied, yet important question remains: How do maladaptive metacognitive beliefs increase vulnerability to PTSD in the aftermath of trauma exposure?

One potential explanation is that metacognitive beliefs affect the way individuals encode a traumatic event. People with greater maladaptive metacognitive beliefs may attend to different types of information during a traumatic experience. Specifically, perhaps they attend more to threat versus non-threat information compared to people with healthier metacognitive beliefs, and this preferential attention to threat increases PTSD risk. Examining this research question helps to determine whether training people to adopt healthy metacognitive beliefs prior to exposure to analogue trauma (i.e., as in Chapter 7; Study 3) changes the way people process and/or encode distressing events. One way to assess these attentional processes is to use eye-tracking software, where people's eye movements can be tracked while processing emotional material such as a trauma film.

According to the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004), following trauma exposure, it is normal for people to experience PTSD

symptoms such as intrusions. However, it is thought that people who go on to develop PTSD, do so, because they engage in dysfunctional coping strategies (i.e., CAS), which disrupt the body's natural recovery process (i.e., RAP) For example, it is thought that a person who engages in repetitive thinking styles such as worry/rumination, or monitors their environment for threat or engages in avoidance of threat, will go on to develop PTSD. Importantly, the metacognitive model proposes that these strategies are initiated and maintained by one's *metacognitive beliefs.* Takarangi, Smith et al. (2017) demonstrated that endorsing maladaptive metacognitive beliefs, prior to trauma exposure, increased one's vulnerability to developing PTSD. This finding gives rise to another potential mechanism at hand. That is, people with maladaptive metacognitive beliefs engage in top-down attention processing, leading them to attend to more threat sources of information when encoding the trauma. In theory, this could then heighten their sense of threat and prolong their symptoms, leading to PTSD. Or, it may heighten their sense of threat, thus triggering the use of the maladaptive coping strategies (e.g., avoidance), which prolongs symptoms and leads to PTSD.

To date, only a handful of studies using eye-tracking to investigate attentional biases in PTSD exist (see Felmingam, 2015; Lazarov et al., 2019 for reviews), and these studies have tended to rely on either the emotional Stroop task (Williams, Mathews, & MacLeod, 1996) or the dot-probe task (MacLeod, Mathews, & Tata, 1986), both of which infer attentional bias via reaction times. For the emotional Stroop task, individuals are asked to name the colour ink that trauma-related words and neutral words are written in. It is proposed that individuals with PTSD will attend more to the trauma-related words compared to the neutral words. This attentional bias towards trauma-relevant stimuli interferes with their ability to quickly name the colour ink of trauma-related stimuli, and consequently they have slower response latency. However,

there are inconsistent findings among the emotional Stroop task in PTSD. For example, some studies found a biased attention towards threat (e.g., Harvey, Bryant, & Rapee, 1996; Martinson, Sigmon, Craner, Rothstein, & McGillicuddy, 2013; McNally, Kaspi, Riemann, & Zeitlin, 1990), whereas other studies found a bias away from threat (e.g., Constans, McCloskey, Vasterling, Brailey, & Mathews, 2004; McNally, Amir, & Lipke, 1996). Within, the dot-probe task, participants are shown two stimuli simultaneously, one being neutral and the other being threat-related (e.g., words, faces). A dot then appears on the screen, at a point where one of the stimuli was previously located. Participants are then asked to make a decision about the probe (e.g., whether the probe is the letter E or F). Attentional bias towards threat is inferred by participants who are faster to respond to probes that replace the location of threat stimuli, compared to the neutral. Similar to the emotional Stroop task literature, the dot-probe task has also yielded mixed results; with some studies reporting an attentional bias towards threat (e.g., Bardeen & Orcutt, 2011), away from threat (e.g., Bar-Haim et al., 2010) and no bias (Schoorl, Putman, & Van Der Does, 2013).

Notably, both the emotional Stroop task and the dot-probe task have their drawbacks. Reaction time-based tasks demonstrate poor reliability (Schmukle, 2005; Staugaard, 2009). Second, reaction-time based tasks rely on a keypress to indicate attention; which may be confounded by other factors such as motor responses (Kimble, Fleming, Bandy, Kim, & Zambetti, 2010). Lastly, these two tasks can only measure attention at a single time point and cannot capture initial and subsequent fixations over time. This is important, as a real-life trauma will encompass many dynamic visual complexities and it is likely that threat fixations will fluctuate at different points during a traumatic event. Using eye-tracking software to track eye movements in an emotional/traumatic scene may prove a more reliable tool. Eye-tracking offers a direct

and ecologically valid measure of attention, that is able to capture several types of attentional processes including those central to facilitated attention (e.g., number of fixations), difficulty with disengagement (e.g., dwell time) and attentional avoidance (e.g., location of subsequent fixations) (see Cisler & Koster, 2010 for a detailed account of each).

In sum, the current study investigated the relationship between pre-existing metacognitive beliefs and attention to threat versus non-threat information, using eye-tracking software and the trauma film paradigm. To date, there appears to be only two published eye-tracking studies that have employed a variant of the trauma film paradigm to assess attentional processes relevant to PTSD (see Haley, 1974; Chen, Basanovic, Notebaert, MacLeod, & Clark, 2017). However, neither of these studies focused on metacognitive beliefs related to PTSD and attentional processing. Thus, it appears that this is the first study to do so. Using the trauma film paradigm offers a unique advantage over using other trauma stimuli (e.g., threatening images/words), as it allows for participants' eye movements to be tracked over time in a moving scene (akin to real-life trauma). This study also included a free memory recall task, to explore whether attention to threat sources of information during the film was associated with the voluntary recall of specific memory details, namely central and peripheral. Exploring this relationship may highlight the use of any dysfunctional coping strategies that participants may employ during the encoding of trauma. For instance, neglecting to recall central information that they have attended to, may indicate the use of avoidant coping strategies; although other explanations are also possible.

6.2. Method

Participants

Thirty healthy participants (female n = 13; age M = 24.14, SD = 8.52) were recruited from Loughborough University and took part in the study. Participants predominantly identified as being Caucasian (n = 24) and were either students or staff members at the university. Participants were recruited via poster advertisement around campus, and the study was advertised as the "the recall of emotional events" study. All participants confirmed prior to the study that they did not hold a diagnosis of PTSD, nor were they currently experiencing PTSD symptoms in relation to a traumatic event they had experienced. All participants were informed beforehand that the study involved them watching an emotional film (i.e., of a road-traffic accident) and that they could withdraw from the study at any point.

All interested participants firstly contacted the research team via email and were reminded once more what the study involved (i.e., watching an emotional film clip) and confirmed they met the eligibility requirements (i.e., participants had no current diagnosis/ symptoms of PTSD and were aged > 18 years old). To protect anonymity, all participants assigned themselves a unique 4-digit identifiable code, therefore, all their responses were saved to this unique code and not to their name or email address.

Design

This study used a cross-sectional design to analyse associations between pre-existing metacognitive beliefs and attention to threat vs non-threat sources of information (via eye-tracking software). Pre-existing metacognitive beliefs were measured via the MCQ 1, 2 and the BAMQ positive. The eye-tracking variables assessed included the proportion of fixations to threat and the proportion of dwell time to threat.

Materials

Trauma film. The same 4-minute film from Study 1 was used in this study. The film was displayed on a 15.6" Dell Precision M4800 laptop computer.

Measures

The same baseline and film rating measures as outlined in Study 1 were used in this study (see Appendix 3). That is, during the pre-screen survey participants were asked to complete several demographic questions, rate their level of trauma history exposure, baseline mood (DASS-21), and pre-existing metacognitive and metamemory beliefs in relation to a previously experienced historic event (MCQ-30; BAMQ; RIQ). As outlined in Study 1, the MCQ 3 and BAMQ negative demonstrated poor reliability, and were thus removed from the analysis. Additionally, immediately prior to, and following the film, participants rated their mood. After, they also rated how much attention they paid to the film using the VAS scales.

Free memory recall. A scoring template was designed to assess the free memory recalls from each online session. This template coded for central and peripheral details as well as word count. We adopted the thematic centrality (Heuer & Reisberg, 1990) definition of centrality. Therefore, central details referred to "any element pertaining to the basic story line that could not be changed or excluded without changing the basic story line" (Heuer & Reisberg, 1990, p. 499) (see also Cahill & van Stegeren, 2003). Three independent judges identified and agreed on the basic storyline of the film (central details), thus anything outside of this was regarded as peripheral information. Examples of central items used were "driver texting while driving", "crash into oncoming car" and any information relating to the victims' wellbeing (e.g., "two girls were unconscious"), visible in the film, as the victims were thematically and emotionally central to the story. Remaining elements were considered to the peripheral

details, such as information related to the environmental surroundings (e.g., weather, road signs), the cars involved (e.g., car model, colour) and descriptive details about the appearance of victims or bystanders clothing (e.g., blue t-shirt) (but not if it related to their wellbeing e.g., blood/injured etc.) The central and peripheral details were agreed and finalised by three independent researchers prior to coding the recalls. The main researcher scored all participants recalls independently whilst blinded to participant conditions. Additionally, a second independent researcher scored 20% of the recalls to ensure reliability of the scores. Any differing scores were discussed between the two judges until a 100% agreement was reached. Overall, we summed the scores for each memory detail (central and peripheral details) to form a measure of recall for each participant (see Appendix 9).

Eye-tracking software. Participants' eye movements were continuously tracked throughout the film using a Senso-Motoric Instruments (SMI) remote eye-tracking device (SMI Redn Scientific), a corneal reflex system set to sample at 60Hz and recording gaze with an accuracy of ± 0.4 degrees. Eye movements were recorded via the SMI experiment centre (SensoMotoricInstruments; SMI). Both prior to and immediately following the film, all participants' eye movements were calibrated via a 5-point calibration test.

Procedure

Full ethical approval was obtained for this study from Loughborough University's Ethics Approval (Human Participants) Sub-Committee (Ref: R16-P160). All participants completed the pre-screen session online, prior to session 1 (lab-based), which included the informed consent. Upon arrival to the lab for session 1, study information and informed consent was verified once more. Next, participants were set up with the remote eye-tracking software and asked to rate their mood using the VAS

scales (immediately prior to the film). Next, participants were asked to watch the film alone in the lab. Following the film, they rated their mood again and rated the level of attention paid to the film. After this, the eye-tracking part of the session was complete, and the remote eye-tracking equipment was removed from participants. Finally, participants then freely recalled everything that they could remember about the film. Note, that as the participants in this study went on to complete the CBM training as outlined in Study 1, all participants were debriefed online the day after the lab session (session 2, 24-hours later) (see Chapter 5, Study 1, for a reminder of the study outline).

6.3. Hypotheses

In line with the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004) it was hypothesised that:

1) The more participants endorse pre-existing maladaptive metacognitive beliefs (i.e., higher scores on the MCQ 1, 2, and the BAMQ positive), the more they will attend to threat sources of information from the trauma film (i.e., a positive correlation between metacognitive beliefs and the proportion of fixations/dwell time to threat).
2) The greater the proportion of fixations to threat and dwell time to threat, the more participants will recall central details in the free memory recall task (i.e., a positive correlation between the proportion of fixations/dwell time to threat and the number of central details recalled).

6.4. Data analysis

There were three criteria in selecting scenes for the analysis: 1) the scene must contain at least one source of threat (i.e., blood, injured people, damaged vehicle) and one non-threat source (i.e., paramedic, environment, bystanders); 2) the scene must last

for at least 1.0 seconds; and 3) the scene must contain a single camera viewpoint (i.e., the camera is still). By applying these criteria, three scenes were identified for analysis, using BeGaze software (version 3.6).

The first scene (see Figure 5), occurred approximately 48 seconds into the film, depicting crashed cars immediately following the accident and lasted 3.2 seconds. The second scene (see Figure 6), occurred approximately 128 seconds into the film and showed an injured man unconscious in the vehicle with members of the emergency services in the background and lasted 2.3 seconds. The final scene (see Figure 7), occurred 142 seconds into the film and was showing blood on the windscreen of the vehicle with members the emergency services in the background, lasting 2.9 seconds in duration. For each scene, using BeGaze software, two dynamic areas of interest (i.e., threat and non-threat) were identified and total dwell time and total number of fixations, were recorded for the threat and non-threat areas of interest. Two variables were calculated from the eye tracking data; the proportion of dwell time to threat and the proportion of fixations to threat. Proportion of dwell time was calculated by first summing the total dwell time (i.e., the total dwell time to threat plus the total dwell time to non-threat). Then, this total was divided by the total dwell time to threat specifically. Likewise, the proportion of fixations to threat was calculated by first summing the total number of fixations (i.e., total number of fixations to threat plus total number of fixations to non-threat), then dividing this total by the total number of fixations to threat specifically. These two proportion variables were the primary eye-tracking outcome measures.

The dataset was analysed for extreme outliers that were more that 3 IQ ranges about the median using boxplots in SPSS. One participant was identified as being a multivariate outlier on both the proportion of fixations to threat and proportion of dwell

time to threat variables. Analysis was run both with and without this participant in the dataset; however, significant effects were lost when the outlier was removed from the data set. This participant was removed from the dataset completely in the results that follow because of their undue influence. Thus, the final analysis was limited to a sample of 29 participants (age *M* = 23.96, *SD* = 8.63).

Figure 5 Analysis Scene 1: Unconscious injured man (threat) and emergency services (non-threat) (Study 2)

Figure 6 Analysis Scene 2: Car crash (threat) and environment (non-threat) (Study 2)

Figure 7 Analysis Scene 3: Blood on windscreen (threat) and emergency services (non-threat) (Study 2)

6.5. Results

Demographic factors, mood, psychological resilience and associations with attention to threat

Firstly, associations between participants' demographic information (i.e., age, gender, trauma history), baseline mood (i.e., DASS-21 and pre-film VAS mood), psychological resilience (EEA) and attention to threat (i.e., proportion of fixations/dwell time to threat) were analysed using Pearson's correlation coefficients. No significant associations were found between demographic information, psychological resilience and attention to threat (*p*s > .16). However, the more participants reported depression symptoms at baseline, the less likely they were to allocate their attention to threat, $r = -.38$, $p = .045$ (two-tailed) (see Table 6).

Metacognitive beliefs and associations with attention to threat

Next, the first hypothesis was explored. Here, associations between participants' pre-existing metacognitive beliefs and attention to threat in the film (i.e., the proportion of fixations/ dwell time to threat) were analysed using Pearson's correlation coefficients. Contrary to prediction, the results showed no significant correlations between pre-existing metacognitive beliefs and attention to threat (ps > .24) (see Table 6). Although non-significant, it appears that the more people endorse maladaptive metacognitive beliefs (i.e., higher scores), the *less* likely they were to fixate on threat information from the three scenes. Despite these results not supporting hypothesis 1, examination of the direction of the correlations suggest that participants with maladaptive metacognitive beliefs are more likely to avoid threat-related information. As there were no significant associations found between metacognitive beliefs and attention to threat, no further analyses were conducted.

Associations between the proportion of fixations/dwell time to threat and the recall of event memory details

Next, the proportion of fixations and dwell time to threat were correlated with the number of central and peripheral details recalled about the trauma film at each session. However, no significant correlations emerged (ps > .16) (see Table 7). Interestingly, descriptively speaking, the relationship between the proportion of fixations to threat and central details, was in the direction predicted. That is, the more people attended to threat information in the film, the more central details they recalled (albeit non-significant). Yet, a negative relationship was found between fixations to threat and peripheral details (non-significant). This would fit with previous literature, outlining the link between heightened emotional arousal and the preferential recall of

central details over peripheral details (e.g., Edelstein et al., 2004; Reisberg & Heuer, 2004, 2007).

Table 6

Correlation matrix showing associations between eye-tracking variables and baseline measures (Study 2)

Measure	Proportion of fixations to threat	Proportion of dwell time to threat
Age	0.12	0.12
TEQ	-0.06	-0.21
EEA	0.24	0.03
DASS-21-D	-0.31	-0.16
DASS-21-A	-0.19	0.06
DASS-21-S	-0.31	-0.25
MCQ-1	-0.18	0.13
MCQ-2	-0.22	-0.01
BAMQ-Positive	-0.22	0.20
Pre-film mood (VAS)	-0.06	-0.15

Note. TEQ = Traumatic Experiences Questionnaire; EEA = Ecological Systems Model of Resilience; DASS-21-D/A/S = Depression Anxiety Stress Scale; BAMQ = Beliefs about Memory Questionnaire; MCQ-1/2= Metacognitions Questionnaire

Table 7

Correlation matrix showing associations between eye-tracking variables and central and peripheral details (Study 2)

Measure	Number of Central Details	Number of Peripheral Details
Proportion of fixations to threat	0.07	-0.00
Proportion of dwell time to threat	0.27	0.03

6.6. Discussion

A growing body of work has outlined that maladaptive metacognitive beliefs are associated with a greater reporting of PTSD symptoms following trauma (e.g., Bennett & Wells, 2010; Takarangi, Smith et al., 2017); yet, the mechanism behind why maladaptive metacognitive increase PTSD risk remains unclear. This eye-tracking study tested whether pre-existing metacognitive beliefs increase vulnerability to PTSD symptoms, by affecting the way that people *encode* distressing events. Specifically, the association between pre-existing metacognitive beliefs and attention to threat information was examined. In line with the metacognitive model, maladaptive metacognitive beliefs lead people to engage in unhealthy coping strategies (e.g., worry, avoidance, threat monitoring). It is thought that these strategies prolong symptoms and lead to PTSD. However, it is possible that the sense of threat that is thought to trigger the use of these strategies stems from the way people with maladaptive metacognitive beliefs encode traumatic/distressing events, that is, they preferentially encode threat over non-threat information.

The results failed to support the two hypotheses: 1) that pre-existing metacognitive beliefs would be positively associated with an increased attention to threat (i.e., increased proportion of dwell time/fixations to threat from the film); and, 2) that fixations to threat will be positively associated with the recall of central details about the film. That is, no significant correlations were found either between fixations/dwell time to threat and pre-existing metacognitive beliefs, or between fixations/dwell time to threat and event memory details (free recall). Interestingly, although non-significant and descriptively speaking, it appeared that maladaptive metacognitive beliefs were negatively associated with attention to threat. Although contrary to prediction, there is another way of viewing these results in line with the metacognitive model. The metacognitive model considers avoidance to be a dysfunctional coping strategy—the use of which is linked to a person's metacognitive beliefs. Engaging in avoidance-based strategies is thought to *prolong* PTSD symptoms and prevent people from returning back to a threat-free way of processing, thus, this might explain the nature of the results. Further, Brewin's DRT (1996; 2010) is also relevant to unpicking these results. It is possible that to the increased stress experiencing during the encoding of the trauma, the C-reps were weakened, meaning that S-reps lost their context and consequently this heightened participants' sense of threat leading to increased levels of avoidance. Notably, this study has several limitations, which may explain the null findings.

Firstly, the study had a low sample size (N = 29) and is likely to be underpowered to detect even small effects between these variables. Indeed, using G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007) the associations between metacognitive beliefs and attention to threat revealed a post-hoc power analysis of .21. This suggests that the study was underpowered to detect a small effect and may explain

the non-significant result. Based on the effect size between metacognitive beliefs and attention to threat (e.g., r = -.22), it would appear that this study would need to collect data from 159 participants in order to detect an effect at 80% power, with alpha set to 0.05. Overall, this study was conducted to get a sense of the effect size; so that future CBM research with eye-tracking software could be carried out. However, due to the difficulty in accessing participants/availability of eye tracking equipment, alongside the small sized and null effects observed, it was decided that the role of metacognitive beliefs in directing emotional scenes was not a mechanism to expend further resources on. Thus, this line of research was not explored any further in this thesis.

Second, participants' PTSD symptoms were not measured in this study. Therefore, it is unknown how the allocation of attention to threat versus non-threat information was related to the reporting of PTSD symptoms. For instance, if greater maladaptive metacognitive beliefs are associated with an avoidance to threat, what impact would this have on the PTSD symptoms (e.g., intrusions)? One would predict a greater number of symptoms, but further research is needed to test this.

Third, voluntarily recall was assessed via a free recall task. Measuring voluntary memory via a recognition test may better pinpoint whether a participant remembered the specific details of interest (e.g., injured victim). For instance, asking participants true/false questions about certain details (i.e., central/peripheral) from the trauma film may help to clarify whether they remembered that type of detail specifically. This could allow for further analysis to examine whether there are any discrepancies between details you know they encoded (i.e., due to fixations/dwell time on this information) and what they later report via a memory test. Although there are many strengths to free memory recall (e.g., participants subjectively recall everything they appear to remember), it is still difficult to grasp whether a failure to report a certain detail is a

result of the participants not remembering it, or whether they do not view it important enough to recall, or any other potential factors (e.g., participant burden of free recall).

Overall, there are few PTSD studies that employ eye-tracking; yet, the approach offers a rich amount of data that are central to key cognitive theories of PTSD (e.g., Brewin et al., 1996; Ehlers & Clark, 2000; Wells, 2000). An interesting line for future research would be to assess whether training people to adopt healthy metacognitive beliefs prior to analogue trauma (e.g., $CBM_{Metacog}$) leads to changes in people's attention to threat versus non- threat information and how this subsequently affects PTSD symptoms development.

In the next study, $CBM_{Metacog}$ training was administered prospectively (i.e., prior to analogue trauma) to determine whether training people to adopt healthy metacognitive beliefs, prior to trauma exposure, is able to increase people's healthy metacognitive beliefs and reduce PTSD symptoms compared to the $CBM_{Control}$. Eye-tracking equipment was not used in the next study due to lack of equipment availability, and because our primary aims were to test whether prospective CBM reduces PTSD symptoms and leads to healthier metacognitive beliefs.

CHAPTER 7: PROSPECTIVE PILOT ANALYSIS OF $CBM_{METACOG}$ TRAINING FOR AN ANALOGUE TRAUMA (STUDY 3)

7.1. Study overview

In the first pilot study, Study 1, the $CBM_{Metacog}$ training was delivered immediately following analogue trauma exposure, akin to a secondary PTSD prevention intervention. However, it remains unclear whether receiving the $CBM_{Metacog}$ training immediately *prior* to analogue trauma, can also help increase healthy metacognitive beliefs and reduce PTSD symptoms associated with analogue trauma. The purpose of Study 3 was to pilot the efficacy of $CBM_{Metacog}$ training when delivered *immediately prior to analogue trauma*, compared to $CBM_{Control}$. This study has strong implications for the *primary prevention* of PTSD for communities who are frequently exposed to trauma within their day-to-day roles, such as first responders (e.g., police officers, ambulance workers). Woud et al. (2013) administered CBM-App training (to target negative self-efficacy appraisals associated with PTSD) prior to analogue trauma, and found that participants who were trained positively (i.e., to adopt healthy appraisals) reported experiencing less intrusion distress compared to the negative group (i.e., trained to adopt negative appraisals). There is a growing need for the development of novel preventative interventions for PTSD (Holmes et al., 2018), and research into the primary prevention of PTSD specifically, remains scarce (Skeffington, Rees, & Kane, 2013). This study explores whether metacognition—an understudied area in PTSD—can offer a novel approach to the prevention of PTSD.

In line with the findings from Study 1, the current pilot study follow-up period was extended by 1-day. This was to help to assess two things: 1) whether the training bias remained after 2-days post-training as opposed to one (i.e., in Study 1); and 2) to provide more time for the development of intrusions.

7.2. Method

Participants

Eighty-three participants (*n* = 33 female) were recruited from campus (*n* = 10) and online via MTurk (*n* = 73). Previous research assessing metacognition in relation to trauma has successfully recruited participants via MTurk (e.g., Takarangi, Smith et al., 2017) and CBM training has been delivered online previously in other research (e.g., Krahé, Mathews, Whyte, & Hirsch, 2016). Participants recruited from MTurk were compensated for completing all three sessions and the remaining participants took part for course credit. Nine participants were excluded as they failed to take part in session 2 or session 3, leaving a final total sample of 74 participants ($CBM_{Control}$ *n* = 35; $CBM_{Metacog}$ *n* = 39). Participants (age *M* = 33.04, *SD* =10.21, *R* = 19–59 years) were residents of the United States (*n* = 58), United Kingdom (*n* = 14) or "other" (*n* = 2) (i.e., Finland and Italy) and were mainly Caucasian (*n* = 58).

The same inclusion/exclusion criteria from Study 1 was applied. That is, all participants confirmed prior starting the study that they did not have a current diagnosis of PTSD, nor were they currently experiencing any PTSD symptoms in relation to an experienced real-life trauma. Participants were all fully informed that the study involved them watching an emotional film (e.g., of a road-traffic accident) and that they could stop the study at any point by exiting the webpage. Alternatively, they could withdraw from the study after completion, by contacting the lead researcher. Ethical approval was obtained from Loughborough University's Ethics Approvals (Human Participants) Sub-Committee (Ref: R16-P160).

Design

A 3 session (session 1, session 2 and session 3) x 2 CBM training ($CBM_{Metacog}$ versus $CBM_{Control}$) mixed design was employed.

Materials

Trauma film. The same 4-minute film from Study 1 was used in this study. The film was uploaded via YouTube on Qualtrics. In attempt to ensure that participants watched the film in full without disruption, the YouTube controls were removed (e.g., pause button, stop button etc.). However, participants could still exit the webpage for ethical reasons in case they wanted to withdraw. Additionally, participants were later asked to recall everything they could remember about the film, so this served as a compliance check too.

CBM training. The same CBM training groups from Study 1 were also used here, with a one exception. As the $CBM_{Metacog}$ training was now being delivered before the trauma film, the training sentences were structured to refer to "a negative event" in general, and not to the film specifically, as was the case in Study 1.

Measures

The same measures as outlined in Study 1 and 2 were also included in this study. All measures demonstrated strong internal reliability, across all sessions, and were thus all included in the analysis; MCQ 1, 2, & 3 (α = .82–.94), BAMQ negative (α = .82–.86), BAMQ positive (α = .91–.94), DASS-21 (α = .88–.97), IES-R (α = .85–.95), psychological resilience (α = .86–.90) and the RIQ (α = .81–.84).

Procedure

The present study was advertised as the "processing emotional events" study (please see Appendix 5 for Study 3's procedural overview). Firstly, in session 1, prior to CBM training, participants' demographic information (e.g., age, gender, occupation), trauma history (TEQ), mood (DASS-21) and pre-existing metacognitive/metamemory beliefs were assessed (BAMQ, MCQ-30 subscales and RIQ—where applicable). Again, participants' metacognitive/metamemory belief questionnaires at this point were

completed in relation to participants' self-nominated worst event from the TEQ (as in Study 1).

Next, participants were randomly allocated to a CBM training group, either $CBM_{Metacog}$ or $CBM_{Control}$ via Qualtrics software. Immediately following the training, all participants completed the ERT to determine index bias scores. Next, participants were asked to rate their mood (VAS scales), watch the film, and then rate their mood again. Participants also rated how much attention they paid to the film. Next, participants completed follow-up measures assessing their metacognitive/metamemory beliefs (now in relation to the film, where applicable). Following this, participants were asked a dichotomous yes/no question of whether they had experienced any intrusions about the film since watching it. Only participants who responded "yes" completed the RIQ in relation to the film. Next, we included an open-ended question to determine whether participants in the $CBM_{Metacog}$ were aware that we were trying to bias their thinking. The question was "please provide your best guess as to what the purpose of today's session was". Only five participants (6.76% of total sample) (all who received the $CBM_{Metacog}$ training; 12.8% of total $CBM_{Metacog}$ sample) gave a response that was closely aligned with the true aim of the session (i.e., CBM to bias thinking/beliefs). Example responses included "making the person aware that gaps in the memory of a bad event are normal and ruminating over them or trying to relieve them are not really beneficial to healing" and "letting people know that their thoughts don't make them crazy". This appeared to be much lower than in Study 1 and may reflect the sample chosen in this study (i.e., not a pure student sample). Session 1 ended with participants being given instructions on how to complete the online intrusion diaries.

At session 2 and 3 (i.e., identical sessions), participants firstly input their intrusion diary data and rated their compliance to completing the dairy. Participants who

reported having intrusions also completed the RIQ. Next, participants completed the ERT, followed by the MCQ, BAMQ, DASS-21 and IES-R. After completing session 3, participants were debriefed and signposted to relevant support services should they wish to seek support as a result of taking part in the study.

7.3. Hypotheses

1) The $CBM_{Metacog}$ group will demonstrate a significantly higher positive bias score and healthier metacognitive beliefs (i.e., lower scores on BAMQ, MCQ subscales and RIQ), at each session, compared to the $CBM_{Control}$ group.
2) The $CBM_{Metacog}$ group will report fewer PTSD symptoms compared to the $CBM_{Control}$ group. Specifically, the $CBM_{Metacog}$ group will report lower IES-R scores, lower intrusion frequency scores (intrusion diary) and lower intrusion distresss (intrusion diary), compared to the $CBM_{Control}$ group.
3) The $CBM_{Metacog}$ group will demonstrate greater self-reported psychological resilience (i.e., higher scores), compared to the $CBM_{Control}$ group.
4) The $CBM_{Metacog}$ group will demonstrate fewer self-reported depression, anxiety and stress symptoms, compared to the $CBM_{Control}$ group.

7.4. Data analysis

All data were analysed with the General Linear Model, with alpha set to .05. This study's hypotheses and analysis plan was also pre-registered via Open Science Framework, prior to data collection (https://osf.io/9g8x5/?view_only=d00415f44ad547938f651ea94ae55863). Thus, all analyses are in line with the pre-registration, unless otherwise stipulated. Therefore, all prior hypotheses tests were one-tailed and the post-hoc comparisons were Holm-Bonferroni corrected (Holm, 1979) to control family-wise error rates. In line with the

pre-registration, all outliers were kept in the final data set for analysis (N = 74). However, when extreme multivariate outliers were identified and removed from the dataset (n = 9) the pattern of results remained the same, thus, they were kept in the final analysis.

7.5. Results

Participant characteristics, baseline measures and film ratings

No significant differences between CBM groups were found in sex, $\chi^2(2) = 1.65$, $p = .44$. Similarly, there were no significant differences in age, trauma history, baseline mood, metamemory beliefs, or the MCQ 1 and MCQ 3 (see Table 8). However, analysis of MCQ 2 at baseline (i.e., pre-training) revealed a significant difference between CBM groups, $t(64.22) = 2.06$, $p = .04$, with the $CBM_{Metacog}$ group reporting significantly higher scores (i.e., more maladaptive) on this scale compared to the $CBM_{Control}$. Thus, MCQ 2 baseline scores were used as a covariate when analysing changes in the MCQ 2.

Table 8

Participants' demographic and baseline measures by CBM group (Study 3)

Measure	$CBM_{Metacog}$ (*n* = 39, 19 female) *M (SD)*	$CBM_{Control}$ (*n* = 35, 14 female) *M (SD)*	*t*-test
Age	31.84 (10.21)	34.34 (10.20)	$t(71) = 1.05$, $p = .30$
TEQ	0.90 (1.12)	0.74 (.92)	$t(72) = 0.65$, $p = .52$
DASS-21-D	10.62 (11.59)	10.00 (12.33)	$t(72) = 0.22$, $p = .83$
DASS-21-A	5.49 (7.42)	4.86 (6.92)	$t(72) = 0.38$, $p = .71$
DASS-21-S	10.67 (8.92)	9.31 (8.03)	$t(72) = 0.68$, $p = .50$
BAMQ-Positive	13.59 (5.45)	13.69 (6.02)	$t(72) = 0.07$, $p = .94$
BAMQ-Negative	9.95 (3.73)	9.71 (3.43)	$t(72) = 0.28$, $p = .78$
MCQ-1	10.21 (4.15)	9.74 (4.36)	$t(72) = 0.47$, $p = .64$
MCQ-2	11.49 (5.67)	9.26 (3.50)	$t(72) = 2.06$, $p = .04$
MCQ-3	12.18 (3.55)	11.03 (4.03)	$t(72) = 1.31$, $p = .20$
Pre-film mood	1.80 (1.13)	1.81 (1.21)	$t(72) = 0.02$, $p = .98$
Post-film mood	3.78 (1.49)	3.52 (1.57)	$t(72) = 0.71$, $p = .45$
Attention to film	9.13(.92)	9.06 (1.03)	$t(72) = 0.32$, $p = .76$

Note. TEQ = Traumatic Experiences Questionnaire; DASS-21-D/A/S = Depression Anxiety Stress-21 subscales; BAMQ = Beliefs about Memory Questionnaire; MCQ-1/2/3 = Metacognitions Questionnaire; RIQ = Response to Intrusions Questionnaire; S2 = Session 2; S3 = Session 3.

Metacognitive appraisals and beliefs

Index bias scores were analysed separately at each session, using one-way ANOVAs, with CBM group as the between-subjects factor. Analysis of session 1 revealed a

significant main effect for CBM group $F(1, 72) = 30.24$, $p < .001$, $\eta_p^2 = .30$, with significantly higher index bias scores (i.e., positive) reported for the $CBM_{Metacog}$ group ($M = 2.39$, $SD = 1.24$) compared to the $CBM_{Control}$ ($M = 1.03$, $SD = .83$), as predicted. Similarly, there was also a significant main effect for CBM group at session 2, $F(1, 72) = 23.52$, $p < .001$, $\eta_p^2 = .25$, with a higher positive bias demonstrated in the $CBM_{Metacog}$ group ($M = 2.43$, $SD = 1.43$) vs the $CBM_{Control}$ group ($M = 1.06$, $SD = .94$). However, no significant differences emerged between groups following the Bonferroni correction of post-hoc univariate tests (ps < .26) These results demonstrate that the $CBM_{Metacog}$ training was successful in inducing a positive—i.e. healthy metacognitive belief—bias in participants at both post-training session 1 and session 2, compared to the $CBM_{Control}$.

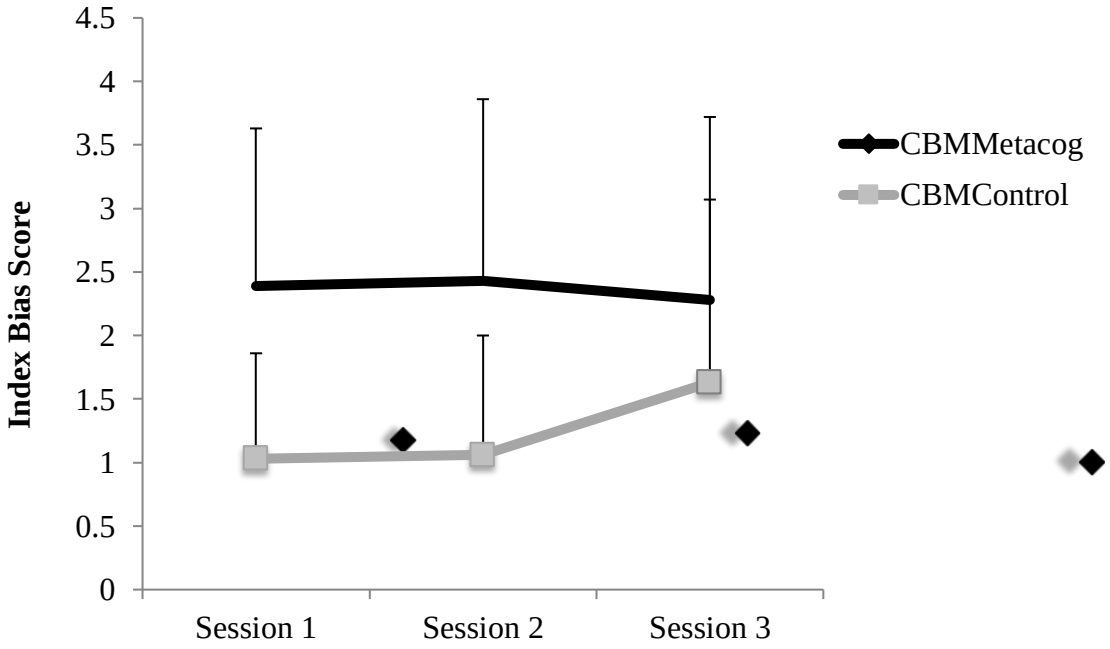


Figure 8 Index bias scores across session by CBM group (Study 3) (larger index bias scores indicate a greater bias towards healthy metacognitive beliefs)

Next, participants' metamemory beliefs were analysed. Here, both BAMQ subscales were subjected to a 2 CBM x 3 session mixed ANOVA. CBM group was the

between-subjects factor and session (session 1 post-training, session 2 and session 3) was the within-subjects factor. There were no significant main or interaction effects (*F*s < 3.00, *p*s > .07) for the BAMQ negative subscale. However, analysis of the BAMQ positive subscale revealed that the $CBM_{Metacog}$ group reported healthier metamemory beliefs about the need to have a complete memory, compared to $CBM_{Control}$, a significant main effect for CBM group $F(1, 72) = 5.69$, $p = .02$, $\eta_p^2 = .07$. Further, the ANOVA revealed a significant session x CBM interaction effect, $F(1.57, 113.54) = 7.41$, $p = .002$, $\eta_p^2 = .09$ (with Greenhouse-Geisser corrections applied to the degrees of freedom). Independent *t*-tests (Holm-Bonferroni corrected) revealed that the $CBM_{Metacog}$ group reported healthier metamemory beliefs at post-training session 1, $t(72) = 2.50$, $p = .02$, $d = .58$ ($M = 10.69$, $SD = 3.97$) and session 2 $t(72) = 3.38$, $p = .001$, $d = .77$, ($M = 10.21$, $SD = 3.85$) compared to the $CBM_{Control}$ group (session 1 $M = 13.60$, $SD = 5.94$; session 2 $M = 10.21$, $SD = 3.85$). However, there were no significant differences found between CBM groups at session 3 ($p = .87$).

MCQ subscales were analysed at each session using a MANOVA. At session 1 post-training, there were no significant differences in MCQ scores between CBM groups, $F(3, 70) =2.53$, $p = .06$; Wilk's $\Lambda = .90$, $\eta_p^2 = .09$. Analysis of MCQ scores at session 2 revealed a significant main effect for CBM group, $F(3, 70) =3.66$, $p = .02$; Wilk's $\Lambda = .86$, $\eta_p^2 = .14$. However, there were no significant differences in MCQ scores between groups following the Bonferroni correction of post-hoc univariate tests (*p*s < .26). Analysis revealed no significant differences in MCQ scores between groups at session 3 ($F = .29$, $p = .84$).

Lastly, participants' beliefs about the meaning of intrusions (RIQ) were analysed. To recap, the RIQ was administered at post-training session 1, session 2 and session 3, only for participants who reported having intrusions since watching the film.

At post-training session 1 ($CBM_{Metacog}$ n = 11; $CBM_{Control}$ n = 2) there were no significant differences between groups on total RIQ scores $t(11) = .01$, $p = .99$, $d = .01$ ($CBM_{Metacog}$ $M = 18.91$, $SD = 8.83$, $CBM_{Control}$ $M = 19.00$, $SD = 7.07$). Similarly, at session 2 ($CBM_{Metacog}$ n = 7; $CBM_{Control}$ n = 6) there were no significant differences between groups on total RIQ scores $t(11) = .78$, $p = .23$, $d = .47$ ($CBM_{Metacog}$ $M = 19.71$, $SD = 4.07$; $CBM_{Control}$ $M = 22.67$, $SD = 9.11$). We were unable to compare group differences for RIQ scores at session 3, as all the participants who had completed the RIQ at session 3 were from the $CBM_{Metacog}$ group.

PTSD symptoms

The IES-R was administered at session 2 and 3 and assessed for the occurrence of PTSD symptoms in relation to the film. No significant differences in IES-R scores were found between CBM groups (Fs < 1.46, ps > .31) (see Table 9).

Next, the total number of intrusions reported in the intrusion diaries at session 2 and session 3 were summed together and the total intrusion frequency was analysed (e.g., see James, Lau-Zhu, Tickle, Horsch, & Holmes, 2016). First, there were no differences in diary compliance ratings between CBM groups at either session 2 $t(72) = 0.40$, $p = .69$ ($CBM_{Metacog}$ $M = 8.87$, $SD = .89$; $CBM_{Control}$ $M = 8.97$, $SD = 1.18$) or session 3 $t(72) = 0.62$, $p = .54$ ($CBM_{Metacog}$ $M = 8.82$, $SD = 1.07$; $CBM_{Control}$ $M = 8.92$, $SD = 1.01$). The same intrusion coding criteria as used in Study 1, was applied in this study. In total eighteen participants ($CBM_{Metacog}$ n = 12; $CBM_{Control}$ n = 6) reported experiencing intrusions in the 2-day intrusion diary. An independent t-test revealed that participants in the $CBM_{Metacog}$ group reported more intrusions ($M = .56$, $SD = .94$) compared to the $CBM_{Control}$ group ($M = .20$, $SD = .41$), $t(72) = 2.12$, $p = .02$, $d = .50$ (one-tailed). Next, an independent t-test was conducted to assess group differences in intrusion frequency only among participants who reported intrusion at least one

intrusion. Again, more intrusions were reported by the $CBM_{Metacog}$ group, compared to the $CBM_{Control}$ group, $t(16) = 2.80$, $p = .01$, $d = .31$ (one-tailed) ($CBM_{Metacog}$ $M = 1.83$; $SD = .72$; $CBM_{Control}$ $M = 1.00$, $SD = .00$) (see Figure 9). Yet, it appeared that both CBM groups experienced similar rates of proportional distress from their intrusions, $t(16) = .80$, $p = .22$, $d = .43$ (one-tailed) ($CBM_{Metacog}$ $M = 4.64$, $SD = 2.26$; $CBM_{Control}$ $M = 5.50$, $SD = 2.26$).

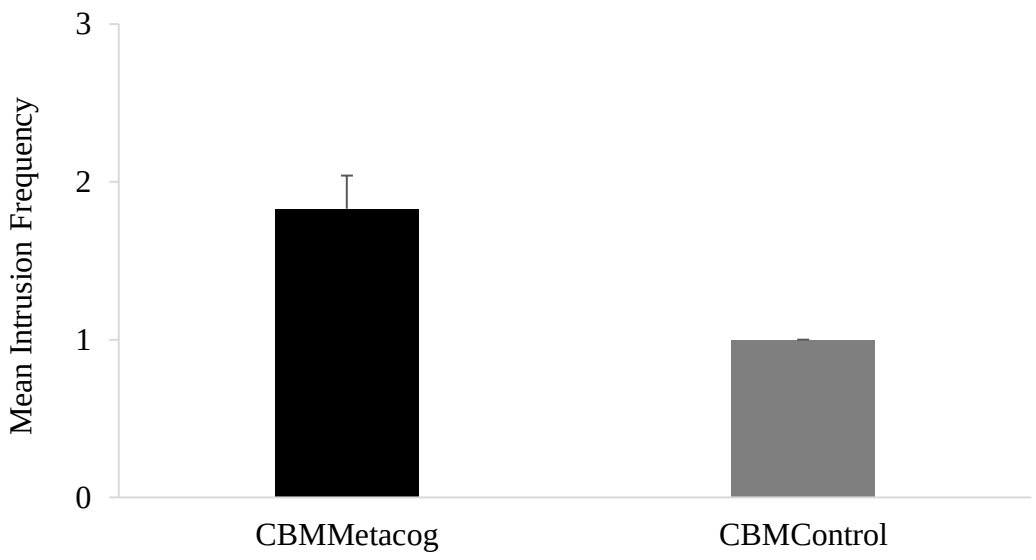
Table 9

IES-R scores at session 2 and session 3 by CBM group (Study 3)

Measure	$CBM_{Metacog}$	$CBM_{Control}$
	M(*SD*)	*M*(*SD*)
IES-R: Intrusion (S2)	2.34 (4.59)	1.80 (4.70)
IES-R: Hyper-arousal (S2)	1.00 (3.03)	1.06 (3.31)
IES-R: Avoidance (S2)	3.51 (5.05)	3.71 (5.81)
IES-R: Total score (S2)	6.87 (11.41)	6.57 (12.72)
IES-R: Intrusion (S3)	1.82 (4.62)	0.83 (2.49)
IES-R: Hyper-arousal (S3)	0.95 (2.91)	0.60 (4.62)
IES-R: Avoidance (S3)	2.67 (4.99)	2.86 (4.39)
IES-R: Total score (S3)	5.44 (10.99)	4.29 (7.63)

Note. S2 = session 2; S3 = session 3

Figure 9 Total mean intrusion diary frequency (+1SEM) by CBM group ($CBM_{Metacog}$ $n = 12$; $CBM_{Control}$ $n = 6$) (Study 3)



Depression, Anxiety & Stress Symptoms

Depression, anxiety and stress scores were analysed separately with a mixed ANOVA, with CBM group as the between-subject's factor and session (session 1 pre-training, and post-training sessions 2, 3) as the within-subjects factor. Analysis of depression scores revealed a significant main effect for session, $F(1.31, 94.47) = 4.58$, $p = .03$, $\eta_p^2 = .06$ (with Greenhouse-Geisser corrections applied to the degrees of freedom). Post-hoc paired *t*-tests (Holm-Bonferroni corrected) revealed that higher depression scores were reported at session 1 ($M = 10.32$, $SD = 11.87$) compared to session 3 ($M = 7.32$, $SD = 11.43$), $t(73) = -2.64$, $p = .01$, $d = .35$, and also between session 2 ($M = 8.73$, $SD = 12.82$) and session 3 $t(73) = .251$, $p = .01$, $d = .16$. This indicates that participants' depression scores decreased over time. No other main effects of interaction effects were significant (Fs < 3.37, ps > .06).

Analysis of anxiety scores revealed a main effect for session, $F(1.42, 102.330) = 5.40$, $p = .01$, $\eta_p^2 = .07$ (Greenhouse- Geisser corrected). Post-hoc paired *t*-tests (Holm-Bonferroni corrected) revealed higher anxiety scores at session 1 ($M = 5.19$, $SD = 7.15$)

versus session 3 (M = 3.41, SD = 7.24), $t(73) = .251$, $p = .01$, $d = .16$. No other effects were found (Fs < 5.40, ps >.16).

Stress scores were significantly higher at session 1 (M =10.02, SD = 8.48) when compared to session 2 (M =7.59, SD = 9.32) $t(73) = 2.73$, $p = .01$, $d = .37$, and when compared to session 3 (M =6.32, SD = 8.44) $t(73) = 4.29$, $p < .005$, $d = .59$. No other effects were found (Fs < 1.77, ps >.19). Overall, these results suggest that, contrary to hypothesis 3, the $CBM_{Metacog}$ was not effective in reducing stress, depression, or anxiety symptoms over time.

Psychological resilience

Total psychological resilience scores were subjected to a 2 CBM group x 3 time mixed ANOVA. No significant difference effects were found (Fs < 1.65, ps > .17).

7.6. Discussion

To recap, the purpose of this study was to determine whether the $CBM_{Metacog}$ training, when delivered prior to analogue trauma, would also lead to healthier metacognitive beliefs and fewer PTSD symptoms, compared to $CBM_{Control}$. As reported in Study 1, here, the $CBM_{Metacog}$ training biased participants thinking in the intended direction; that is, participants in the $CBM_{Metacog}$ group exhibited a significantly higher (i.e. positive) index bias score compared to the $CBM_{Control}$. However, at session 3 (2-days post-training), no significant differences were found between CBM groups for index bias scores. Initially, this may appear that the $CBM_{Metacog}$ training had lost its potency after 2-days. However, it seems that this difference was no longer significant because the $CBM_{Control}$ group's index bias score had, unexpectantly, increased at session 3. This may be explained by the sample that was used in this study. For instance, it is possible that participants in the $CBM_{Control}$ group were completing the ERT in line with their personal beliefs, (which may arguably be healthy) as opposed to what they had

learned from the training. Study 3 also replicated the metamemory beliefs findings from Study 1. The $CBM_{Metacog}$ training increased participants' healthy metamemory beliefs as measured by healthier positive BAMQ scores compared to $CBM_{Control}$. However, there were no differences in MCQ scores between the CBM groups. Therefore, it appears that the CBM training protocol appears to be well suited to modifying participants' metamemory beliefs, but not their metacognitive beliefs as measured by the MCQ. There is one possible explanation for this. The $CBM_{Metacog}$ training sentences in this study were framed to refer to "a negative event". Thus, it is likely that participants are better able to apply what they have learned from the CBM training, to the film, because the film is clearly a negative event. This may allow for transfer effects for the BAMQ over the MCQ, as the BAMQ measure is always tied to a specific event, that is, the film in this study (post-training)—allowing for transfer effects to be captured by the BAMQ. However, the MCQ subscales are not linked to an event specifically; instead, they capture people's general overall metacognitive beliefs, which might explain why a transfer effect was not observed. Taken together, it may be that to modify participants' metacognitive beliefs, it is best to adapt the self-report metacognitive beliefs questionnaires to always refer to a specific event you are measuring (e.g., beliefs about a trauma film).

It was hypothesised that the $CBM_{Metacog}$ group would report experiencing fewer PTSD symptoms (i.e., lower IES-R scores and intrusion frequency/distress scores) compared to the $CBM_{Control}$ group. Contrary to prediction, the $CBM_{Metacog}$ group reported significantly more intrusions during the 48-hour follow-up period compared to the $CBM_{Control}$. However, no significant differences were found in intrusion distress. Importantly, only 24% of the total sample reported experiencing intrusions in this sample. This puts into question the reliability of this data and the conclusions that can

be drawn. The direction of these results suggests a heightened intrusion frequency and distress for the $CBM_{Metacog}$ group versus the $CBM_{Control}$. This supports the direction of intrusion diary results from Study 1 also. In sum, there is a clear need to replicate this study, to better determine the frequency and distress of intrusions by CBM group.

It may be that assessing intrusions via an online diary in this way is unreliable. Although Rattel et al. (2019) found no differences in intrusion frequency, distress or compliance between intrusion assessment methods, Rattel et al. (2019)—like many other intrusion diary studies—provided participants with a tangible tool to record their intrusions, for instance, using either a pen-and-paper diary or an App (see Rattel et al., 2019). Yet, in the current study, participants were relied upon to record the occurrence of their intrusions themselves (i.e., no App) and then enter in this information in the follow-up sessions. This might explain why the intrusion frequencies were so low and suggests poor compliance, despite no difference being found of subjective diary compliance between CBM groups.

Replication of this pilot study is needed to further explore the effects found in the present study. One possible explanation for the heightened intrusion scores in the $CBM_{Metacog}$ group focuses on the role of meta-awareness. In other words, it is possible that the $CBM_{Metacog}$ group reported more intrusions compared to the $CBM_{Control}$ group, because they were more *meta-aware* of their own intrusions. Indeed, previous research highlights that people can lack awareness of their trauma-related intrusions (Takarangi et al., 2014) and that people's metacognitive beliefs can influence the occurrence and meta-awareness surrounding these intrusions (Takarangi, Nayda et al., 2017). Further, according to the metacognitive model (Wells, 2000), awareness of one's cognition is viewed as a positive strategy—one that is central in the recovery of psychological disorders. Therefore, in theory, people who hold healthier metacognitive beliefs, (as

predicted for the $CBM_{Metacog}$ group) should be more aware of their own cognition—including involuntary cognition such as intrusions.

In the next chapter, the prospective CBM study outlined here was replicated in the lab. Running the study in the lab versus online (as done in here), offers more experimental control, allowing better conclusions to be made on whether $CBM_{Metacog}$ training—when delivered prior to analogue trauma—reduces PTSD symptoms (e.g., intrusions) and increases healthy metacognitive beliefs, compared to the $CBM_{Control}$. The replication study was also extended to measure participants' meta-awareness of their intrusions, using methods adopted from the mind-wandering literature.

CHAPTER 8: INVESTIGATING THE ROLE OF META-AWARENESS IN $CBM_{METACOG}$ TRAINING (STUDY 4)

8.1. Study overview

This study replicated and extended Study 3, by investigating whether receiving the $CBM_{Metacog}$ training prior to analogue trauma, increased participants' meta-awareness of their intrusions. Simply put, meta-awareness refers to the awareness of one's own cognition—including involuntary cognition (i.e., intrusions). In Study 3, it is possible that $CBM_{Metacog}$ participants reported more intrusions, not because they necessarily experienced more intrusions, but that they experienced more intrusions that *reached meta-awareness*, compared to the $CBM_{Control}$ group. Thus, assessing meta-awareness of intrusions helps to separate out the frequency with which people *report* intrusions, from the frequency with which they *experience* them (see Takarangi et al., 2014). This has important implications for the use of intrusion diaries, as they rely heavily upon people having accurate meta-awareness of the contents of their consciousness (e.g., intrusions). Yet, it is clear from mind-wandering research that people do not accurately track shifts in their attention (see Smallwood & Schooler, 2006). Recent studies report that metacognitive beliefs affect people's meta-awareness of their intrusions (Takarangi, Nayda et al., 2017), so it is plausible that $CBM_{Metacog}$ training may also lead to shifts in one's meta-awareness. Lastly, the results from Studies 1 and 3 largely focus on the frequency of intrusions. Although data on participants' appraisals of their intrusions were also collected (i.e., RIQ and distress ratings from the intrusion diary), a small fraction of participants reported intrusions, and thus, the results were based upon a small sample. Further, the RIQ focused solely on the meanings people attach to experiencing intrusions (e.g., "it means I am psychologically unwell"). Although this is important information to collect—and relevant to the metacognitive

model of PTSD—it may also be useful to obtain further appraisal ratings on how participants *experienced* their intrusions. Thus, Study 4 captured this information.

8.2. Method

Design

A 2 CBM training ($CBM_{Metacog}$ versus $CBM_{Control}$) x 2 monitoring condition (self-caught only condition versus self-caught-plus-probes condition) x 2 session (session 1 and session 2) mixed experimental design was employed. Both CBM training and monitoring condition were the between-subject's factors, and session was the within-subjects factor.

Participants

One hundred and fifty-six participants (student sample) signed up to the study and completed the pre-screen questionnaire. Twenty-one participants then dropped out either prior to, or immediately after session 1, leaving 135 participants completing the full study (i.e., pre-screen, session 1 and session 2) in exchange for money and/or course credits. Participants were recruited via poster advertisement on campus and through the School of Psychology's Research Participation System. Participants (*n* = 126 female) (age *M* = 19.27; *SD* = 1.56, *R* = 18-31) mostly identified as Caucasian (British) (71.9%), followed by South Asian (9.6%), other (8.9%) (e.g., mixed race), Black (5.2%) and East Asian (4.4%). Previous studies using the self-caught versus probe-caught methods to assess meta-awareness of intrusions in analogue trauma studies (e.g., Takarangi, Nayda et al., 2017) reported a medium effect size of *d* = .49 for probe-caught intrusions. Thus, an a priori sample size calculation, using G*Power software (Faul, et al., 2007), to detect a medium (*d* = .49) effect size, with alpha set to .05 revealed that a sample size of 134 participants would be sufficient to detect

differences between groups at 80% power. The same participant inclusion/exclusion criteria from Studies 1–3 were also applied in this study. Ethical approval was obtained from Birmingham University's Science, Technology, Engineering and Mathematics Ethical Review Committee (Ref: ERN_17-1155A).

Materials

Trauma film. The exact same trauma film from Studies 1–3 was used here again in this study, to allow for comparison across studies.

CBM training. The same CBM training protocols (i.e., $CBM_{Metacog}$ and $CBM_{Control}$) from Study 3 were used once more in this study with was one exception; the training sentences from the $CBM_{Control}$ group were now reduced so that both the $CBM_{Metacog}$ and $CBM_{Control}$ had an equal amount of training sentences and comprehension questions (i.e., 72 training sentences and 24 comprehension questions) (see Appendix 1-2).

Monitoring phase reading task. The monitoring phase reading task was run using PsychoPy software (Peirce, 2007). Based on previous studies that have utilised this task (e.g., Baird et al., 2013; Takarangi et al., 2014; Takarangi, Nayda et al., 2017) the research team (DH), developed the task in PsychoPy. Here, participants read a brief article (i.e., 1121 words) about a science topic (i.e., the structure of a cell) (unrelated to metacognitive beliefs). The article has previously been used to promote mind-wandering (e.g., Takarangi, Nayda et al., 2017) and it was displayed to participants one paragraph at a time (i.e., seven paragraphs in total) (see Appendix 6 for the full article). Participants would self-advance to the next paragraph by clicking the right arrow key. The aim of this reading task was to give participants a primary task whereby task performance can be measured. Therefore, mind-wandering can be measured when people are off-task (i.e., not focused fully on the article). All participants were

instructed to press the space bar key every time they noticed themselves having an intrusion about the film (i.e., intrusions with meta-awareness), and were then instructed to then refocus back on reading the article. For participants in the self-caught-plus-probes condition, in addition to pressing the space bar key every time they noticed themselves experiencing an intrusion, they were also periodically probed while reading the article. As outlined by Takarangi, Nayda et al. (2017), the probes would appear on the computer screen displayed as written text (i.e., "Just now what were you thinking about?"). Three response options were outlined below the probe question, and participants were asked to respond to the probe question by pressing the number associated with their response: (1) "Press 1 if you were thinking about the film"; (2) "Press 2 if you were thinking about the article you were reading"; (3) "Press 3 if you were thinking about something else". Participants were asked to respond as quickly as possible and were then returned back to the paragraph they were previously reading (see Appendix 7 for full probe text). Probe timings were adapted from previous studies (e.g., Takarangi, Nayda et al., 2017). On average, the probes appeared every 34 seconds (R = 7–139 seconds) and appeared independent of self-caught intrusions. Based on previous studies (e.g., Takarangi, Nayda et al., 2017), these probes were considered to be adequate for capturing the occurrence of intrusions that occur *without meta-awareness* (otherwise participants would have self-caught them). As outlined by Takarangi, Nayda et al. (2017), these two conditions were included, because it is possible that the presence of probes could reduce self-caught intrusions (by potentially drawing attention to film-related intrusions that would have eventually reached meta-awareness). Conversely, probes could cue people to report more intrusions. Therefore, to determine the effect of probes on a participants' ability to self-capture their intrusions, and better understand whether probes modify the number of self-caught probes, self-caught and self-caught-

plus-probes conditions were included. Following the reading task, participants were given a 10-item multiple-choice comprehension test in relation to the material in the article (e.g., “what is the cell’s membrane?”). The number of self-caught only intrusions was summed to give a total self-caught only intrusion frequency score. For participants exposed to probes, the proportion of probes that were about the film, the reading task (i.e., on-task) or about something else (i.e., other) were calculated for each CBM group.

Measures

The main measures from Study 3 were also used here. All measures demonstrated strong internal reliability (i.e., > α = .70), except for the BAMQ negative subscale, which at session 2, demonstrated poor reliability (α = .52), and therefore, was subsequently removed from the analysis. The MCQ 3 demonstrated a Cronbach’s alpha of α = .69, just below acceptable levels. It was included in the analysis, but it is noted that the results are tentative.

Although this study utilised the same measures as outlined in Study 3, there were a few exceptions. First, given the importance of understanding how participants experience their intrusions, the Experience of Intrusions Scale (EIS; Saulters-Pedneault, Vine, Mills, Park, & Litz, 2009) was included. The EIS assessed how participants experienced their intrusions and includes five items measuring; intrusion frequency (i.e., “How often have you found yourself thinking to any degree about the film since seeing it?”), intrusion distress (i.e., “On average, how distressed were you when these thoughts came to mind?”), unpredictability (i.e., “On average, to what degree did the thoughts about the film clip come out of the blue?”), unwantedness (i.e., “On average, when you’ve had these thoughts, how unwanted were they?”) and interference (i.e., “On average, when you’ve had these thoughts, how much did they interfere with what you were doing at the time?”). The EIS was assessed at two time points in Study 4; session 1

following the monitoring period task (i.e., in relation to participants' film intrusions up to that point in the session) and at session 2 one-week later (i.e., in relation to the intrusions they may have experienced over the week). The total EIS score was summed for analysis and each item was also analysed separately. Reliability analysis found the EIS to have strong internal consistency at session 1 (α = .73) and at session 2 (α = .78).

Second, the intrusion diary included in this study was a traditional 7-day pen-and-paper format intrusion diary instead of an online intrusion diary that was used in Studies 1 and 3. Due to the small sample of participants who reported intrusions via the diaries in Study 1 and Study 3, a pen-and-paper 7-day intrusion diary was opted for as it is the most well-established method to effectively measure intrusions in analogue studies (James et al., 2016; Rattel et al., 2019). However, participants were still asked to record the same information as outlined in Studies 1 and 3. Total intrusion frequency score was calculated for each person by summing up the total amount of image-based intrusions (i.e., distress rating > 0) over the week. Further, proportional distress rating was calculated for each participant by summing up the distress ratings and dividing by the number of intrusions they had reported.

Third, the psychological resilience measure was removed as previous studies (i.e., Study 1 and 3) revealed no significant effects.

Fourth, as the thought-monitoring reading task was included in this study, an additional VAS mood rating was included post-reading task as well as a reading task comprehension test (10-item multiple choice comprehension test). The multiple-choice test was included to assess relationships between task performance and probe-caught intrusions.

Lastly in addition to participants rating their mood pre and post-film, participants were also asked to rate how unpleasant and distressing they found the film,

using the same VAS scale. Further, they rated how well they adhered to the instructions to self-capture intrusions. Those who received probes, were also asked to rate how accurate they were when responding to the probes (using the same 11-point scale). Further, all participants were asked to rate how interesting (0 = *not at all*, to 4 = *highly*) and difficult (0 = *very easy* to 4 = *very difficult*) they found the reading task.

A diary compliance rating was included at session 2, to capture participants' subjective compliance towards the intrusion diary. Participants were asked to "please rate how accurate you were at completing the 7-day intrusion diary" on an 11-point scale (0 = *not at all* to 10 = *extremely*).

Procedure

Prior to session 1, participants' informed consent, demographic information, baseline mood (DASS-21), trauma history (TEQ) and pre-existing metacognitive/metamemory beliefs were measured via an online pre-screen survey. This survey was complete within 7-days prior to participants taking part in session 1. Further, participants were randomly allocated to monitoring condition, upon sign-up to the study (i.e., before taking part in session 1).

Session 1 was conducted in the lab. Firstly, all participants were informed again as to the nature of the study (i.e., to watch an emotional film) and participant inclusion/exclusion criteria was verified. Additionally, participants' understanding of intrusions (e.g., definition, examples) was also verified. In session 1, participants were randomly allocated (via Qualtrics randomisation software) to a CBM training group (either $CBM_{Metacog}$ or $CBM_{Control}$). They completed the CBM, which was immediately followed by the ERT to determine index bias scores. Immediately following the CBM training and ERT, participants were asked to watch the film on the computer, using headphones. Next, participants were asked to freely recall everything that they could

remember about the film. After this, participants were given verbal and written instructions from the researcher about the monitoring phase (i.e., reading task). Here, participants were informed that: 1) they would be asked to read a brief article about a science topic and to pay attention to the material as there might be questions about it after; 2) that the article would be displayed one paragraph at a time, and that they could self-advance to the next paragraph by pressing the right arrow key; and 3) that anytime they noticed themselves having an intrusion about the film, they should press the space bar key.

Appendix 8 outlines the procedures for the current study. Despite participants being randomly allocated to different monitoring conditions, all participants received the *same* instructions at the start of the reading task, that is, to press the space bar key whenever they noticed themselves having an intrusion. Therefore, we did not inform participants in the self-caught-plus-probes condition to anticipate probes (i.e., similar to Takarangi et al., 2014 Experiment 2; Takarangi, Nayda et al., 2017). Immediately following the reading task, participants rated their mood once more, and were given a 10-item multiple-choice comprehension test about the article. Participants then completed several questionnaires including the EIS, MCQ-30 subscales, BAMQ and the RIQ (where applicable). Session 1 ended with all participants being given a 7-day intrusion diary (paper copy) and instructions on how to complete it.

Session 2 occurred 7-days later, again in the lab. Participants firstly handed in their completed intrusion diaries. They then completed several follow-up measures via a Qualtrics survey, which included intrusion diary compliance ratings, the ERT, EIS, DASS-21, MCQ-30 three subscales, BAMQ, RIQ (where applicable) and the IES-R. After completing the Qualtrics survey, the intrusion diary was checked by the researcher with the participant, to give participants the opportunity to ask any questions about their

diary recordings. Session 2 ended with all participants being debriefed about the study and reimbursed for their time.

8.3. Hypotheses

1) The $CBM_{Metacog}$ group will demonstrate a significantly higher positive bias score and healthier metacognitive beliefs (i.e., lower scores on BAMQ, MCQ subscales and RIQ), compared to the $CBM_{Control}$ group.

2) The $CBM_{Metacog}$ group will exhibit enhanced meta-awareness of their intrusions, compared to the $CBM_{Control}$ group. Enhanced meta-awareness by the $CBM_{Metacog}$ group will be assessed via the thought-monitoring task and demonstrated in two ways: 1) reporting a greater amount of self-caught intrusions (one-tailed); and 2) by exhibiting fewer probe-caught film intrusions (in the self-caught-plus-probes condition) (one-tailed).

3) The $CBM_{Metacog}$ group will report a greater intrusion frequency score (diary), and IES-R intrusion score, but lower intrusion distress (diary), compared to the $CBM_{Control}$ group (thus replicating Study 2 finding for frequency). Secondly, the $CBM_{Metacog}$ group will report lower scores on the IES-R hyperarousal and avoidance subscales, compared to the $CBM_{Control}$.

4) The $CBM_{Metacog}$ group, will report lower scores on the EIS, indicating that their intrusions were experienced in a less traumatic way (e.g., less distressing, unwanted, spontaneous), compared to $CBM_{Control}$.

5) The $CBM_{Metacog}$ group will demonstrate fewer self-reported depression, anxiety and stress symptoms, compared to the $CBM_{Control}$ group.

8.4. Data analysis

All data were analysed with the General Linear Model, with alpha set to .05. This study's hypotheses and analysis plan was also pre-registered via Open Science Framework (see both https://osf.io/nhbkg/?view_only=0c4aeafb674a44a7aa991c1596c38876 and https://osf.io/gqdsp/?view_only=91a26df4f19a477288a890a119b782de pre-registrations). Post-hoc comparisons were Holm-Bonferroni corrected (Holm, 1979) to control family-wise error rates. Data for three participants in the self-caught-plus-probes condition were removed as they failed to complete the mind-wandering task correctly. Consequently, their data for their self-caught intrusions, probe-caught intrusions and EIS scores session 1 (as the EIS was complete in relation to film intrusions experienced in session 1, including ones throughout the reading task) were excluded from these analyses.

In line with the pre-registration, all outliers were kept in the final data set for analysis. However, when extreme multivariate outliers were identified and removed from the dataset (n = 13) the main results remained the same. To recap, the BAMQ negative subscales were removed from the analysis due to poor reliability scores.

8.5. Results

Participant characteristics, baseline measures and film ratings

To assess for baseline differences, separate two-way ANOVAs were conducted, using CBM group and monitoring condition group as the between-subject's factors. Results showed that participants, across all groups, did not differ in age, trauma history, baseline mood or pre-existing metacognitive/metamemory beliefs (see Table 10).

Film Impact

Next, participants' film and mood ratings were assessed. Separate 2 CBM x 2 monitoring condition between-subjects ANOVAs were conducted to assess for group differences in film attention, distress and unpleasantness ratings. There were no significant group differences on ratings of attention paid to the film or distress ratings for the film. Interestingly, it appeared that participants in the $CBM_{Metacog}$ training group, rated the film as being significantly more unpleasant compared to the $CBM_{Control}$ group, a significant main effect for CBM group $F(1,131) = 4.23$, $p = .04$, $\eta_p^2 = .03$ ($CBM_{Metacog}$ $M = 8.42$, $SEM = .23$; $CBM_{Control}$ $M = 7.76$, $SEM = .23$).

Next, participants' mood throughout the experiment was analysed with a 2 CBM x 2 monitoring condition x 3 time (pre-film, post-film, post-reading task) mixed ANOVA, using the combined mood scores as the within-subjects factor. The ANOVA revealed a significant main effect for time, $F(1.58, 206.66) = 225.63$, $p < .001$, $\eta_p^2 = .63$ (Greenhouse-Geisser corrected). Post-hoc paired *t*-tests (Holm-Bonferroni corrected) revealed that participants reported feeling worse in mood (i.e., higher combined mood scores) after watching the trauma film ($M = 3.98$, $SD = 1.54$) compared to before the film ($M = 2.27$, $SD = 1.40$), $t(134) = 15.31$, $p < .001$, $d = 1.32$. This demonstrates that the film had the desired emotional effect of worsening participants' mood. Following the reading task, participants' mood also continued to worsen, compared to post-film, $t(134) = 9.43$, $p < .001$. $d = .82$ ($M = 5.97$, $SD = 2.33$ versus $M = 3.98$, $SD = 1.54$ respectively) and pre-film, $t(134) = 18.29$, $p < .001$, $d = 1.58$ ($M = 5.97$, $SD = 2.33$ versus $M = 2.27$, $SD = 1.40$, respectively). This is contrary to Takarangi, Nayda et al. (2017), who found that participants' mood *worsened* pre-to post-film, but then improved post reading task. Further, the ANOVA revealed a significant time x CBM group interaction, $F(1.58, 206.66) = 5.60$, $p = .01$, $\eta_p^2 = .008$ (Greenhouse-Geisser correction applied to the degrees of freedom). To assess this interaction, post-hoc

independent *t*-tests were conducted to assess for differences between CBM groups at each time point. It appeared that the interaction was driven by CBM group differences in mood post-reading task, with the $CBM_{Metacog}$ group (M = 6.10, SD = 2.30) reporting worse mood, compared to the $CBM_{Control}$ group (M = 5.29, SD = 2.32), $t(133) = 2.04$, $p = .04$, $d = .35$. No significant differences in mood were found at either pre film ($p = .37$, $CBM_{Metacog}$ M = 2.16, SD = 1.28; $CBM_{Control}$ M = 2.38, SD = 1.52) or post film ($p = .89$, $CBM_{Metacog}$ M = 4.00, SD = 1.42; $CBM_{Control}$ M = 3.96, SD = 1.66). These results indicate that all groups experienced comparable increases in negative mood post-film, and these increases were maintained post-reading task.

Table 10

Participants' demographic and baseline measures by CBM and monitoring condition (Study 4)

	Self-caught-only		Self-caught-plus-probes			Monitoring	
	$CBM_{Metacog}$	$CBM_{Control}$	$CBM_{Metacog}$	$CBM_{Control}$	CBM group	condition	Interaction
Measure	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*F*(1,131)	*F*(1,131)	*F*(1,131)
Age	19.42 (2.29)	19.51 (1.29)	18.94 (.92)	19.21 (1.45)	<1	2.13	<1
TEQ	0.61 (1.02)	0.77 (1.37)	0.74 (1.14)	0.61 (.83)	<1	<1	<1
MCQ-1	10.73 (4.02)	10.37 (3.80)	10.26 (3.61)	10.12 (3.93)	<1	<1	<1
MCQ-2	12.15 (3.91)	13.37 (5.83)	11.79 (4.80)	11.12 (4.34)	<1	2.50	1.32
MCQ-3	10.52 (2.36)	11.31 (3.68)	11.56 (3.82)	10.97 (3.53)	<1	<1	1.40
BAMQ-Positive	12.36 (3.67)	13.60 (5.21)	11.88 (4.36)	11.76 (3.79)	<1	2.44	<1
BAMQ-Negative	11.61 (5.24)	11.06 (4.78)	9.74 (2.77)	10.79 (3.76)	<1	2.14	1.20
DASS-21-D	7.64 (9.66)	7.95 (9.97)	5.52 (7.69)	8.91 (10.60)	1.26	<1	<1

DASS-21-A	7.09 (8.51)	7.77 (9.03)	4.12 (5.78)	6.67 (9.48)	1.27	2.02	<1
DASS-21-S	10.73 (9.47)	11.94 (10.72)	8.88 (8.78)	10.55 (9.58)	<1	<1	<1
Film attention	8.91 (1.16)	9.06 (.97)	9.15 (1.42)	8.70 (1.13)	<1	<1	2.17
Film distress	7.15 (1.92)	6.57 (1.63)	7.32 (1.57)	6.94 (1.95)	2.49	<1	<1
Film unpleasantness	8.42 (1.94)	7.86 (1.59)	8.41 (1.67)	7.67 (2.17)	4.23*	<1	<1

Note. TEQ = Traumatic Experiences Questionnaire; DASS-21-D/A/S = Depression Anxiety Stress-21 subscales; BAMQ = Beliefs about Memory Questionnaire; MCQ-1/2/3 = Metacognitions Questionnaire subscales; RIQ = Response to Intrusions Questionnaire;
*$p < 0.05$

Metacognitive appraisals and beliefs

A 2 session x 2 CBM mixed AVOVA revealed a significant main effect for CBM group, $F(1,133) = 7.38$, $p = .007$, $\eta_p^2 = .05$, with the $CBM_{Metacog}$ group demonstrating a significantly higher positive bias ($M = 1.72$, $SEM = .09$) compared to the $CBM_{Control}$ ($M = 1.36$, $SEM = .09$), as predicted. Interestingly, the ANOVA also revealed a significant session x CBM interaction effect, $F(1,133) = 18.58$, $p < .001$, $\eta_p^2 = .12$. Post-hoc independent *t*-tests (Bonferroni-Holm corrected) showed that this interaction was driven by CBM group differences at session 1, $t(133) = 5.22$, $p < .001$, $d = .90$ ($CBM_{Metacog}$ $M = 2.01$, $SD = 1.27$; $CBM_{Control}$ $M = 1.06$, $SD = .80$), but not session 2, $t(133) = 1.14$, $p = .256$, $d = .20$ ($CBM_{Metacog}$ $M = 1.42$, $SD = 1.10$; $CBM_{Control}$ $M = 1.65$, $SD = 1.22$). One-sample *t*-tests revealed that index bias scores at session 1, from both CBM groups, were significantly different from zero ($CBM_{Control}$ $M = 1.06$, $SD = .80$, $t(67) = 10.95$, $p < .001$; $CBM_{Metacog}$ $M = 2.01$, $SD = 1.27$, $p < .001$, $t(66) = 12.96$, $p < .001$). Overall, this indicates that both groups demonstrated a healthy positive bias.

To determine whether the CBM training was able to modify participants' explicit metacognitive/metamemory beliefs, as measured via self-report questionnaires, separate 2 session x 2 CBM mixed ANOVAs were conducted on the BAMQ positive and the MCQ 1, 2, 3. Overall, the $CBM_{Metacog}$ group ($M = 11.16$, $SEM = .47$) demonstrated healthier metamemory beliefs (BAMQ positive), compared to the $CBM_{Control}$ group ($M = 13.62$, $SEM = .47$), a significant main effect for CBM training group, $F(1,133) = 13.79$, $p < .001$, $\eta_p^2 = .09$, as predicted.[5] These results replicate those

[5] Participants' baseline (i.e., pre-existing metamemory/metacognitive beliefs, about a historic event) scores were also entered as a covariate in the model and the results remained the same.

reported in Studies 1 and 3. No other main or interaction effects were significant (*F*s < 2.56, *p*s > .11).

The MCQ 1 revealed a significant main effect for session $F(1,133) = 4.71$, $p = .03$, $\eta_p^2 = .03$, with healthier scores being reported post-training session 1 ($M = 10.99$, $SEM = .33$) compared to session 2 ($M = 11.50$, $SEM = .34$). No other main effects of interaction effects were significant (*F*s < 2.01, *p*s > .16). The MCQ 2 revealed no significant main or interaction effects **(***F*s < 1, *p*s > .59). Analysis of the MCQ 3 revealed a main effect for session $F(1,133) = 8.45$, $p < .005$, $\eta_p^2 = .06$, with healthier beliefs being reported at session 2 ($M = 9.61$, $SEM = .23$) versus session 1 post-training ($M = 10.16$, $SEM = .25$). No other main or interactions effects were significant (*F*s < 2.43, *p*s > .12).

Lastly, participants' beliefs about the meaning of intrusions were measured using the RIQ. The RIQ was only administered to participants who reported "yes" to experiencing film intrusions at post-training session 1, and at session 2. At session 1, 117 participants completed the RIQ and an independent *t*-test revealed no significant CBM group differences in total RIQ score $t(115) = .31$, $p = 75$, $d = .06$ ($CBM_{Metacog}$ $M = 19.89$, $SD = 6.01$; $CBM_{Control}$ $M = 20.25$, $SD = 6.12$). At session 2, 114 participants completed the RIQ. Here, there were no significant differences in total RIQ score between CBM groups $t(112) = .98$, $p = .33$, $d = .19$ ($CBM_{Metacog}$ $M = 21.28$, $SD = 8.28$; $CBM_{Control}$ $M = 19.86$, $SD = 7.14$).

Meta-awareness of intrusions

Self-caught intrusions. To recap, the primary focus of this study was to assess whether participants who received the $CBM_{Metacog}$ training demonstrated enhanced meta-awareness of their intrusions, compared to the $CBM_{Control}$ group. To answer this, firstly the frequency of participants' self-caught intrusions was examined using a 2

CBM group x 2 monitoring condition (self-caught-only versus self-caught-plus-probes) between groups ANOVA. It was predicted that participants who received the $CBM_{Metacog}$ training would report a greater frequency of self-caught intrusions (because they are more aware of their intrusions), in both monitoring conditions, compared to the $CBM_{Control}$ group. However, CBM group did not appear to affect the frequency of self-caught intrusions, $F(1, 128) = .11$, $p = .74$, $\eta_p^2 = .00$ (see Figure 10). Further, the main effect for monitoring condition and the CBM group x monitoring condition interaction, were all non-significant (Fs <1, ps > .42).

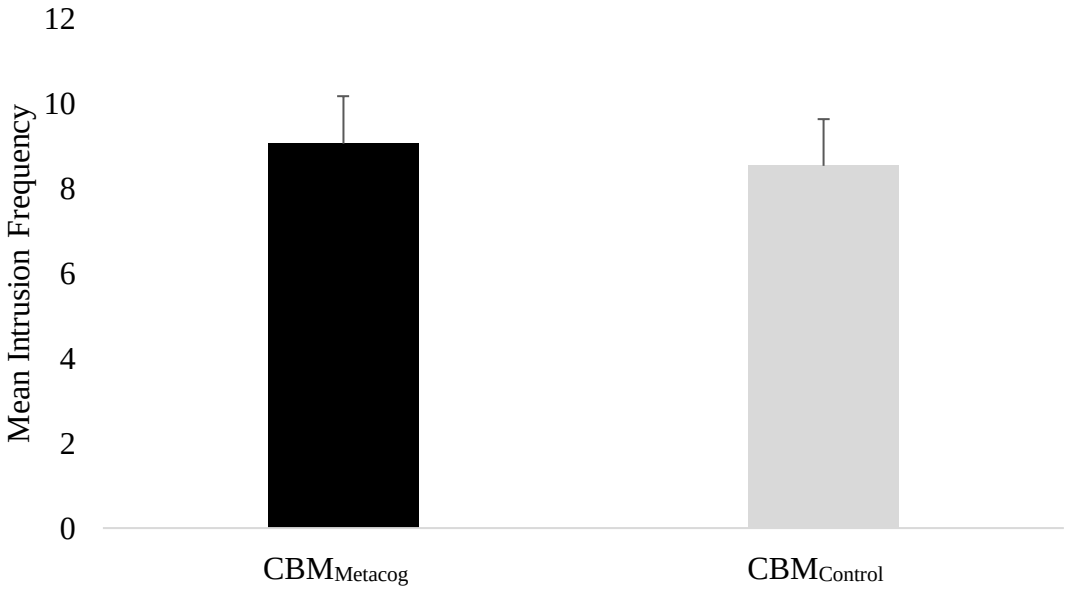


Figure 10 Mean (+1 SEM) frequency of self-caught intrusion frequency scores by CBM group (Study 4)

Probe-caught intrusions. Next, probe-caught intrusions were analysed. Based on previous work (e.g., Takarangi, Nayda et al., 2017), it was hypothesised that for participants exposed to probes, a proportion of their intrusions would be experienced without awareness. In line with the meta-awareness hypothesis, it was predicted $CBM_{Metacog}$ participants, would demonstrate enhanced meta-awareness, by reporting

fewer probe-caught intrusions, compared to the $CBM_{Control}$ group. To recap, data for three participants were removed as they failed to complete the mind-wandering task correctly.

On average, participants were exposed to 7.89 probes (*SD* = 4.71, *R* = 1–27) throughout the reading task, with no difference in probe frequency between CBM training groups, $t(62) = .18$, $p = .85$, $d = .05$ ($CBM_{Control}$ $M = 8.00$, $SD = 5.12$; $CBM_{Metacog}$ $M = 7.78$, $SD = 4.35$). Participants reported that they were thinking about the article on 56.43% of the probes, and "other" things on 15.45% of the probes. Thus, participants reported that they were thinking about the film on 28.12% of the probes. This percentage is comparable to rates documented previously (28.86% in Takarangi et al., 2014; 25.89% in Takarangi, Nayda et al., 2017). However, there were no significant differences in the percentage of probe-caught film intrusions between CBM training groups, $t(62) = .70$, $p = .25$, $d = .18$ (one-tailed) ($CBM_{Metacog}$ $M = 38.32$, $SD = 33.27$; $CBM_{Control}$ $M = 33.03$, $SD = 26.56$) (see Figure 11). This result, combined with the self-caught intrusion results, suggests that the $CBM_{Metacog}$ training did not enhance participants' meta-awareness of their intrusions, as originally predicted.

Next, the proportion of probe-caught thoughts about the article (i.e., on-task) and about "something else" were explored and revealed two unexpected findings. Participants who received the $CBM_{Metacog}$ were significantly more off-task (i.e., not focused on completing the reading task as they should be). This is evident by the $CBM_{Metacog}$ group demonstrating a lower percentage of probe-caught thoughts being about the article $t(62) = 2.45$, $p = .02$, $d = .62$ (two-tailed) ($CBM_{Metacog}$ $M = 42.16$, $SD = 30.78$; $CBM_{Control}$ $M = 59.37$, $SD = 25.08$) and a greater percentage of probe-caught other thoughts $t(62) = 2.72$, $p = .01$, $d = .69$ (two-tailed) ($CBM_{Metacog}$ $M = 19.53$, $SD = 21.93$; $CBM_{Control}$ $M = 7.61$, $SD = 11.58$) (see Figure 11). This data suggests that the

$CBM_{Metacog}$ group were significantly more off-task and mind-wandering more than the $CBM_{Control}$ group.

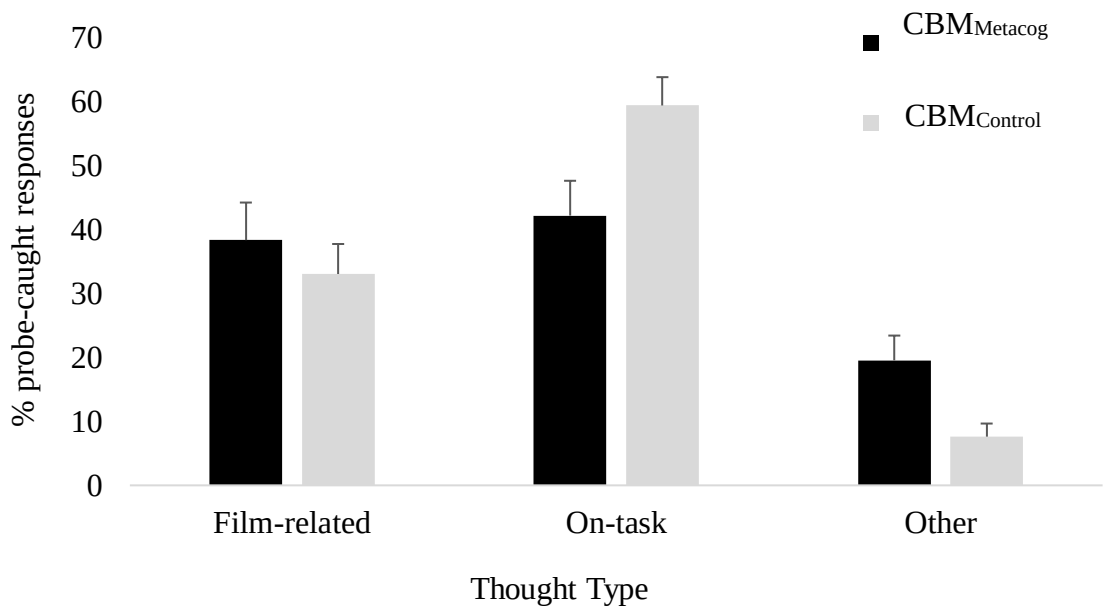


Figure 11 Frequency of probe-responses (%) by CBM group (+1SEM) (Study 4)

Finally, there were no significant group differences in reading test comprehension scores between CBM or monitoring condition groups (Fs < 2.27, ps > .13). Further, the number of self-caught intrusions was not significantly correlated with reading task performance, when controlling for overall time spent on the reading task, for both the CBM groups nor the monitoring condition groups (ps > .27). This suggests that, unlike previous findings (e.g., Takarangi, Nayda et al., 2017), exposure to probes and the number of self-caught intrusions were not detrimental to reading comprehension. It also appeared that for participants exposed to probes, the more they were caught thinking about the film, the more they reported adherence to reading task instructions to self-capture intrusions, $F(1, 62) = 14.33$, $r = .43$, $R^2 = .19$, $p < .001$, but

this was not found for self-caught intrusions (p = .57). This suggests that exposure to probes may have helped people feel as if they were accurately capturing all instances of their intrusions.

PTSD symptoms

The IES-R total score, in addition to the three subscales, we analysed separately using a 2 CBM x 2 monitoring condition between-subjects ANOVA.[6] Results showed no significant main or interaction effects (Fs < 3.47, ps > .07) (see Table 11 for means per CBM group). Interestingly, analysis of the IES-R total score and IES-R intrusion subscale revealed a main effect for monitoring condition that was approaching significance, (p = .07 and p = .08 respectively), demonstrating greater scores (i.e., higher PTSD symptoms) in the self-caught only condition compared to the self-caught-plus-probes (see Table 12 for means per monitoring condition group). Further analyses were also conducted using film unpleasantness rating as a covariate (given previous unexpected differences between CBM groups) in the model, however the results remained the same.

[6] The original pre-registration plan was to run an independent t-test to assess CBM group differences in the IES-R and intrusion diary data. However, monitoring condition was entered into the ANOVA model for exploratory analyses, to determine whether monitoring condition also affected the reporting of PTSD symptoms.

Table 11

Mean (SEM) IES-R scores by CBM group (Study 4)

Measure	$CBM_{Metacog}$	$CBM_{Control}$
	M(SEM)	*M (SEM)*
IES-R: Total Score	11.07 (1.30)	12.58 (1.29)
IES-R: Intrusions	5.72 (0.58)	5.78 (0.58)
IES-R: Hyper-arousal	1.17 (0.30)	1.63 (0.30)
IES-R: Avoidance	4.19 (0.63)	5.17 (0.63)

Table 12

Mean (SEM) IES-R scores by monitoring condition (Study 4)

Measure	Self-caught only	Self-caught-plus-probes
	M(SEM)	*M (SEM)*
IES-R: Total Score	13.53 (1.29)	10.12 (1.30)
IES-R: Intrusions	6.47 (0.58)	5.03 (0.58)
IES-R: Hyper-arousal	1.74 (0.30)	1.06 (0.30)
IES-R: Avoidance	5.32 (0.63)	4.03 (0.63)

Intrusion frequency. Firstly, intrusion frequency after 2-days was analysed to determine whether the effects of Study 3 (i.e., a greater reporting of intrusions for the $CBM_{Metacog}$ group versus $CBM_{Control}$) were replicated in the current study.

Here, after 2 days, 103 participants reported experiencing distressing imaged-based intrusions. That is, 76% of participants in this study reported having intrusions after 2 days compared to only 24% of participants after 2 days in Study 3. Intrusion frequency after 2 days was subjected to a 2 CBM x 2 monitoring condition between-

subjects ANOVA[7]. There was a trend towards $CBM_{Metacog}$ participants reporting fewer intrusions after 2 days, compared to the $CBM_{Control}$ group (*M* = 1.75, *SEM* = .25 versus *M* = 2.43, *SEM* = .25, respectively), $F(1, 131) = 3.74$, $p = .055$, $\eta_p^2 = .03$. This finding is contrary to that found in Study 3, as here, it appears that $CBM_{Metacog}$ group reported fewer intrusions, not more, compared to $CBM_{Control}$ group. Next, the ANOVA analysis was confined to only include those participants who reported intrusions after 2-days (i.e., 103 participants). The ANOVA revealed a significant main effect for CBM group, $F(1, 99) = 5.55$, $p = .02$, $\eta_p^2 = .05$, with fewer intrusions being reported by the $CBM_{Metacog}$ group (*M* = 2.29, *SEM* = .27) versus the $CBM_{Control}$ (*M* = 3.17, *SEM* = .26). No other effects were found (*F*s < 1, *p*s > .69). Taken together, these two findings suggest that the $CBM_{Metacog}$ had a preventative effect on reducing intrusions compared to the $CBM_{Control}$ group.

Next, the 7-day intrusion diary was analysed. In total, 113 participants reported experiencing distressing imaged-based intrusions across the 7-day diary. A 2 CBM x 2 monitoring condition between-subjects ANOVA revealed a significant main effect for CBM training group, $F(1, 131) = 4.88$, $p = .03$, $\eta_p^2 = .04$ ($CBM_{Control}$ *M* = 4.08, *SEM* = .44; $CBM_{Metacog}$ *M* = 2.70, *SEM* = .44). Next, analysis was adjusted to only include participants who reported intrusions (i.e., 113) across the 7-day period. Once more, a significant main effect for CBM training group, $F(1, 109) = 6.93$, $p = .01$, $\eta_p^2 = .06$, with fewer intrusions being reported by the $CBM_{Metacog}$ group (*M* = 3.17, *SEM* = .47) versus the $CBM_{Control}$ group (*M* = 4.94, *SEM* = .48) No other significant effects were found (*F*s < 1, *p*s > .56).

[7] Please note, entering monitoring condition into the analysis was a deviation from the original pre-reg analysis plan (which just focused on CBM effects). Therefore, exploring the effects of monitoring condition on PTSD symptoms was considered post data collection

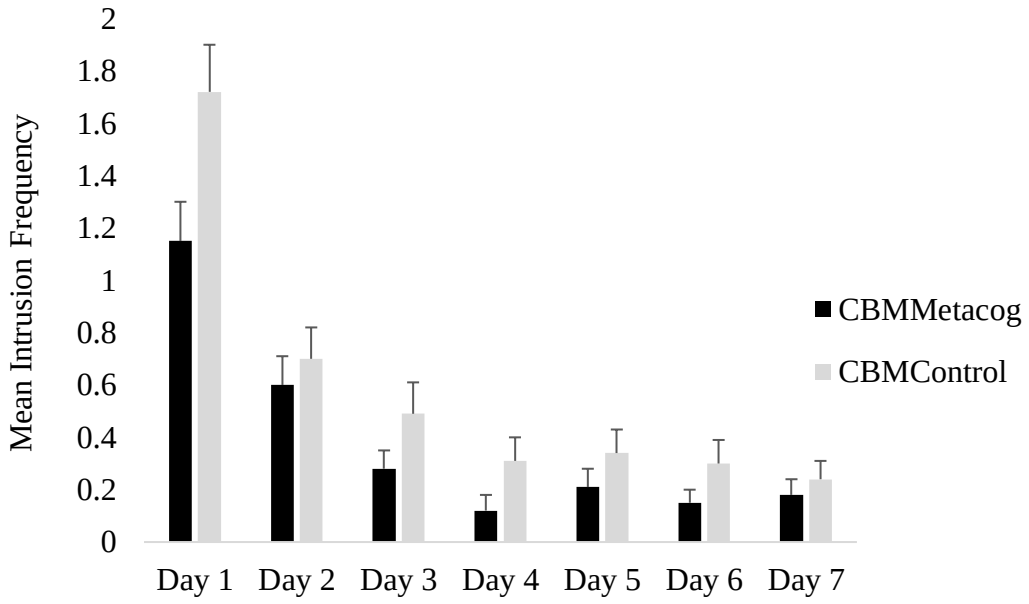


Figure 12 Breakdown of mean intrusion frequency (+1SEM) per day, per CBM group (Study 4)

In sum, these findings suggest that the intrusion frequency results from Study 3 may have been unreliable, as only a small proportion of participants (24%) reported experiencing intrusions in Study 3, compared to the current lab-based study (see Figure 12 for breakdown of 7-day intrusion diary by CBM group). Overall, these results offer support for the original overarching hypothesis, that is, participants who receive the $CBM_{Metacog}$ training will report significantly fewer trauma intrusions compared to $CBM_{Control}$, suggesting that training to adopt healthier metacognitive/metamemory beliefs helps reduce distressing intrusive symptoms.

Intrusion distress. A 2 CBM x 2 monitoring condition revealed a significant main effect for CBM group $F(1, 113) = 4.16$, $p = .04$, $\eta_p^2 = .04$, with the $CBM_{Metacog}$ group reporting lower distress ($M = 3.92$, $SEM = .24$) associated with their intrusions, compared to the $CBM_{Control}$ group ($M = 4.61$, $SEM = .24$). No other main or interaction effects were found (Fs < 1, ps > .84).

Experience of intrusions (EIS)

To recap, the EIS was administered at session 1 after the CBM task and reading task, to retrospectively assess how participants experienced any intrusions they had during the reading task. The EIS was summed to give an overall total score for analysis and each item was also analysed separately[8]. Separate 2 CBM x 2 monitoring condition between-subjects ANOVAs revealed no significant group differences in EIS scores between CBM training groups or monitoring conditions (Fs < 1, ps >.55)[9]. Further, there was no CBM x monitoring condition interaction (F < 1, p = .65). Interestingly, it appeared that the number of self-caught intrusions in the reading task, predicted several EIS variables at session 1; EIS frequency $F(1, 130) = 54.48$, $r = .54$, $R^2 = .30$, $p < .001$, EIS spontaneous $F(1, 130) = 12.54$, $r = .30$, $R^2 = .09$, $p < .001$, and EIS interference $F(1, 130) = 15.84$, $r = .33$, $R^2 = .11$, $p < .001$. However, probe-caught film thoughts did not predict EIS scores at session 1 (ps > .06). Taken together, these results suggest that the more participants self-caught film intrusions during the task, the more they reported their intrusions to hold trauma-like qualities.

Participants also completed the EIS at session 2, to determine how they retrospectively experienced any intrusions they reported in the intrusion diary. However, results revealed no significant main or interaction effects (Fs < 1, ps > .62). Table 13 outlines the mean EIS scores at both sessions, by CBM group. Overall, these results suggest that, descriptively speaking, neither $CBM_{Metacog}$ training, nor monitoring

[8] Data (i.e., self-caught intrusions and probe caught intrusions) from three participants in the self-caught-plus-probes condition was removed as they failed to receive any probes during the reading task as they read through the paragraphs in the article too quickly.

[9] Please note, the between-subjects factor “monitoring condition” was added to the analyses here for exploratory analyses. The original hypotheses and pre-registration was only focused on the effects of CBM group on EIS, however I also explored the effects of “monitoring condition” on EIS scores too, post data collection”.

condition, affected the way participants experienced their intrusions. However, although non-significant, examination of the mean scores the EIS items suggest that the $CBM_{Control}$ experienced their intrusions in a more distressing (i.e., traumatic) way compared to the $CBM_{Metacog}$—that is, more spontaneous, unwanted and distressing. Interestingly, $CBM_{Metacog}$ participants reported higher mean scores on the EIS interference item.

Table 13

Mean (SD) EIS scores at session 2, by CBM group (Study 4)

Measure	$CBM_{Metacog}$ (*n* = 61)	$CBM_{Control}$ (*n* = 58)
	M(SD)	*M (SD)*
Session 2 EIS: Frequency	1.10 (0.77)	1.35 (0.71)
Session 2 EIS: Distress	1.10 (0.87)	1.26 (0.83)
Session 2 EIS: Spontaneous	1.51 (1.09)	1.57 (0.90)
Session 2 EIS: Unwanted	0.64 (0.73)	0.67 (0.85)
Session 2 EIS: Interference	1.77 (1.04)	1.55 (1.08)

Depression, anxiety, stress symptoms

Overall, participants reported greater symptoms of depression at session 2 (M = 9.91, SEM = .88), $F(1, 131) = 4.53$, $p = .04$, $\eta_p^2 = .03$, compared to baseline (M = 7.50, SEM = .82). No other effects were significant (Fs < 2.08, ps > .15). Analysis of anxiety symptoms revealed a significant main effect for monitoring condition, with the self-caught-only condition demonstrating greater anxiety symptoms compared to the self-caught-plus-probes condition $F(1, 131) = 4.16$, p = .04, $\eta_p^2 = .03$ (self-caught only M = 8.10, SEM = .72 versus self-caught-plus-probes M = 6.01, SEM = .73). No other effects

were significant (*F*s < 1.76, *p*s > .19). Similarly, it appeared that the self-caught-only condition (*M* = 12.58, *SEM* = .88) reported being more stressed compared to the self-caught-plus-probes condition (*M* = 9.82, *SEM* = .88), $F(1, 131) = 4.94$, $p = .03$, $\eta_p^2 = .04$. No other effects were significant (*F*s < 1.61, *p*s > .21). In sum, these results do not support hypothesis 5, that $CBM_{Metacog}$ training would reduce symptoms of depression, anxiety or stress. However, they do suggest that the way in which participants monitor their intrusions affects the level of distress they experience; with the presence of probes possibly reducing levels of anxiety and stress experienced compared to SC only.

8.6. Discussion

This study replicated Study 3 (pilot study) to determine whether training people to adopt healthy metacognitive beliefs, prior to trauma exposure, lead to healthier metacognitive beliefs and reduced intrusions. In light of the Study 3 results (i.e., a greater reporting of intrusion symptoms for the $CBM_{Metacog}$ group versus the $CBM_{Control}$), this study was also extended to examine whether $CBM_{Metacog}$ training increased participants' meta-awareness. According to the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004), increasing people's healthy metacognitive beliefs is associated with an increase in one's meta-awareness, a skill that is deemed to be beneficial to recovery. The metacognitive model of PTSD proposes that meta-awareness allows people to: 1) notice when they are engaging in unhelpful coping strategies (e.g., worry, rumination, threat monitoring) that may maintain their symptoms; and 2) recognise any trauma-related intrusions they are experiencing. In short, one possibility is that it is better to be aware of cognitive experiences like intrusions so that we can manage them effectively (e.g., by accepting that they are a normal occurrence, or re-appraising their meaning) (Wells, 2000; Wells & Sembi, 2004). Yet, there is no

empirical research examining whether increasing people's healthy metacognitive beliefs leads to increase in one's meta-awareness. Therefore, this study appears to be the first to examine these links.

Firstly, the $CBM_{Metacog}$ training in this study worked to bias participants' thinking in the intended direction compared to $CBM_{Control}$ group. The $CBM_{Metacog}$ group demonstrated higher index bias scores compared to the $CBM_{Control}$ group. Interestingly, the CBM x session interaction effect showed that group differences were only found at post-training session 1, but not session 2. This result suggests that the effects of a single session of $CBM_{Metacog}$ training may be harder to detect after 1-week. Perhaps, multiple training sessions are needed to maintain the bias over a longer period of time. Importantly, this study replicated findings from Study 1 and 3; demonstrating that the $CBM_{Metacog}$ training appears lead to healthier metamemory beliefs compared to the $CBM_{Control}$. Overall, these results indicate that metamemory beliefs may be more effectively manipulated via CBM training than other types of metacognitive beliefs (e.g., MCQ). It could be that the $CBM_{Metacog}$ training more easily transfers over to metacognitive beliefs about a specific event (i.e., the film), as opposed to general metacognitive beliefs (as measured by the MCQ).

Again, no CBM group differences were found in the RIQ—beliefs about the meaning of intrusions. One limitation to the use of this measure is that, only participants who report experiencing intrusions go on to complete it. Due to this, the sample sizes for the RIQ analysis have remained low in Studies 1 and 3, as only a small proportion of participants reported intrusions. However, they were much higher in this study (due to the greater proportion of people reporting experiencing intrusions), but, still no significant differences were found. One possible explanation for this focuses on the type of sample used in the present study. For instance, this study, like Studies 1 and 3, used a

healthy (predominantly student) sample, whom arguably already hold healthy beliefs about intrusions and know that they are a normal occurrence. Consequently, the $CBM_{Metacog}$ training may not increase people's healthy metacognitive beliefs in relation to intrusions, when they already hold healthy beliefs. Alternatively, it could be that the $CBM_{Metacog}$ training sentences for the MCQ and RIQ items were not effective enough to target and increase healthy metacognitive beliefs.

Taken together, this study replicated two important findings from Study 1 and Study 3, suggesting that $CBM_{Metacog}$ training can reliably bias participants thinking in the intended direction, and this has some effect at increasing healthy metacognition—specifically, healthy metamemory beliefs (as measured via the BAMQ).

The next primary outcome variable of interest was PTSD symptoms. This study was conducted to replicate Study 3 and explore whether $CBM_{Metacog}$ training lead to more or less intrusions, compared to the $CBM_{Control}$. Given the small proportion of participants who actually reported intrusions in Study 3, it was unclear whether the previous results were a genuine effect or a fluke. In line with the previous mixed findings from pilot Studies 1 and 3, the results from this replication study could either support the original PTSD symptom hypotheses (i.e., reduced PTSD symptoms for the $CBM_{Metacog}$ group compared to the $CBM_{Control}$ group) or they could support the newly proposed meta-awareness hypotheses. Importantly, the data in the current study offer support for the original hypothesis. The intrusion diary data here, suggests that training people to adopt healthy metacognitive beliefs, prior to trauma exposure, significantly reduces intrusion frequency and distress, compared to the $CBM_{Control.}$ This finding is in line with the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004). Despite both groups reporteing similar levels of adherence to the diary, the intrusion diary data in pilot Study 3 indicated that only 24% of participants reported intrusions

during this time frame. Whereas, in this study, 76% (*n* = 103/135) of participants reported having intrusions after 2-days; suggesting that there could have been an under-reporting of intrusion symptoms in pilot Study 3 (and likely pilot Study 1 also). This calls into question the reliability of assessing trauma film intrusions online. Understandably, it could be that participants in Study 4 were more primed to detect intrusions due to the mind-wandering task that was administered; however, this would be the case for both CBM groups. In sum, this is the first study to demonstrate that healthy metacognitive beliefs may play a causal role in reducing PTSD symptoms following analogue trauma.

The primary outcome variables for the meta-awareness hypothesis were the number of self-caught intrusions and the proportion of probe-caught intrusions that were about the film. Here, no significant CBM group differences were found in the number of self-caught intrusions, suggesting that receiving CBM training to increase healthy metacognition prior to trauma, did not increase participants' meta-awareness, compared to the $CBM_{Control}$ group. Next, analysis of the proportion of probe-caught intrusions that were about the film also revealed no significant differences, again suggesting that $CBM_{Metacog}$ training did not enhance participants' meta-awareness.

Similar to previous studies (e.g., Takarangi et al., 204; Takarangi, Nayda et al., 2017), this study also found that people are not always aware of their trauma-related cognition; that is, participants were frequently caught thinking about the film. Further, the analysis revealed two unexpected findings: 1) the $CBM_{Metacog}$ group were less likely to respond to probes saying they were thinking about the article, and 2) the $CBM_{Metacog}$ group were more likely to respond to probes by saying they were thinking about other things. Therefore, the $CBM_{Metacog}$ group were more off-task during the reading task compared to the $CBM_{Control}$ group. So, what were they thinking about? An interesting

possibility is that $CBM_{Metacog}$ participants were mind-wandering about the CBM training they had received, possibly reflecting on the information they had gathered from the training and what it means for them going forward (i.e., what intrusions mean, what it means to have gaps in one's memory for a trauma etc.). Indeed, research has shown that mind-wandering is associated with healthy cognition (Baars, 2010) and is mainly future focused (Smallwood, Nind, & O'Connor, 2009), so it is a possibility. Further research, could test this hypothesis by including open-text response probes during the reading task, whereby participants can quickly type what they are thinking about (e.g., content), rather than using forced choice responses, as used in this study and previous studies (e.g., Takarangi, Nayda et al., 2017).

Lastly, although no significant CBM group differences were found on the EIS items at session 1 or session 2 as predicted, there were some interesting findings. The more people self-caught intrusions during the task, the higher they scored on the frequency, spontaneous and interference EIS items. However, this was not the case for probe-caught intrusions. Thus, it is possible that catching intrusions (i.e., having meta-awareness of one's intrusions) leads people to experience them in a more traumatic way. The findings also support the anxiety and stress symptom results, whereby people in the self-caught only condition reported greater anxiety and stress symptoms compared to those exposed to probes. However, the EIS at session 1 was completed after the reading task, and retrospectively asked people to rate how they experienced their intrusions in the reading task, meaning that it is vulnerable to recall bias. To address this, future studies could seek to capture experience ratings of self-caught and probe-caught film thoughts *in the moment*, as soon as participants experience them, rather than asking participants to retrospectively rate such experiences. This data will shed light on how self-caught and probe-caught intrusions are experienced and whether

receiving $CBM_{Metacog}$ training affects these experiences. For example, it is possible that the $CBM_{Metacog}$ had fewer distressing self-caught and probe-caught intrusions, compared to the $CBM_{Control}$, however the current study does not allow for this to be examined. Further, at present, it is unclear how people evaluate failures in their meta-awareness. For instance, do they feel worse off for failing to report an intrusion? This is an area that warrants research.

There are several limitations to this study. First, for ethical reasons, the $CBM_{Metacog}$ training was tested on non-clinical student sample whom are likely to already hold healthy pre-existing metacognitive beliefs. Thus, it is unknown whether these results would also be found among clinical samples. To tackle this, the next step might be to test the efficacy of $CBM_{Metacog}$ training among people who report higher pre-existing maladaptive beliefs in relation to a historic experienced event, to ascertain whether $CBM_{Metacog}$ successfully reduces maladaptive metacognitive beliefs and symptoms. A further step would then consider prospectively testing the training out among trauma exposed populations (e.g., first responders) and assessing beliefs and symptoms in relation to an experienced trauma over time, or testing against a clinical sample (i.e., those with PTSD diagnosis). Second, this study only included a positive CBM condition (i.e., that trained people to adopt healthy metacognition) relative to a control group. Therefore, it would also be useful to test a negative $CBM_{Metacog}$ condition (i.e., one that trains people to adopt unhealthy metacognitive beliefs), compared to a control, to better determine the causal effects of metacognitive beliefs on PTSD symptoms. For instance, would a negative $CBM_{Metacog}$ group lead to increases in intrusion frequency and distress ratings, or would it lead to a reduction—possibly due to enhanced suppression attempts? Further research is warranted, however there are ethical concerns surrounding training people to adopt unhealthy thinking styles and safety

measures (e.g., clear study debriefing, signpost to support services) should be put into place when carrying out this type of research. As outlined by Takarangi, Nayda et al. (2017), it is possible that some of the probe-caught film thoughts were actually non-reported meta-aware continuations of a previously self-caught film thought. Previous studies have addressed this by asking participants to respond to probes by selecting whether their film thought was a continuation of previously self-caught film thought. However, previous data do indicate that this accounts for some, but not all of the probe-caught film thoughts (Green et al., 2016). Lastly, it is possible that the $CBM_{Metacog}$ group could have encoded the trauma film in a different way to participants in the control group, meaning that any differences found in PTSD symptoms between groups is down to differences at encoding rather than due to the nature of the CBM training (i.e., targeting metacognitive beliefs).

In sum, this is the first study to manipulate metacognitive beliefs using a CBM training protocol and the main results here do suggest that metacognitive beliefs may play a causal role in the development of PTSD. However, further research (e.g., a negative CBM training condition) is needed before causality can be established. This data does indicate that training people to adopt healthy metacognitive beliefs prior to trauma exposure may help to mitigate against the development of PTSD. This study has implications for the primary prevention of PTSD, an area pertinent to first responder communities such as police officers, who routinely encounter trauma within their day-to-day roles.

CHAPTER 9: INVESTIGATING THE EFFECTS OF $CBM_{METACOG}$ TRAINING ON VOLUNTARY MEMORY RECALL

9.1. Chapter overview

Intrusions are a cardinal symptom of PTSD. For this reason, much clinical and experimental research has been conducted on the ways to help mitigate the negative impact of intrusions, and ultimately reduce psychological suffering. As outlined by James et al. (2016), an intervention that reduces intrusions (i.e., *involuntary* memory) without affecting the accuracy of one's *voluntary* memory for an event is desirable; and would have important clinical, forensic and theoretical implications. Despite this, few experimental studies investigate how an intervention may affect voluntary trauma memory (see Lau-Zhu, 2017). The studies that do assess both voluntary and involuntary memory for the same trauma, tend to focus on memory accuracy alone, rather than the specific types of event memory details recalled. Examining the types of memory details voluntarily recalled, may provide better insight into what drives the development of intrusions. For instance, PTSD interventions may serve to strengthen the *voluntary* recall of certain event memory details over others, which in turn, may have consequences for the development of intrusions linked to the same event.

Chapters 5–8 have primarily examined how varying people's metacognitive beliefs—through $CBM_{Metacog}$ training—affected the development of intrusions (i.e., *involuntary* memory) for an analogue trauma. This chapter extends previous chapters, by firstly investigating how $CBM_{Metacog}$ training affects the type of event memory details voluntarily recalled—namely, central and peripheral details. Secondly, it explores the relationship between the voluntary recall of central and peripheral details and PTSD symptoms, all linked to the same analogue trauma event.

The ways in which emotion impacts a person's memory for an event is a topic central to the understanding of memory in PTSD. It is well accepted that, compared to events which do not evoke emotional arousal, those that do, are found to enhance memory. However, subsequent research demonstrates that emotion enhances memory for some *details* more than

others, namely central more so than peripheral details (see Kensinger, 2009). Central details refer to details that are associated with an emotional stimulus (e.g., a weapon used by a perpetrator), whereas, peripheral details are those unrelated to the emotional aspects of the event, such as background information (e.g., the colour shirt worn by a bystander) (see Christianson, 1992 for a review). Events that elicit negative emotional reactions, such as fear, heighten memory for thematically central details, and impair memory for peripheral details about the event (Edelstein, et al., 2004; Reisberg & Heuer, 2004, 2007). Similarly, focusing on sources of distress is associated with better recall for central details versus peripheral (Christianson, 1992), and when positive emotions are linked to an event, peripheral details tend to be remembered better than central (Talarico, Berntsen, & Rubin, 2009). Thus, investigating how PTSD interventions affect a person's voluntary memory for central and peripheral details may provide further insight into the mechanisms behind PTSD symptom development. For example, it is possible that an effective psychological intervention works to reduce intrusions by reducing the amount of central details a person voluntarily recalls.

Interventions that reduce the key emotional aspects (i.e., central details) of a trauma, may consequently help to reduce a person's sense of current threat, which may ultimately reduce the development of PTSD (i.e., intrusions). Brown et al. (2012) found that enhancing low self-efficacy (i.e., poor perceived coping ability), prior to analogue trauma, led people to display greater memory for central, but not peripheral details. This finding suggests that inducing low self-efficacy affects the way people remember analogue trauma, with a greater memory for central over peripheral details. In line with this, enhanced memory for central details over peripheral may be associated with an increased sense of threat and vulnerability to PTSD. Thus, exploring voluntary memory for central and peripheral details may hold implications for key cognitive models of PTSD. In line with Ehlers and Clark's (2000) cognitive model of PTSD, reducing a person's voluntary memory for the central details of a

trauma may reduce a person's sense of threat by modulating a person's cognitive appraisal style, or by facilitating memory elaboration. Unlike Ehlers and Clark's (2000) cognitive model of PTSD, and other cognitive models (e.g., Brewin et al., 1996), the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004), does not propose that cognitive appraisals or memory elaboration techniques are important to reduce the perception of threat linked to PTSD symptom development. Instead, the metacognitive model proposes that the CAS—thought to be directly linked to maladaptive metacognitive/metamemory beliefs—maintains threat. Thus, it is possible that maladaptive metacognitive beliefs are linked to a greater reporting of PTSD symptoms, because maladaptive metacognitive beliefs affect the way people remember a distressing/traumatic event. That is, they may demonstrate enhanced memory for central compared to peripheral details.

Several analogue trauma studies which have assessed both involuntary and voluntary memory for a trauma film, and these have largely employed memory recognition tests to assess memory accuracy for the film (see LauZhu, 2017 for a review). Another way to assess voluntary memory is via a free recall task; whereby participants are asked to recall everything that they can remember about the film, without being exposed to a retrieval cue. Although testing free recall for complex visual stimuli is extremely challenging, free recall does offer advantages compared to recognition tests, as it offers a rich amount of data that can be analysed in several ways (e.g., scoring for different memory details). Secondly, due to the lack of task-relevant cues, free recall tasks help researchers to ascertain what details people voluntarily choose to recall themselves, helping to rule out the idea that they only report such details because of a cue being present. Consequently, in Studies 1, 3 and 4 voluntary memory recall was assessed via a free memory recall measure, all for the same analogue trauma film. In each study, participants were instructed to recall everything that they could remember about the film and to be sure to leave nothing out. Free-memory recalls were coded and

analysed for each participant within each study using the same coding protocol. Therefore, the upcoming methods section equally applies to all three studies. However, the results from each study will be outlined separately in the results section.

In sum, this chapter explored whether $CBM_{Metacog}$ training is associated with the recall of fewer central details, compared to the $CBM_{Control}$ group. Secondly, the relationship between the number of central and peripheral details voluntarily recalled and PTSD symptoms was also examined.

9.2. Method

Scoring of free memory recall

Each participant's memory recall at each session was saved into separate word documents for analysis. A scoring template that coded for central and peripheral details, as well as word count, was developed to assess the free memory recalls at each session. A thematic centrality (Heuer & Reisberg, 1990) definition of centrality was adopted. Central details referred to "any element pertaining to the basic story line that could not be changed or excluded without changing the basic story line" (Heuer & Reisberg, 1990, p. 499) (see also Cahill & van Stegeren, 2003). Three independent judges identified and agreed on the basic storyline of the film and this was used to determine the central details of the event. All other event details were coded as peripheral information. Examples of central items used included "driver texting while driving", "crash into oncoming car" and any information relating to the victims' wellbeing (e.g., "two girls were unconscious"), that was visible in the film, as the victims were thematically and emotionally central to the story. Remaining elements were considered to the peripheral details, such as information related to the environmental surroundings (e.g., weather, road signs), the cars involved (e.g., car model, colour) and descriptive details about the physical appearance of victims' or bystanders' clothing (e.g., blue t-shirt). The central and peripheral details were agreed and finalised by three

independent researchers prior to coding the recalls. All recalls were coded independently by one researcher, whilst blind to participant conditions. Additionally, a second independent researcher scored at least, 20% of the recalls, from each study, to ensure reliability of the scores. Any differing scores were discussed between the two judges, and if disagreement remained, a third independent judge finalised the decision until a 100% agreement was reached. Word count was summed for each recall (i.e., for each session) (see Appendix 9 for the coding template).

9.3. Data analysis

Data were analysed using the General Linear Model, with alpha set a .05 throughout. Post-hoc planned comparisons were then conducted to assess significant interaction effects using the Holm-Bonferroni correction to adjust for multiple comparisons (Holm, 1979).

9.4. Study 1: Analysis of Retrospective $CBM_{Metacog}$ training for an analogue trauma

Due to the design of Study 1 (see Appendix 4 for overview), participants were asked to recall everything that they could remember about the film immediately following the film in session 1—prior to receiving the CBM training. Participants then recalled their memory of the film once more at session 2, the following day. Therefore, from this design, there is a measure of recall both pre (i.e., session 1) and post-CBM training (i.e., session 2).

Hypotheses

- The $CBM_{Metacog}$ group will recall significantly fewer central details post-CBM training, compared to the $CBM_{Control}$ group (directional hypothesis)

Results

Firstly, word count from session 1 and session 2 were analysed with a 2 CBM ($CBM_{Metacog}$ versus $CBM_{Control}$) x 2 session (session 1 and session 2) mixed ANOVA. Participants recalled more words at session 1 (M = 211.88, SEM = 12.74) compared to

session 2 (*M* = 173.90, *SEM* =12.11), $F(1, 72) = 12.57$, $p = .001$, $\eta_p^2 = .15$. However, CBM group did not affect word count, $F(1, 72) = .11$, $p = .75$, $\eta_p^2 = .00$. Further, the CBM x session interaction effect was non-significant ($p = .52$).

Next, the number of central and peripheral details were analysed via a 2 memory details (central and peripheral) x 2 session (session 1 versus session 2) x 2 CBM ($CBM_{Metacog}$) versus $CBM_{Control)}$ mixed ANOVA (see Table 14 for a breakdown of means per CBM condition). Session and memory details were the within-subjects factors and CBM was the between-subjects factor.

The ANOVA revealed a main effect for memory details, $F(1, 72) = 290.40$, $p < .001$, $\eta_p^2 = .80$, with a greater amount of central details being reported overall (*M* = 14.24, *SEM* = .43) versus peripheral (*M* = 6.56, *SEM* = .51). Additionally, there was a main effect for session, $F(1, 72) = 27.94$, $p < .001$, $\eta_p^2 = .28$, with more details being reported at session 1 (*M* = 11.23, *SEM* = .45) versus session 2 (*M* = 9.57, *SEM* = .44). However, CBM group did not affect the recall of memory details ($p = .65$). Additionally, the memory details x CBM group and memory details x session interactions were both non-significant (*ps* > .06). Overall, these results indicate that, contrary to prediction CBM group did not affect the voluntary recall of memory details about the trauma film.

Table 14

Mean (SD) of central and peripheral details by CBM group at each session (Chapter 9)

	$CBM_{Metacog}$ (*n* = 38, 29 female)	$CBM_{Control}$ (*n* = 36, 27 female)
Measure	*M* (*SD*)	*M* (*SD*)
Central details: S1	14.82 (4.85)	15.75 (3.68)
Central details: S2	12.79 (4.16)	13.61 (3.96)
Peripheral details: S1	7.11 (4.51)	7.24 (5.39)

Peripheral details: S2	6.13 (3.66)	5.76 (4.95)

Note: S1 = session 1; S2 = session 2

Exploratory Pearson's correlational analyses were conducted to examine the relationship between the number of central and peripheral details recalled at session 1 and session 2, with PTSD symptoms (i.e., IES-R and intrusion diary frequency) (see Table 15). Here, as central details were proposed to be associated with an increased perception of threat, it was predicted that the recall of central details would be positively associated with the self-reporting of PTSD symptoms, specifically intrusions, regardless of CBM condition. However, it appeared that the more participants recalled peripheral details at sessions 2 (post-CBM training), the more intrusions they reported in the diary.

Table 15

Correlation matrix showing the relationship between central and peripheral details and analogue PTSD symptoms (N = 74) (Chapter 9)

Measure	Intrusion Diary Frequency	IES-R: Hyperarousal	IES-R: Intrusion	IES-R: Avoidance	IES-R: Total
Central details: S1	0.19	-0.03	0.02	-0.03	-0.01
Central details: S2	0.18	-0.05	0.10	0.02	0.05
Peripheral details: S1	0.22	0.14	-0.00	0.05	0.06
Peripheral details: S2	0.33**	0.15	0.14	0.11	0.15

Note: ** Correlation is significant at the 0.01 level (two-tailed); * Correlation is significant at 0.05 level (two-tailed); S1 = session 1; S2 = session 2

9.5. Study 3: Analysis of Prospective $CBM_{Metacog}$ training for an analogue trauma

Given the design of Study 3 and 4 (see Appendix 5 and 8 for study overviews), all participants were randomly allocated to a CBM training group, *prior* to watching the film. Thus, the recalls at session 1 and at the follow up sessions (i.e., session 2 and session 3), were all *post* CBM training, allowing for CBM group differences on recall to be assessed at each session. However, due to this design, unlike Study 1, there is no "pre" CBM memory recall data, only "post" CBM.

Hypotheses

- The $CBM_{Metacog}$ group will recall significantly fewer central details, compared to the $CBM_{Control}$ group (directional hypothesis)

Results

The total word count at each session was analysed with a 3 session x 2 CBM mixed ANOVA. It appeared that word count did not vary by session, $F(2, 144) = .65$, $p = .53$, $\eta_p^2 = .01$, or by CBM group $F(1, 72) = 1.15$, $p = .29$, $\eta_p^2 = .02$. Additionally, the CBM x session interaction was non-significant ($p = .30$).

Next, the number of memory details recalled at each session were analysed with a 2 memory details (central, peripheral) x 3 session x 2 CBM group mixed ANOVA (see Table 16 for a breakdown of the means per CBM group). The ANOVA revealed a significant main effect for memory details, $F(1, 72) = 405.15$, $p < .001$, $\eta_p^2 = .85$, with a greater amount of central details being recalled ($M = 11.24$, $SEM = 4.40$) compared to peripheral details ($M = 4.40$, $SEM = .40$). All other effects were non-significant (ps $> .17$).

Table 16

Mean (SD) of central and peripheral details by CBM group at each session (Chapter 9)

	$CBM_{Metacog}$ (*n* = 39, 19 female)	$CBM_{Control}$ (*n* = 35, 14 female)
Measure	*M* (*SD*)	*M* (*SD*)
Central details: S1	11.06 (4.31)	9.40 (4.29)
Central details: S2	10.76 (4.29)	8.84 (4.75)
Central details: S3	10.51 (4.47)	8.91 (4.55)
Peripheral details: S1	4.94 (4.12)	4.40 (3.49)
Peripheral details: S2	4.46 (3.48)	3.84 (3.70)
Peripheral details: S3	4.38 (3.36)	4.19 (3.61)

Note: S1 = session 1; S2 = session 2

Next, the relationship between the number of central and peripheral details recalled at each session, and PTSD symptoms reported at session 2 and session 3 was examined. Again, as central details were proposed to be associated with an increased perception of threat, it was predicted that the recall of central details would be positively associated with the self-reporting of PTSD symptoms in session 1 and session 2, regardless of CBM condition (see Table 17). The results only revealed one significant association, demonstrating that the fewer peripheral details people called at session 1, the more intrusions they reported over the follow-up period.

Table 17

Correlation matrix showing the relationship between central and peripheral details and analogue PTSD symptoms (N = 74) (Chapter 9)

	Intrusion Frequency (diary)	IES-R Intrusion: S2	IES-R Hyper: S2	IES-R Avoid: S2	IES-R Total: S2	IES-R Intrusion: S3	IES-R Hyper: S3	IES-R Avoid: S3	IES-R Total: S3
Central details: S1	-0.13	-0.15	-0.13	-0.05	-0.12	0.04	0.07	0.04	0.06
Central details: S2	-0.04	-0.19	-0.17	-0.03	-0.13	0.09	0.12	0.14	0.14
Central details: S3	-0.03	-0.22	-0.20	-0.04	-0.16	-0.15	-0.13	-0.02	-0.10
Peripheral detail: S1	-0.23*	-0.14	-0.02	-0.02	-0.06	0.07	0.03	0.17	0.12
Peripheral details: S2	-0.16	-0.21	-0.12	-0.10	-0.16	0.00	0.01	0.07	0.03
Peripheral details: S3	-0.18	-0.20	-0.12	-0.06	-0.14	-0.12	-0.09	0.04	-0.05

Note: ** Correlation is significant at the 0.01 level (two-tailed); * Correlation is significant at 0.05 level (two-tailed); S1 = session 1; S2 = session 2

9.6. Study 4: Investigating the role of meta-awareness in computerised $CBM_{Metacog}$ training

To recap, Study 4 replicated Study 3 by randomly allocating participants to a CBM training group *prior* to analogue trauma (see Appendix 8 outline of the study), however in Study 4, the frequency of participants intrusions was measured over a one-week period versus 2 days (as in Study 3).

Hypotheses

- The $CBM_{Metacog}$ group will recall significantly fewer central details, compared to the $CBM_{Control}$ group (directional hypothesis)

Results

Firstly, word count at both sessions was analysed with a 2 session x 2 CBM group mixed ANOVA. The ANOVA revealed a main effect of session, $F(1, 131) = 9.07$, $p = .003$, $\eta_p^2 = .06$, with a greater number of words being recalled at session 1 ($M = 227.36$, $SEM = 10.53$) versus session 2 ($M = 189.34$, $SEM = 8.05$). The main effect for CBM group was non-significant and interaction effect were non-significant ($Fs < 1$, $ps >. 48$).

Next, central and peripheral memory details were subjected to a 2 memory details (central versus peripheral) x 2 session x 2 CBM mixed ANOVA (see Table 18). There was a significant main effect for memory details, $F(1, 131) = 206.03$, $p < .001$, $\eta_p^2 = .61$, with a greater amount of central details being recalled ($M = 14.92$, $SEM = .34$) versus peripheral ($M = 7.84$, $SEM = .45$). Participants also recalled more details at session 1 ($M = 12.21$, $SEM = .35$) versus session 2 ($M = 10.55$, $SEM = .31$), $F(1, 131) = 54.43$, $p < .001$, $\eta_p^2 = .29$. However, these effects were qualified by a significant memory details x CBM interaction effect, $F(1, 131) = 4.72$, $p = .03$, $\eta_p^2 = .03$. To

examine this interaction further, separate 2 session x 2 CBM group mixed ANOVAs were conducted for each memory detail type. Analysis revealed that the interaction was driven by a CBM group difference in central details, a significant main effect for CBM group $F(1, 131) = 6.49$, $p = .01$, $\eta_p^2 = .05$, with a greater number of central details being recalled by the $CBM_{Metacog}$ group (M =15.78, SEM = .48) versus the $CBM_{Control}$ (M = 14.01, SEM = .48).

Table 18

Mean (SD) of central and peripheral details by CBM group at each session (Chapter 9)

	$CBM_{Metacog}$ (n = 67, 63 female)	$CBM_{Control}$ (n = 68, 63 female)
Measure	*M* (*SD*)	*M* (*SD*)
Central details: S1	16.50 (4.09)	14.78 (4.57)
Central details: S2	15.07 (4.61)	13.32 (3.97)
Peripheral details: S1	8.63 (5.90)	8.92 (6.06)
Peripheral details: S2	6.64 (4.81)	7.17 (4.83)

Note: S1 = Session 1; S2 = Session 2

Lastly, the relationship between the number of central and peripheral details at each session and PTSD symptoms was explored using Pearson's correlational analysis, (see Table 19). Here, the results revealed that the more participants recalled peripheral details at session 1 and session 2, the more intrusions they reported experiencing via the 7-day diary.

Table 19

Correlation matrix showing the relationship between central and peripheral details and analogue PTSD symptoms (N = 74) (Chapter 9)

	Intrusion Frequency (diary)	IES Intrusion: S2	IES Hyper: S2	IES Avoid: S2	IES Total: S2
Central details: S1	0.07	0.00	-0.11	-0.13	-0.09
Central details: S2	0.09	0.04	-0.11	-0.10	-0.06
Peripheral details: S1	0.04	0.24**	0.02	0.14	0.18*
Peripheral details: S2	0.07	0.17*	-0.09	0.10	0.10

Note: ** Correlation is significant at the 0.01 level (two-tailed); * Correlation is significant at 0.05 level (two-tailed); S1 = Session 1; S2 = Session 2

9.7. Discussion

This chapter aimed to explore whether a novel CBM intervention, designed to increase healthy metacognitive beliefs (i.e., $CBM_{Metacog}$), would affect the voluntary memory recall of central and peripheral details about a trauma film, compared to $CBM_{Control}$. Secondly, it examined the relationship between the voluntary recall of central and peripheral details and PTSD symptoms (including intrusions). Examining *what* details people specifically remember about a trauma film (i.e., memory details) following a psychological intervention may provide insight into the potential mechanisms that are behind these interventions and is a promising avenue for research. For instance, in other literature the recall of central details over peripheral details is associated with negative emotional reactions and emotional distress. Consequently, it is

possible that voluntarily recalling central details over peripheral could heighten one's risk for PTSD by leading to the development of PTSD symptoms. Thus, exploring the recall of central and details following psychological interventions is worthwhile, and may be a possible mechanism behind the efficacy of some psychological interventions. For example, a psychological intervention may be effective at reducing PTSD symptoms (e.g., intrusions) because it alters the details that people *voluntarily* remember about a trauma. The two research questions from this chapter will be discussed in turn below.

Research Question 1: Did $CBM_{Metacog}$ training affect the number of central, peripheral and perceptual voluntary memory details, compared to the $CBM_{Control}$ group?

The results across the three studies were mixed, with only one effect being found in Study 4. In Study 1, participants were asked to watch a trauma film then immediately recall everything that they could remember. Following this, participants were randomly allocated to a CBM training group and they were asked to recall their voluntary memory of the trauma film at the follow-up session (i.e., the next day). This design allowed for a pre and post-CBM measure of memory recall to be collected. The main hypothesis here was that participants who received the CBM_{Metcog} training would recall fewer central details at session 2, compared to the $CBM_{Control}$ group. However, contrary to prediction, it did not appear that CBM group affected the voluntary recall of central or peripheral details.

In Study 3 all participants were randomly allocated to a CBM training group prior to the trauma film; thus, all voluntary memory recall measures were post-CBM

training. However, similar to Study 1, there were no significant differences in the number of central or peripheral details recalled between CBM groups.

Interestingly, in Study 4, the analysis revealed a significant effect for CBM group, demonstrating that the $CBM_{Metacog}$ group reported more central details overall compared to the $CBM_{Control}$ group. This was contrary to prediction; however, perhaps there is another way of looking at these results. It is possible that the $CBM_{Metacog}$ training reduced participants' perception of threat meaning that they were less likely to employ maladaptive coping strategies, such as avoidance, when recalling the event, meaning they recalled more central details as opposed to less. Future research could seek to address this by investigating whether training people to adopt healthy metacognitive beliefs affects people's attention/avoidance to threat information when watching an analogue trauma film via eye-tracking technology—similar to Study 2 from this thesis.

Research Question 2: What there any relationship between the types of voluntary memory details recalled and self-reported PTSD symptoms?

The correlational analysis assessing the relationship between voluntary memory details and PTSD symptoms was mixed across the three studies. In Study 1, there appeared to be a positive relationship between the recall of peripheral details at session 2 and the frequency of intrusions. Here, at session 2, people firstly entered their intrusion diary data, then later recalled their memory of the film. Thus, it is possible that the intrusions people experienced between session 1 and session 2, strengthened their memory for peripheral details, for instance via rehearsal, leading them to recall more peripheral details at session 2. Still, taken together this result suggests that peripheral details, as opposed to central (as predicted) was positively associated with the

development of intrusions. In, Study 3 the opposite effect was found. Here, there was a negative relationship between the recall of peripheral details and intrusions. However, as mentioned in Chapters 5 and 7, the reliability of the intrusion diary data from these two pilot studies is questionable, given that only a small proportion of participants actually reported experiencing intrusions, thus these mixed results should be interpreted with caution.

However, in the main CBM intervention study—Study 4— the results showed that the recall of peripheral details at session 1 and session 2 was positively associated with development of intrusions. Again, this is contrary to the hypothesis, but also fits well with the data outlined previously. That is, in Study 4, the $CBM_{Metacog}$ group reported *more* central details compared to the $CBM_{Control}$ group. One possibility is that $CBM_{Metacog}$ training works to reduce PTSD risk by *enhancing* the recall of central details (possibly due to reduced avoidance). Thus, the recall of peripheral details, not central, are associated with heightened vulnerability to PTSD. It would be interesting to assess the voluntarily recall of central and peripheral details within other psychological interventions to see if similar effects are found (i.e., greater recall of central) or whether this is a finding specific to metacognitive beliefs. The DRT (Brewin 1996; 2001) may also offer an explanation for these results, as the heightened stress that participants experienced during the encoding of the trauma film may have weakened the processing of C-reps and thus instead, strengthened the processing of S-reps. This would lead to an imbalance between C-reps and S-reps, and S-reps would consequently lose its context and be retrieved involuntary (i.e., intrusions).

Overall discussion

Previous research has found that assessing voluntary recall, prior to the intrusions can reduce the frequency of intrusions (e.g., Jobson & Dalgleish, 2014,

Experiment 2; Krans, Näring, Holmes, & Becker, 2009). Perhaps because it activates a voluntary retrieval mode, and not an involuntary mode. This finding is applicable to all three CBM studies in this chapter. However, it would seem that if the frequency of intrusions were affected by the voluntary recall of the film, then both CBM groups would equally demonstrate a reduction in intrusions and no group differences would be found, yet they were. Future work could modify the study designs and counterbalance the order of memory tests, or only assess for group differences in voluntary free memory recall at one time point (e.g., follow-up) following the assessment of intrusions to better account for this.

Overall, research examining the relationship between voluntary and involuntary memory for the same trauma remains scarce. Analogue trauma research that has examined voluntary memory has predominantly used recognition memory measures, neglecting the use of free recall. The rich amount of data that is provided from free memory recall measures offers researchers a great amount of flexibility to examine specific types of memory details recalled. By examining the recall of different types of memory details, as opposed to memory accuracy outcomes alone, this may provide further insight into how therapeutic interventions, designed to reduce intrusions of a trauma, may influence voluntary memory recall. Also, by investigating the recall of specific memory details and their relationship with intrusions, this may spark the development of novel interventions which seek to either heighten or reduce those specific memory details most associated with distressing intrusions. As outlined by James et al. (2016), to help encourage further research using the trauma film paradigm, it may be beneficial to develop an international database of validated trauma films similar to that of the International Affective Picture System (Lang, Bradley, & Cuthbert, 2008). In addition to this, it would also be valuable for researchers to make free recall

coding templates openly available, to help increase the use of free memory recall measures in research and allow for better comparisons of findings amongst studies.

The majority of analogue trauma studies that employ the trauma film paradigm tend to use multiple different trauma film scenes all compiled together (see James et al., 2016). Perhaps this is why researchers have tended to opt for a memory recognition test as opposed to free-recall tasks, as with free-recall it may prove difficult to reliably pinpoint which details belong to which scene; especially if they are related scenes (e.g., multiple car crash scenes). More importantly, maybe compiled trauma films are a poor trauma analogue when researchers are wanting to unpick the relationship between voluntary and involuntary memory. For instance, real-life trauma memories form part of one's episodic memory, they are autobiographical memories about a specific event. Thus, compiled analogue trauma films are not only limited by the fact that they are not autobiographical, but also because they are not about a specific episode, and may be processed differently. This is an important consideration for future research wanting to investigate the relationship between voluntary and involuntary memories for the same event.

CHAPTER 10: GENERAL DISCUSSION

This chapter will outline the main findings from this thesis, highlight the strengths and limitations of the research, and discuss the wider implications of the findings. Firstly, this chapter will outline the key findings from each study, as well as summarise the effects of $CBM_{Metacog}$ training on both metacognitive beliefs and PTSD symptoms from across the three CBM studies. Next, the strengths and limitations will be considered. Following this, the implications of this research will be discussed. The chapter will end by highlighting areas for future research and summarising how this thesis has contributed to our understanding of metacognitive beliefs in PTSD.

10.1. Main Findings

The development of PTSD hinges on a person's exposure to a traumatic event. Consequently, it seems that there is a window of opportunity—immediately after the trauma, or where possible, prior to trauma (e.g., first responders)—whereby an intervention could potentially prevent the PTSD development. This thesis explored one novel approach to prevention, a new CBM technique designed to enable people to adopt healthier metacognition (i.e., metacognitive beliefs) that was developed based on the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004). The main findings from this thesis demonstrate that training people to adopt healthy metacognitive beliefs via a CBM training protocol may help to prevent the development of analogue PTSD symptoms following a distressing experience.

Table 20 summarises the main findings from the CBM studies. Study 1 was the first pilot study to determine the causal role of metacognitive beliefs in PTSD. Here, it appeared that compared to the control group condition (i.e., $CBM_{Control}$), participants who received the $CBM_{Metacog}$ training demonstrated significantly higher index bias scores. This indicated that the $CBM_{Metacog}$ training was able to successfully bias

participants' thinking styles (i.e., metacognitive beliefs) by increasing healthy metacognitive beliefs. Further, there was some evidence that the $CBM_{Metacog}$ training transferred over to other self-report metacognitive belief measures also, including positive metamemory beliefs about the film (BAMQ), positive beliefs about worry (MCQ 1) and beliefs about the need to control thoughts (MCQ 3). Here, participants who received the $CBM_{Metacog}$ compared to $CBM_{Control}$ reported healthier metamemory beliefs, healthier beliefs about worry, and healthier beliefs about the need to control thoughts overall post-training. In this pilot, participants' PTSD symptoms in relation to the analogue film were assessed at follow-up (1-day post-film). PTSD symptoms were measured via a validated scale, the IES-R, and via a 24-hour intrusion diary. Contrary to prediction and despite the gains made in healthier metacognitive beliefs, there were no significant differences in PTSD symptoms (IES-R and intrusion diary frequency/distress) between the CBM groups.

Study 2 was an eye-tracking study that explored whether pre-existing maladaptive metacognitive beliefs increase vulnerability to PTSD (following trauma exposure) by affecting the way people *encode* a traumatic event. Understanding whether pre-existing maladaptive metacognition increases PTSD risk by either: 1) changing the way people encode trauma; or, 2) by changing how people process the trauma afterwards, is important, and has implications for therapeutic tools that focus on increasing people's metacognitive beliefs (e.g., $CBM_{Metacog}$). The study also examined whether attention to sources of threat was related to the voluntary recall of central details of the film. This was a novel study that employed eye-tracking software to monitor people's eye movements whilst they watched a trauma film. Overall, the results found no evidence to suggest that pre-existing maladaptive metacognitive beliefs are associated with an increased attentional bias towards threat-related information. There

was a trend suggesting that the more people endorse maladaptive metacognitive beliefs, the less likely they were to fixate on threat. It is possible that people with greater maladaptive metacognitive beliefs were more likely to engage in avoidance towards the film—a dysfunctional coping strategy—however, this conclusion cannot be drawn from this data. Further, the data did not show any significant correlations between an attentional bias towards threat, and the recall of central details about the film. However, this study was based on a small sample size and further research surrounding the role of metacognitive beliefs in the encoding of trauma is warranted. Nevertheless, the size of the association between metacognitive beliefs and oculomotor behaviour was small, and thus, it was concluded that any differences in attention allocation that stem from metacognitive beliefs were too small in magnitude to consider further in relation to a prospective CBM treatment.

Study 3 tested the causal role of metacognitive beliefs in the primary prevention of PTSD. Study 3 was similar to Study 1, however in Study 3 the $CBM_{Metacog}$ training was administered *prior* to analogue trauma. This study focused on whether training people to adopt healthy metacognitive beliefs *prior to trauma exposure* would have a preventative effect on reducing the development of PTSD symptoms. This was an online pilot study and the follow-up period to assess PTSD symptoms was extended to 2 days (compared to 1 day in Study 1). Results showed that the $CBM_{Metacog}$ training successfully biased participants' thinking styles in the intended direction. That is, participants who received the $CBM_{Metacog}$ training demonstrated significantly higher index bias scores compared to the $CBM_{Control}$ group. Additionally, the $CBM_{Metacog}$ training exerted effects on other self-report measures including the BAMQ positive subscale. Here, compared to participants in the $CBM_{Control}$ group, those in the $CBM_{Metacog}$ group reported healthier positive metamemory beliefs overall post-training.

Interestingly, and contrary to prediction, it appeared that participants who received the $CBM_{Metacog}$ training reported significantly more intrusions over the 2-day period, compared to the $CBM_{Control}$ group. Similarly, although non-significant, examination of the intrusion subscale of the IES-R demonstrated a greater mean intrusion frequency for the $CBM_{Metacog}$ versus the $CBM_{Control}$. Taken together, this study suggested that training people to adopt healthy metacognitive beliefs prior to trauma exposure could lead to a greater frequency of intrusions. In other words, training people to adopt healthy metacognitive beliefs prior to trauma can yield a detrimental effect on PTSD symptom development.

However, there are two important points to consider when interpreting these results. Similar to Study 1, only a small proportion of participants actually reported experiencing any intrusions in this study. One possible explanation for this is the methods that were employed to assess intrusions were not sensitive or reliable enough. The intrusion diaries used in both Study 1 and this study were completed *online* by participants. Participants were required to keep track of their own intrusions themselves by noting them down as soon as they occurred, but they were not provided with any record keeping diaries to do so. It is possible that participants did not accurately enter all information on all the intrusions that they may have experienced, as they had no physical record to keep (e.g., pen-and-paper intrusion diary). Thus, the reliability of this finding is questionable and begs for further replication. A second point considers the role of meta-awareness (i.e., awareness of one's own cognition). One possible explanation that may account for the increased reporting of intrusions by the $CBM_{Metacog}$ group versus the $CBM_{Control}$ group is that $CBM_{Metacog}$ participants experienced more intrusions that reached meta-awareness, compared to the $CBM_{Control}$ group. That is, $CBM_{Metacog}$ participants did not necessarily experience more intrusions, *but they*

experienced more intrusions that reached meta-awareness. Indeed, a growing body of research has demonstrated that people can lack meta-awareness of their intrusions (e.g., Takarangi et al., 2014; Takarangi, Nayda et al., 2017). Thus, it is clear that further replication of this prospective study was needed to better determine the direct of PTSD effects, and also one that assessed for the potential role of meta-awareness.

Study 4 replicated and extended Study 3 by assessing the role of participants' meta-awareness of their intrusions. Here, participants received either $CBM_{Metacog}$ or $CBM_{Control}$ training immediately prior to analogue trauma. They then engaged in a mind-wandering task that determined participants' meta-awareness of their intrusions using self-caught and probe-caught techniques (Takarangi et al., 2014). After completing post-training measures (e.g., metacognitive beliefs) participants were provided with a 7-day pen-and-paper intrusion diary to record the occurrence of any intrusions they have about the film over the week. One-week later they returned to the lab and completed several follow-up measures including the IES-R to assess their experience of PTSD symptoms over the week. Once more, there was evidence that the $CBM_{Metacog}$ training successfully biased participants thinking in the intended direction (i.e., higher index bias scores in the $CBM_{Metacog}$ group versus $CBM_{Control}$). Similarly, $CBM_{Metacog}$ participants endorsed healthier positive metamemory beliefs post-training overall, compared to the $CBM_{Control}$ group. The most important finding in this Study was in relation to PTSD symptoms. Here, $CBM_{Metacog}$ participants reported significantly fewer intrusions over the 7-day period and lower overall intrusion distress, compared to the $CBM_{Control}$ group. This is the first study to manipulate metacognitive beliefs using a CBM training protocol and the main results here do align with a causal account of metacognitive in the development of PTSD, however further research is needed before causality can be firmly established. Specifically, including a negative CBM training

condition (to train people to adopt unhealthy metacognitive beliefs) would more precisely address whether metacognitive beliefs play a causal role in PTSD. However, the study does also add to the growing literature around the use of CBM training protocols to successfully modulate trauma related thinking styles and appraisals (see Woud et al., 2017). However, the data did not suggest that the $CBM_{Metacog}$ group demonstrated enhanced meta-awareness of their intrusions compared to the $CBM_{Control}$ group.

Chapter 9 explores the effects of $CBM_{Metacog}$ training on people's voluntary memory for an analogue trauma event. Exploring how psychological interventions affect a person's *voluntary* memory, as well as their involuntary memory for an event, is a key clinical priority (see James et al., 2016). A handful of analogue trauma studies have assessed how psychological interventions affect the voluntarily recall of a distressing event, but these studies have tended to focus on overall memory accuracy as opposed to the *details* that people recall. Examining what details people remember about an analogue trauma following psychological interventions may provide further insight into the development of PTSD symptoms such as intrusions and is thus a relatively understudied area in trauma research. In this chapter, voluntary memory recall data from Studies 1, 3 and 4 were analysed separately to determine how $CBM_{Metacog}$ training affected a person's voluntary memory of the trauma film. Specifically, the details that people remember about the trauma film—that is, the central and peripheral details—voluntarily recalled about the trauma film were analysed. This chapter aimed to determine whether: 1) the $CBM_{Metacog}$ group recalled significantly fewer central details compared to the $CBM_{Control}$; and 2) whether there was any association between memory details and PTSD symptoms, including intrusions specifically.

The results showed no significant CBM group differences in the number of central or peripheral details recalled in either Study 1 or Study 3. However, it appeared that in Study 4, participants who received the $CBM_{Metacog}$ training reported significantly more central details overall compared to the $CBM_{Control}$ group. This finding was contrary to prediction; central details were predicted to be associated with a greater perception of threat and were thus predicted to be greater in the $CBM_{Control}$ group versus $CBM_{Metacog}$. Further, it appeared that the recall of peripheral details, not central details, was associated with the reporting of intrusive memories about the film. It is possible that the peripheral details coded in these studies captured the recall of any sensory perceptual details about the film. Given the link between sensory perceptual details and PTSD (Ehlers & Clark, 2000), this might explain why peripheral details, and not central details, was associated with intrusion development. It is possible that participants recalled more peripheral, as opposed to central, as they were avoiding thinking about the central details of the film. Linking this to Brewin et al.'s (1996; 2010) DRT, it is possible that the heightened levels of stress experienced during the encoding of the trauma film, weakened the C-reps, meaning that their associated S-reps lost their context. In line with theory, this would then lead to a heightened sense of threat, thus increasing avoidant behaviours (both internal and external).

Table 20

Overview of the main outcome variables by CBM study

Measure	Study 1 (retrospective pilot)	Study 3 (prospective pilot)	Study 4 (prospective main CBM study)
Metacognitive beliefs			
Index bias scores	**$CBM_{Metacog}$ > $CBM_{Control}$**	**$CBM_{Metacog}$ > $CBM_{Control}$**	**$CBM_{Metacog}$ > $CBM_{Control}$**
Self-report metamemory	**$CBM_{Metacog}$ healthier beliefs versus $CBM_{Control}$**	**$CBM_{Metacog}$ healthier beliefs versus $CBM_{Control}$**	**$CBM_{Metacog}$ healthier beliefs versus $CBM_{Control}$**
PTSD symptoms			
IES-R	No CBM group difference	No CBM group difference	No CBM group difference
Intrusion diary	No CBM group difference	**$CBM_{Metacog}$ > $CBM_{Control}$**	**$CBM_{Metacog}$ < $CBM_{Control}$**

10.2. Implications

This thesis suggests that metacognitive beliefs may play a causal role in the development of PTSD symptoms. Specifically, it appeared that training people to adopt healthy metacognitive beliefs prior to trauma exposure has a preventative effect on reducing the development of intrusive memories. This finding has important therapeutic implications, as it suggests that targeting people's metacognitive beliefs to make them healthier, will help them to cope better and reduce the risk of PTSD when exposed to a traumatic event. Specifically, these results have implications for the primary prevention of PTSD among first responder communities. First responders, such as police officers and ambulance workers are frequently exposed to traumatic events as part of their occupational roles, as are other groups such as front-line healthcare workers whom respond to natural disasters/emergencies and pandemics. The majority of psychological interventions geared towards protecting against the development of PTSD within first responders are either delivered after the trauma exposure or are treatment interventions. For instance, only those who present with symptoms receive the intervention, meaning that intervention is only given once people already start to become unwell. There is a real scarcity of research pertaining to the primary prevention of PTSD, despite prevention remaining a key research and clinical priority among these groups (see Skeffington et al., 2013). To help train and educate first-responder communities in healthy metacognition, the CBM study could be expanded and adapted into a workshop training event instead. For instance, incorporating a workshop at the beginning of workers' service (e.g., police) which discusses mental health and factors that may increase vulnerability to PTSD would be a vital next step. This workshop could include key psychoeducation information about PTSD as well as training people in the

importance of healthy thinking styles and beliefs to reduce vulnerability to PTSD following trauma exposure in their jobs. Evaluating the validity of such an intervention would be key and workers could be followed up over a period of time to assess their coping responses following exposure to trauma, as well as their metacognitive beliefs, trauma appraisals and current PTSD risk/symptoms.

10.3. Strengths and Limitations

There are several strengths to this thesis. To date, there is no published work assessing the causal role of metacognitive beliefs in the development of PTSD. Thus, this is the first study to investigate the causal link between metacognitive beliefs and analogue PTSD symptoms. Second, employing CBM training as a tool to manipulate metacognitive beliefs is also viewed as a strength. CBM has been shown to successfully target and modify participants' trauma-related appraisals (see Woud et al., 2012; 2013; 2017) and this thesis suggests that metacognitive beliefs can also be targeted via novel a CBM training protocol. CBM offers several advantages as a tool to manipulate beliefs. For instance, due to its systematic, repetitive and non-explicit nature it is able to consistently reinforce a desired thinking style. Third, this thesis employed a suitable control group to act as a comparison group for the $CBM_{Metacog}$ training. Adding a relevant control group improved the quality of the studies as it minimised the effects of all other variables except the independent variable; allowing the effects of metacognitive beliefs on outcomes to be observed. Fourth, this thesis explored an understudied but important concept in the modification of metacognitive beliefs—meta-awareness. Understanding the relationship between changes in one's metacognitive beliefs and levels of meta-awareness is important for the advancement of the metacognitive model (Wells, 2000; Wells & Sembi, 2004). Lastly, this thesis sought to

explore the relationship between voluntary and involuntary memory for the same analogue trauma. Specifically, it discussed the importance of exploring the role of memory details when assessing voluntary memory, and how the *details of what people remember* may hold implications for the development of intrusions.

The studies within this thesis are not without their limitations. First, these studies did not assess real-life trauma. All studies employed the trauma film paradigm and were experimental analogue trauma studies. Although the trauma film paradigm is a well-established paradigm known to reliably induce trauma-related reactions (see James et al., 2016), it lacks ecological validity and is limited in the generalisations it can make to real-life trauma.

Second, as the bulk of these studies assessed the efficacy of a novel CBM training protocol ($CBM_{Metacog}$), a non-clinical sample (i.e., healthy participants) was selected for ethical reasons. Thus, one limitation to this is that we do not know whether we would find these effects among a clinical sample.

Third, there was no pre-training bias assessment, only post-training bias assessments. Thus, strictly speaking, it is unclear whether metacognitive appraisal style changed as a result of the CBM training.

Fourth, measures on the use of maladaptive coping strategies such as rumination, worry or avoidance were not included. It is unclear in Study 4, how $CBM_{Metacog}$ training led to a reduction in intrusive memories compared to $CBM_{Control}$. One possibility is that the $CBM_{Metacog}$ training lead to a reduction in the use of maladaptive coping strategies such as worry, rumination or avoidance, however this was not tested in this thesis.

Fifth, a measure of people's general proneness to intrusions was not included. It is possible that some people from the $CBM_{Control}$ group were generally more prone to

experience intrusions, and thus reported more than the $CBM_{Metacog}$ group. However, it is likely that if this was a potential confounder to the results, then it would also apply to participants in the $CBM_{Metacog}$ group also.

Sixth, participants were advised not to take part in the study if they thought viewing an emotional film, such as a road traffic accident, would be too distressing for them. Consequently, there might be a response bias, i.e. our sample might only include participants who felt that they could cope or would be less distressed by watching this type of film, thus excluding participants who may hold the type of characteristics (e.g., maladaptive metacognitive beliefs) that were desirable to target.

Seventh, although there was some evidence demonstrating that $CBM_{Metacog}$ was able to change people's self-report metacognitive beliefs, it is possible that metacognitive beliefs could be better measured via implicit measures and not self-report. An interesting avenue would be to adopt an implicit association task to capture changes in people's metacognitive beliefs. For instance, similar to Woud, Zlomuzica et al. (2017) the IAT (Greenwald et al., 1998) could be employed to capture implicit metacognitive beliefs, with separate IATs for each metacognitive belief being assessed. The IAT involves participants sorting stimuli (e.g., words) into four categories: two of which represent the target concept and two which represent opposing ends of a dimension. Each target category is displayed alongside both ends of the attribute dimension and faster reaction times during a target-attribute combination are indicative of a strong association between the two. Therefore, the *traumatised self* IAT used in Woud, Zlomuzica et al. (2017) could be adapted to target metacognitive beliefs instead. For instance, focusing on metamemory beliefs, there could be two target concepts "incomplete memory vs complete memory" (example words for incomplete memory: "memory gaps" "incomplete" "memory blanks" and example words for complete

memory “full memory”, “complete memory” “detailed memory”) and the attributes “traumatised vs healthy”). Thus, participants who hold unhealthy metamemory beliefs should have a faster reaction time in the trauma and incomplete memory assignment, compared to the trauma and complete memory assignment.

Eight, in Study 4, it is possible that some of the probe-caught film thoughts were continuations of previously self-caught (meta-aware) intrusions. If so, this would have led to a greater number of probe-caught intrusions, when really, they were continuations of self-caught intrusions. Thus, possibly inflating the number the of probe-caught film thoughts. Future studies could address this by adding a probe-caught option that allows participants to state whether it is a continuation of a previous thought.

10.4. Future Research

Study 4 found that training people to adopt healthy metacognitive beliefs prior to trauma exposure had a preventative effect on reducing the development of intrusive memories of a 7-day period. This result is promising; however important questions still remain. Firstly, the studies in this thesis employed analogue trauma. Analogue trauma films involve participants watching distressing films from a bystander viewpoint and are arguably less personally relevant as compared to personally experienced events. Perhaps, the next step for testing $CBM_{Metacog}$ would be to test it out against a different type of analogue trauma, people’s negative/traumatic autobiographical memories, similar to Woud, Zlomuzica et al. 2017. Should $CBM_{Metacog}$ demonstrate preventative effects on reducing PTSD symptoms associated with a negative/traumatic autobiographical memory, then future research could explore the effects of CBM using clinical samples—whom will most likely hold greater pre-existing maladaptive metacognitive beliefs.

Future research could explore the mechanisms behind why training people to adopt healthy metacognitive beliefs prior to trauma exposure (i.e., $CBM_{Metacog}$) lead to fewer intrusive memories. Chapter 9 explored one possible mechanism behind the efficacy of $CBM_{Metacog}$, that is, people's voluntary memory of the film. However, there are several other possibilities worth investigating, for example, the reduced use of maladaptive coping strategies.

Previous CBM studies that have targeted trauma related appraisals have adopted the use of a positive and negative CBM training groups (e.g., see Woud et al., 2017). In line with this, it would be interesting to test out a negative $CBM_{Metacog}$ training condition (i.e., one that trains people to adopt maladaptive metacognitive beliefs). Future research could develop this to help better understand the direction of observed effects, particularly from Study 4. That is, does a negative $CBM_{Metacog}$ training condition lead to more intrusions compared to the $CBM_{Control}$? Further, does it also lead to reduced meta-awareness or enhanced? These are important considerations for future research exploring the causal role of metacognitive beliefs in PTSD.

Future research should seek to explore the role of meta-awareness in relation to the metacognitive model of PTSD. For example, the metacognitive model of PTSD (Wells, 2000; Wells & Sembi, 2004) proposes that the CAS is associated with low meta-awareness. Further, metacognitive strategies utilised within metacognitive therapy, such as detached mindfulness are thought to increase a person's meta-awareness. Thus, increased meta-awareness is viewed as a positive process that is accompanied by changes/removal of the CAS, such as modifying one's metacognitive beliefs to be healthier. However, it is unclear how people evaluate failures in their meta-awareness. For instance, when someone experiences a probe-caught intrusion (i.e., an intrusion that they were not meta-aware of themselves), what do they interpret this to

mean? Is this failure in meta-awareness viewed positively, negatively or neither? Future research could tackle this question, and in doing so it would help pinpoint how people experience enhanced meta-awareness levels. This knowledge could help explain why meta-awareness is viewed as a positive and beneficial mechanism within metacognitive therapy, and other cognitive therapies too.

As these results hold important implications for the primary prevention of PTSD, the ideal study would focus on delivering a preventative intervention among people whom are vulnerable to frequent and high levels of trauma exposure, such as first responder communities (e.g., police, ambulance workers). For instance, incorporating training on the role of metacognitive beliefs and trauma responses at the start of their service, (e.g., part of their basic training) would be a fruitful line of research. Ideally this would employ a longitudinal design, to allow for the measurement of peoples' exposure to trauma, metacognitive beliefs, and PTSD symptoms over time.

10.5. Conclusion

PTSD hinges on a person's exposure to a traumatic event. This suggests that timely interventions can be delivered either prior to or immediately following trauma exposure, to help prevent the development of PTSD—a key clinical priority. Correlational data outlines the associations between metacognitive beliefs—including metamemory beliefs—and the reporting of PTSD symptoms. Yet, it remains unclear whether metacognitive beliefs play a causal role in PTSD. The results presented in this thesis are the first to suggest that metacognitive beliefs may play a causal role in the development of PTSD and further work is needed to better establish claims of causality. This suggests that interventions that are particularly geared towards the *primary prevention of PTSD* may benefit from incorporating education and training around the

role of healthy metacognitive beliefs to help reduce first-responders' vulnerability to developing PTSD.

Appendices

Appendix 1: $CBM_{Metacog}$ training sentences (as used in Study 4).

Block 1

Having gaps in my memory for a negative event is [u n – e r s t – n d a b - e] (***understandable)***

Gaps in my memory for a negative event show that I am [a d - u s t - n g] (***adjusting)***

Having memory blanks about a negative event is a [n o r - a l r e a - t i o n] (***normal reaction)***

Comprehension Question: Is it the case that you think it's normal to have gaps in your memory for a negative event? (Yes / No) **(Yes)**

Worrying excessively about a negative event is [c o u - t e r p r o - u c t i v e] (***counterproductive)***

Worrying a lot prevents me from finding [s o l - t i o n s] (***solutions)***

When I notice myself worrying about a negative event happening, I know I can always [s - o p / i t] (***stop it)***

Comprehension Question: Is it true that you think worrying too much helps you tackle problems? (Yes / No) **(No)**

People can have intrusive memories of a negative event they have experienced. Therefore, experiencing intrusive memories, shows I am [c - m p e t e - t] (***competent)***

When memories of a negative event that I have experienced pop back into my mind, this means that I am *[c o - i n g w e - l]* ***(coping well)***

Intrusive memories following a negative event are [n o r - a l] ***(normal)***

Comprehension Question: Is it the case that having intrusions show that you are coping well? (Yes / No) **(Yes)**

Block 2

When I notice gaps in my memory for a negative event, it is important that I pay them [l i t t - e / a t - e n t i o] (***little attention)***

If I can only remember small fragments about a negative event I experience, it means that I am psychologically [h e a l t – y] (***healthy)***

Having memory blanks for a negative event means that I cope with stress [w e - l] (***well)***

Comprehension Question: Is it true that having a fragmented memory for a negative event means you are psychologically unwell? (Yes / No) **(No)**

Worrying excessively over a negative event prevents me from [m o - i n g / o -] ***(moving on)***

No matter how much I ruminate about a negative event, I know my thoughts will [n - t / h - r m/ m e] (***not harm me)***

Worrying about a negative event occurring maintains my [a n - i e t y / l e - e l s] (***anxiety levels)***

Comprehension Question: Is it the case that you view worrying as an unhelpful coping strategy? (Yes / No) **(Yes)**

Experiencing intrusive memories following a negative event is [c o m - o n] (***common)***

When memories of a negative event flash into my mind spontaneously, it shows I am [h e - l t h y] (***healthy)***

Having spontaneous recurring thoughts about a negative event (after it has occurred) means I am *[p - o c e - s i n g / i t]* ***(processing it)***

Comprehension Question: Is it true that experiencing intrusive memories is an abnormal reaction to negative event? (Yes / No) **(No)**

Block 3

Having gaps in my memory for a negative event means I did [n o - h i n g / - r o n g] (***nothing wrong)***

Having a fragmented memory for a negative event is to be [e x - e c t e d] (***expected)***

Filling in any gaps in my memory for a negative event should be [a v o i - e d] (***avoided)***

Comprehension Question: Is it the case that it is **not** important to fill in any gaps in your memory for a negative event? (Yes / No) **(Yes)**

No matter how upsetting my worries are about a negative event, they are [m a n a - e a b l e] (***manageable)***

Worrying excessively about a negative event happening is [u n p - o d - c t i v e] (***unproductive)***

Repeatedly going over an experienced negative event in my mind can [h i n - e r / m y / r e - o v e r y] (***hinder my recovery)***

Comprehension Question: Is it true that upsetting worries are uncontrollable? (Yes / No) **(No)**

Intrusive memories about negative events are just thoughts. I know they will cause me [n o / - a r m] (***no harm)***

Spontaneously reliving traumatic/negative events in my mind shows that I am [c o - i n g] (***coping)***

When I have a spontaneous memory of a negative event it's best to just *[a c c e - t / - t]* ***(accept it)***

Comprehension Question: Is it the case that intrusive memories are harmless? (Yes / No) **(Yes)**

Block 4

Having gaps in my memory for a negative event is to be [e x p e - t e d] ***(expected***)

When I notice gaps in my memory for a negative event, I feel [u - c o n c - r n e d] (***unconcerned)***

Having gaps in my memory for a negative event indicates I am [d e a l - n g / - i t h / i t] (***dealing with it)***

Comprehension Question: Is it true that having blanks in your memory for a negative event is concerning? (Yes / No) **(No)**

Repeatedly worrying about negative events that could happen means my safety levels are [u n - f f e - t e d] (***unaffected)***

Worrying and ruminating about a negative event does not make me feel [m - r e / p r - p a - e d] (***more prepared)***

No matter how much I worry, I know at any point I can [s - o p] (***stop)***

Comprehension Question: Is it true that worrying about a negative event does not make you any more prepared? (Yes / No) **(Yes)**

Having intrusive memories following a negative event is a sign that I am processing the event the [b e s - / I / c – n] (***best I can)***

Having random thoughts or images of the negative event (that I have experienced) pop into my mind shows I am mentally [s t - o n g] (***strong)***

Intrusive memories following a negative event are completely [n a t - r a l] (***natural)***

Comprehension Question: Is it the case that intrusive memories following a negative event are unnatural? (Yes / No) **(No)**

Block 5

If I have an incomplete memory for a negative event it shows I am [r e c o - e r I – g] (***recovering)***

When I notice gaps in my memory for a negative event I should [a c c e p t t h e m a n d m o v - / o n] (***accept them and move on***)

Having gaps in my memory for a negative event is [o r - I n a r y] (***ordinary)***

Comprehension Question: Is it the case that having gaps in your memory for a negative event is a sign of recovery? (Yes / No) **(Yes)**

Spontaneous, distressing thoughts following a negative event do not require me to [c o n - r o l / t - e m] (***control them)***

Worrying about negative events happening can be unhelpful, but I know it won't [h - r m/ m e] (***harm me***)

Controlling any spontaneous thoughts, we have following a negative event is [u n a c - I e v - b l e] (***unachievable)***

Comprehension Question: Is it true that, after a negative event, you can control all the spontaneous thoughts you have about the event? (Yes / No) **(No)**

Having intrusions about a negative event mean that my mind is reacting [n o r m a - l y] (***normally)***

Having unwanted spontaneous memories of a negative event shows that I am responding [h - a l t h - l y] (***healthily)***

When images of a negative event (that I have experienced) randomly pop into my mind, I accept that they are a [r - g u l a r / o c c u r - e n – e] (***regular occurrence)***

Comprehension Question: Is it the case that intrusive memories following a negative event are a regular occurrence? (Yes / No) **(Yes)**

Block 6

Having gaps in my memory for a negative event is [- c c e p t a b - e] (***acceptable)***

When I notice gaps in my memory for a negative event, it is best I avoid [f i x a - i n g / - n / t - e m] (***fixating on them***)

Having gaps in my memory for a negative event, shows that I did [n o t - i n g / - r o n g] (***nothing wrong)***

Comprehension Question: Is it the case that you should fixate on memory gaps? (Yes / No) **(No)**

Although worrying is unhelpful, I know it won't [d a - a g e / m e] (***damage me)***

Ruminating about a negative event (that I have experienced) prevents me from feeling [l e - s / s t r e s s - d](***less stressed)***

If I worry about a negative event happening, it will not make me any [m o - e / p r - p a r e d] ***(more prepared)***

Comprehension Question: Is it true that ruminating about a negative event makes you feel more stressed? (Yes / No) **(Yes)**

Intrusive memories of a negative event are a sign that I am in [c o n - r o l] (***control)***

Having intrusive memories following a negative event is [t o/ b e/ e x - e c t – d] ***(to be expected)***

Having random intrusions about a negative event shows that, compared to others, I am [s i m i - a r] ***(similar)***

Comprehension Question: Is it the case that having intrusive memories following a negative event makes you different to others? (Yes / No) **(No)**

Block 7

If I can't remember everything about a negative event I have experienced, it shows that I am [c o -i n g / f - n e] ***(coping fine)***

Having blanks in my memory following a negative event shows that I can [g - t / o v e - / i t] (***get over it***)

Sometimes we do not remember every detail of a negative event and this is [n o t/ c - n c e r - i n g] ***(not concerning)***

Comprehension Question: Is it the case that having memory blanks for a negative event means you are coping well? (Yes / No) **(Yes)**

Not being in control of my thoughts is completely [n o r - a l] (***normal)***

Ruminating on what happened during a negative event is [n o t / b e n e - I c I a l] (***not beneficial)***

If I avoided worrying about a negative event happening, I would be [p s y - h o l o g i c - l l y / w e l l] ***(psychologically well)***

Comprehension Question: Is it the case that not being in control of your thoughts is abnormal? (Yes / No) **(No)**

Having spontaneous memories following a negative event means that I am of [s o - n d / m - n d] (***sound mind)***

Reliving a negative event over in my mind at random moments indicates that I am a [p s - c h o l o g i c a l l y / s t r o – g] (***psychologically strong)***

Experiencing random intrusive memories following a negative event shows that I am [s a – e] (***sane)***

Comprehension Question: Is it the case that having random intrusions following a negative event means you are sane? (Yes / No) **(Yes)**

Block 8

Having an incomplete memory for a negative event is [n o t / d e t - i m e n t – l] ***(not detrimental)***

Memory blanks following a negative event indicate that I did nothing [w r - n g]

(***wrong)***

Gaps in my memory for a negative event, show that I am [a d j u - t i n g / w e – l]

(***adjusting well***)

Comprehension Question: Is it the case that having gaps in your memory for a negative event show that you did something wrong (Yes / No) **(No)**

Worrying about a negative event happening prevents me from [t a c - l i n g /my/ p r o - l e m s] (***tackling my problems)***

Worrying excessively over a negative event occurring disrupts the [a d a - t a t I - n/ p r o c - s s] (***adaptation process***)

When I notice myself worrying about a negative event, it is best I don't [e - g a g e / w I - h / I t] (***engage with it)***

Comprehension Question: Do you think worrying [about a negative event] prevents you from managing your problems? (Yes / No) **(Yes)**

Having intrusive memories about a negative event (that I have experienced) is something to be [u n c - n c e r n - d / a b o u t] (***unconcerned about)***

When memories for a negative event I have experienced pop into my mind unexpectedly, this just shows I am [o v - r c o m i n g / i t] (***overcoming it)***

Having random images of a negative event (that I have experienced) pop into my mind is part of the [r e - o v e r y / p r - c e s s] (***recovery process)***

Comprehension Question: Is it true that having intrusive memories following a negative event, is not part of the recovery process? (Yes / No) **(No)**

Appendix 2: $CBM_{Control}$ training sentences

Block 1:

Because the weather was pleasant you decided to have your lunch [o – t s – d e]

(***outside***)

You have cracked your tooth and need to book an appointment at the [d e – t i s t]

(***dentist***)

Catching up with an old friend is one of your favourite [p – s t t i m - s] (***pastimes***)

Comprehension Question: Is it the case that you decided to have your lunch outside because the weather was nice? (Yes/No) **(Yes)**

Your morning routine involves having a coffee and reading a [n – w s p a – e r]

(***newspaper***)

You had to throw away a cake you made because you used too much [s – g a r] (***sugar***)

It is your friend's birthday, so you go to the shop to buy a [c a - d] (***card***)

Comprehension Question: Is it the case that your morning routine involves having tea and doing a crossword? (Yes/ No) **(No)**

You need to walk your dog, but can't find where you put the [l e - d] (***lead***)

Recycling your used plastics, glass and cardboard is good for the [e – v i r o n – e n t]

(***environment***)

Listening to your favourite music album while cleaning makes it more [e n – o y a b - e]

(***enjoyable***)

Comprehension Question: Is it the case that recycling plastics, glass and cardboard is damaging to the environment? (Yes/No) **(No)**

Block 2:

You noticed that the clutch on your car was starting to stick. You booked it in early for its 6-monthly [s – r v – c e] (***service***)

You have to post a letter but need to buy a [s t – m p] (***stamp***)

Your local theatre is showing a performance of your favourite play, so you rush to buy [t i – k – t s] (***tickets***)

Comprehension Question: Is it the case that your local theatre is showing a play that interests you, so you buy some tickets? (Yes/No) **(Yes)**

The weather outside looks cold, so you decide to keep extra warm by wearing a [s – a r f] (***scarf***)

Driving on the motorway with so many cars requires a lot of [c o n – e n t r a – i o n] (***concentration***)

You finally decide to mow the lawn, but realise the lawnmower is [b – o k e n] (***broken***)

Comprehension Question: Is it the case that there are not many cars on the road so driving requires no concentration? (Yes/No) **(No)**

The carpet in your house is looking a little worse for wear, so you decide to buy [l a m i n a t e f – o o r – n g] (***laminate flooring***)

These days you don't have to go into your bank to pay a bill, you can do it [o n – i n e] (***online***)

Exercising regularly and balanced eating is all part of a healthy [l i – e s t y - e] (***lifestyle***)

Comprehension Question: Is it the case that you can pay for your bills through online banking? (Yes/No) **(Yes)**

Block 3:

You have finally decided to take a break, so you have gone ahead and booked your dream [h – l i d a -] (***holiday***)

Every night after dinner you make sure to load the [d – s h w a – h e r] (***dishwasher***)

When driving somewhere new, you always make sure to check the quickest [r – u t e] (***route***)

Comprehension Question: Is it the case that you have booked a holiday? (Yes/No) **(Yes)**

When at a party with friends you spill red wine on your white shirt. So, the next day you take it to the [d r y c l – a n e - s] (***dry cleaners***)

You receive a bonus from work. You decide to spend the money by booking a city break for the [w – e k e - d] (***weekend***)

It has been a while since you had your car cleaned, so you take it to the [c a r w – s h] (***car wash***)

Comprehension Question: Is it true that you have no weekend trips away booked? (Yes/No) **(No)**

When the weekend arrives, you try to spend time with friends and [f a – i l y] (***family***)

Every week you like to cook a roast [d i – n - r] (***dinner***)

You realise it has been 5 months since your last haircut, so you make [a n / a p p – i n t m – n t] (***an appointment***)

Comprehension Question: Is it true that you haven't had your hair cut in a while? (Yes/No) **(Yes)**

Block 4:

One of the things that makes your job more pleasurable is your relationship with you [c o l – e a g – e s] (***colleagues*)**

One of your favourite snacks to eat is cheese on [t o – s t] (***toast*)**

Every year there is a fun fair in your hometown. Every time you go you enjoying eating [c a n d y f – o s s] (***candyfloss*)**

Comprehension Question: Is it the case that you get on well with your work colleagues? (Yes/No) **(Yes)**

You take out a new mobile phone contract and decide to pay for it monthly via [d i r e c t d e – i t] **(*direct debit*)**

During the summer you enjoy going visiting the countryside and [c a m – i n g] (***camping***)

You get a text from your friend asking you to meet for a [c – f f e -] (***coffee*)**

Comprehension Question: Is it the case that you enjoy camping during the summer? (Yes/No) **(Yes)**

As you walk home from work each day you go to the local shop to by [g r – c e r i e s] **(*groceries*)**

You notice a small crack in your car windscreen so you take it to the mechanics to get [f i – e d] **(fixed)**

You have been invited to a birthday party and the theme is fancy [d – e s s] **(*dress*)**

Comprehension Question: Is it the case that you rarely go to the local grocery shop? (Yes/No) **(No)**

Block 5:

In a morning you can hear the sounds of the birds [s i – g – n g] (***singing*)**

You have to be contactable at anytime, anywhere. You sometimes wondered how people managed before without [m – b i l e p - - - e s] (***mobile phones***)

At lunchtime you tend to have a sandwich, however today you decided to go for [s o u -] (***soup***)

Comprehension Question: Would you agree that you always each a sandwich for lunch each day? (Yes/No) **(No)**

The weather forecast warns you to expect snow, so you decide to wear your [w e l – i n g t o n s] (***wellingtons***)

Hoovering the house is a regular part of your [c l e a n i n g r o – t i n e] **(*cleaning routine*)**

Every night before bed, you prepare your lunch for work the next [d - y] **(*day*)**

Comprehension Question: Is it the case that you hoover up as part of your cleaning routine? (Yes/No) **(Yes)**

Going for a run in the morning helps you feel more relaxed and [p r o – u c t – v e] **(*productive*)**

You accidently break your glasses, so you go out and buy a new [p a i -] (***pair***)

It is important that you try and eat five fruit and vegetables a day for a healthy [d i - t] **(*diet*)**

Comprehension Question: Is it the case that running in a morning make you feel less productive? (Yes/No) **(No)**

Block 6:

After having contracted food poisoning, your enthusiasm for seafood has [d i m – n i s h - d] (***diminished***)

You find yourself struggling to see words on the computer screen clearly and decide to book an eye [t e - t] **(*test*)**

Every year you set yourself some new year's [r e – o l u t i – n s] **(*resolutions*)**

Comprehension Question: Is it the case that you recently booked an appointment for an eye test? (Yes/No) **(Yes)**

Before going food shopping, you always make a [s h o p p i n g l i – t] **(*shopping list*)**

The weather is cold outside so make sure to wear your [g – o v - s] (***gloves*)**

When studying for an exam, you prefer to listen to classical [m – s i c] **(*music*)**

Comprehension Question: Is it the case that you never make shopping lists? (Yes/No) **(No)**

You notice a button missing from your shirt, so you try and find your **[**s e w i n g k i -] **(*sewing kit*)**

To make the living room cosier you light some [c a n – l e s] **(*candles*)**

You bought some new jeans online recently, but they do not fit you. You send them back and ask for a [r e – u n d] **(*refund*)**

Comprehension Question: Do you feel that lighting candles makes a room look cosier? (Yes/No) **(Yes)**

Block 7:

It has been almost 6 years now since your lounge last saw a lick of paint. You decide it is time for [r e - - c o r a t – n g] **(*redecorating*)**

When you look out of your window at night you can see the stars shining [b r – g – t l y] (***brightly*)**

You have a meeting in town soon, so you book your train tickets and reserve a [s e - t] **(seat)**

Comprehension Question: Is it the case that you need to decorate your living room? (Yes/No) **(Yes)**

You are walking into town when it starts to rain. Suddenly you remember you did not bring your [u m – r e l - a] **(*umbrella*)**

Watering your plants everyday helps them survive [l – n g - r] **(*longer*)**

You have an exam coming up, so you take time to revise each [d - y] (***day*)**

Comprehension Question: Do you think that neglecting to water your plants helps them survive longer? (Yes/No) **(No)**

During the winter you enjoy going outdoor [i – e s – a t i n g] **(*ice-skating*)**

You notice the DVD remote control has stopped working, so you go and buy some new [b a – t e – i e s] **(*batteries*)**

Your birthday is coming up and you can't wait to throw a [p a – t y] **(*party*)**

Comprehension Question: Is it true that you enjoy ice skating? (Yes/No) **(Yes)**

Block 8:

Buying and selling a house are among some of life's most stressful [e v – t s] (***events*)**

In an attempt to be healthy, you always try to take the stairs instead of the [l i - t] **(*lift*)**

You are running late to meet a friend, so you take a taxi instead of [w a l – i - g] (***walking*)**

Comprehension Question: Is it the case that buying a house is not a stressful event? (Yes/No) **(No)**

You came in from a long day at work and can't be bothered to cook, so you order a [t a – e a - y] **(*takeaway*)**

You have an important meeting coming up, so you make sure to iron your [s – i r t] **(*shirt*)**

Before every evening meal you set the table with plates and [c – t l e - y] **(*cutlery*)**

Comprehension Question: Is it the case that you iron your shirts for important meetings? (Yes/No) **(Yes)**

You watch the news daily to keep up with world [a f – a – r s] (***affairs*)**

When walking to work, you stop to tie your [s h o e l a – e s] (***shoelaces*)**

You are doing a spring clean and decide to defrost the [f r e e – e r] (***freezer*)**

COMP Q: Is the case that you watch the news daily to keep up to date with world affairs? (Yes/No) **(Yes)**

Appendix 3: Encoding Recognition Task

Encoding:

Title: Memory beliefs

Sentence: My beliefs about what it means to have gaps in my memory have changed since taking part in this study session

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

Title: Thinking time

Sentence: By taking part in this study session, I have changed how I relate to negative/emotional memories

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

Title: Spontaneous memories

Sentence: By taking part in this study session, I can guess what others would think if I was to explain to them that, following a negative event, I sometimes experience spontaneous memories of the event

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

Title: Thought control

Sentence: Taking part in this study session has helped me to realise the level of control I have over my thoughts

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

Title: Event aftermath

Sentence: By taking part in this study session, I know how best to relate to my thoughts following a negative/emotional event

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

Title: Fixating on memories

Sentence: By taking part in this study session, I now realise how useful it is to fixate on gaps in my memory for a negative event

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

Title: Intrusive memories

Sentence: By taking in this study session, I have gained a better understanding of what it means to experience intrusive memories

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

Title: Incomplete memories

Sentence: By taking part in this study session, I understand what it means to have an incomplete memory for a negative/emotional event

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

Title: Prepare for the future

Sentence: By taking part in this study session, I understand how rumination prepares me for the future

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

Title: Random thoughts

Sentence: By taking part in this study session, I now realise what it means to experience spontaneous thoughts that about a negative/emotional event, after it has occurred

Rating: To what extend does this describe you? (1 – *does not describe me at all* – 5 *describes me perfectly*)

<u>Recognition Statements:</u>

Rating scale used throughout:

Each sentence rated on scale 1-5

1= Not at all similar

2= Slightly similar

3= Moderately similar

4= Very similar

5= Extremely similar

Title: Memory beliefs

P TARGET Sentence 1: As a result of this study session, I now understand that having gaps in my memory shows I am psychologically healthy

N TARGET Sentence 2: As a result of this study session, I now understand that having gaps in my memory shows I am psychologically unhealthy

FOIL Sentence 3: As a result of this study session, I now understand that I can remember if I try harder

FOIL Sentence 4: As a result of this study session, I now understand that I can remember less if I am tired

Title: Thinking time

P TARGET Sentence 1: As a result of this study session, I now understand that excessively worrying about a negative/emotional event will be detrimental for my wellbeing

N TARGET Sentence 2: As a result of this study session, I now understand that excessively worrying about a negative/emotional event will be helpful for my wellbeing

FOIL Sentence 3: As a result of this study session, I now understand that excessively worrying about a negative/emotional event will cause me to eat unhealthy foods

FOIL Sentence 4: As a result of this study session, I now understand that excessively worrying about a negative/emotional event will cause me to eat healthy foods

Title: Spontaneous memories

P TARGET Sentence 1: As a result of this study session, if I explained how my thoughts can be interrupted by spontaneous memories of a negative/emotional event that I have experienced, most people **would be** understanding

N TARGET Sentence 2: As a result of this study session, if I explained how my thoughts can be interrupted by spontaneous memories of a negative/emotional event that I have experienced, most people **would not** be understanding

FOIL Sentence 3: As a result of this study session, if I explained how my thoughts can be interrupted by spontaneous memories of a negative/emotional event that I have experienced, most people would think I need to take a break from work

FOIL Sentence 4: As a result of this study session, if I explained how my thoughts can be interrupted by spontaneous memories of a negative/emotional event that I have experienced, most people would think I am overworked

Title: Thought control

P TARGET Sentence 1: As a result of this study session, I now realise that I have no control over the thoughts that pop into my mind and that is normal

N TARGET Sentence 2: As a result of this study session, I now realise that I have no control over the thoughts that pop into my mind and that is abnormal

FOIL Sentence 3: As a result of this study session, I now realise that I have no control over the thoughts that pop into my mind and that shows I need more sleep

FOIL Sentence 4: As a result of this study session, I now realise that I have no control over the thoughts that pop into my mind and that shows I need less sleep

Title: Event aftermath

P TARGET Sentence 1: As a result of this study session, I know that worrying excessively about negative/emotional events **will not** help me to recover

N TARGET Sentence 2: As a result of this study session, I know that worrying excessively about negative/emotional events **will** help me to recover

FOIL Sentence 3: As a result of this study session, I know that worrying excessively about negative/emotional events shows I am a deep thinker

FOIL Sentence 4: As a result of this study session, I know that worrying excessively about negative/emotional events shows I am analytical

Title: Fixating on memories

P TARGET Sentence 1: As a result of this study session, I know that fixating on any gaps in my memory for a negative/emotional event should be avoided

N TARGET Sentence 2: As a result of this study session, I know that fixating on any gaps in my memory for a negative/emotional event should be encouraged

FOIL Sentence 3: As a result of this study session, I know that fixating on any gaps in my memory for a negative/emotional event improves my concentration

FOIL Sentence 4: As a result of this study session, I know that fixating on any gaps in my memory for a negative/emotional worsens my concentration

Title: Intrusive memories

P TARGET Sentence 1: As a result of this study session, I know that experiencing intrusive memories after a negative/emotional event is normal

N TARGET Sentence 2: As a result of this study session, I know that experiencing intrusive memories after a negative/emotional event is abnormal

FOIL Sentence 3: As a result of this study session, I know that experiencing intrusive memories after a negative/emotional event shows I am a responsible person

FOIL Sentence 4: As a result of this study session, I know that experiencing intrusive memories after a negative/emotional event shows I am an irresponsible person

Title: Incomplete memorie

P TARGET Sentence 1: As a result of this study session, I know that memories for negative/emotional events can be incomplete and this is not concerning

N TARGET Sentence 2: As a result of this study session, I know that memories for negative/emotional events can be incomplete and this is concerning

FOIL Sentence 3: As a result of this study session, I know that memories for negative/emotional events can be incomplete and this shows I am a happy person

FOIL Sentence 4: As a result of this study session, I know that memories for negative/emotional events can be incomplete and this shows I am a sad person

Title: Prepare for the future

P TARGET Sentence 1: As a result of this study session, I understand that ruminating over negative/emotional events **will not** make me more prepared for any future negative/emotional events

N TARGET Sentence 2: As a result of this study session, I understand that ruminating over negative/emotional events **will** make me more prepared for any future negative/emotional events

FOIL Sentence 3: As a result of this study session, I understand that ruminating over negative/emotional events will help me to focus more

FOIL Sentence 4: As a result of this study session, I understand that ruminating over negative/emotional events will help me to focus less

Title: Random thoughts

P TARGET Sentence 1: As a result of this study session, I know that having spontaneous thoughts about a negative/emotional event pop into my mind (after it has occurred) is to be expected

N TARGET Sentence 2: As a result of this study session, I know that having spontaneous thoughts about a negative/emotional event pop into my mind (after it has occurred) is unusual

FOIL Sentence 3: As a result of this study session, I know that having spontaneous thoughts about a negative/emotional event pop into my mind (after it has occurred) indicates I have a wild imagination

FOIL Sentence 4: As a result of this study session, I know that having spontaneous thoughts about a negative/emotional event pop into my mind (after it has occurred) indicates I have little imagination

Appendix 4: Study 1 overview

Pre-screen: Online

Informed Consent

Demographic Information

Questionnaires
MCQ
BAMQ
RIQ
DASS-21
EEA

Session 1: Lab

Trauma Film

Free memory recall

CBM ($CBM_{Control}$ vs $CBM_{Metacog}$)

Encoding Recognition Task

Questionnaires
(MCQ/BAMQ/RIQ)

Intrusion Diary Instructions

Session 2: Online (24 hours later)

Intrusion Diary

Encoding Recognition Task

Free memory recall

Questionnaires
MCQ
BAMQ
RIQ
DASS-21
EEA
IES-R

Appendix 5: Study 3 overview

Session 1: Online

Informed Consent

Demographic Information

Questionnaires

CBM ($CBM_{Control}$ vs $CBM_{Metacog}$)

Encoding Recognition Task

Trauma Film

Free memory recall

Questionnaires
(MCQ/BAMQ/RIQ)

Intrusion Diary Instructions

Session 2 (24 hours) & Session 3 (48 hours): Online

Intrusion Diary

Encoding Recognition Task

Free memory recall

Questionnaires
MCQ
BAMQ
RIQ
DASS-21
EEA
IES-R

Appendix 6: Study 4 reading article used in mind-wandering task

Topic - The Structure of a Cell

The cell has been compared to many things, from 'a complex chemical refinery' (by the physicist James Trefil) to 'a vast, teeming metropolis' (the biochemist Guy Brown). A cell is both of those things and neither. It is like a refinery in that it is devoted to chemical activity on a grand scale and like a metropolis in that it is crowded and busy and filled with interactions that seem confused and random but clearly have some system to them. But it is a much more nightmarish place than any city or factory that you have ever seen. To begin with there is no up or down inside the cell (gravity doesn't seem meaningfully apply at the cellular scale), and not an atom's width of space is unused. There is activity everywhere and a ceaseless thrum of electrical energy. You may not feel terribly electrical, but you are. The food we eat and the oxygen we breathe are combined in the cells into electricity. The reason we don't give each other massive shocks or scorch the sofa when we sit down is that it is all happening on a tiny scale: a mere 0.1 volts travelling distances measured in nanometres. However, scale that up and it would translate as a jolt of 20 million volts per metre, about the same as the charge carried by the main body of a thunderstorm.

Whatever their size or shape, nearly all your cells are built to fundamentally the same plan: they have an outer casing or membrane, a nucleus wherein resides the necessary genetic information to keep you going, and a busy space between the two called the cytoplasm. The membrane is not, as most of us imagine it, a durable, rubbery casing, something that you would need a sharp pin to prick. Rather, it is made up of a type of fatty material known as lipid, which has the approximate consistency 'of a light grade of machine oil', to quote Sherwin B. Nuland. If that seems surprisingly insubstantial, bear in mind that at the microscopic level things

behave differently. To anything on a molecular scale water becomes a kind of heavy-duty gel and a lipid is like iron.

If you could visit a cell, you wouldn't like it. Blown up to a scale at which atoms were about the size of peas, a cell itself would be a sphere roughly half a mile across and supported by a complex framework of girders called the cytoskeleton. Within it, millions upon millions of objects- some the size of basketballs, others the size of cars- would whiz about like bullets. There wouldn't be a place you could stand without being pummelled and ripped thousands of times every second from every direction. Even for its full-time occupants the inside of a cell is a hazardous place. Each strand of DNA is on average attacked or damaged once every 8.4 seconds- ten thousand times in a day- by chemicals and other agents that whack into or carelessly slice through it, and each of these wounds much be swiftly stitched up if the cell is not to perish.

The proteins are especially lively, spinning, pulsating and flying into each other up to a billion times a second. Enzymes, themselves a type of protein, dash everywhere, performing up to a thousand tasks a second. Like greatly speeded-up worker ants, they busily build and rebuild molecules, hauling a piece off this one, adding a piece to that one. Some monitor passing proteins and mark with a chemical those that are irreparably damaged or flawed. Once so selected, the doomed proteins proceed to a structure called a proteasome, where they are stripped down and their components are used to build new proteins. Some types of protein exist for less than half an hour; others survive for weeks. But all lead existences that are inconceivably frenzied. As de Duve notes, 'the molecular world must necessarily remain entirely beyond the powers of our imagination owing to the incredible speed with which things happen in it.'

But slow things down, to a speed at which the interactions can be observed, and things don't seem quite so unnerving. You can see that a cell is just millions of objects- lysosomes,

endosomes, ribosomes, ligands, peroxisomes, proteins of every size and shape- bumping into millions of other objects and performing mundane tasks: extracting energy from nutrients, assembling structures, getting rid of waste, warding off intruders, sending and receiving messages, making repairs. Typically, a cell will contain some twenty thousand different types of protein, and of these about two thousand types will each be represented by at least fifty thousand molecules. 'This means,' says Nuland, 'that even if we count only those molecules present in amounts of more than 50,000 each, the total is still a very minimum of 100 million protein molecules in each cell. Such a staggering figure gives some idea of the swarming immensity of biochemical activity within us.'

It is all an immensely demanding process. Your heart must pump 343 litres of blood an hour, over 8,000 litres every day, 3 million litres a year- that's enough to fill four Olympic-sized swimming pools- to keep all those cells freshly oxygenated. (And that's at rest. During exercise the rate can increase as much as sixfold.) The oxygen is taken up by the mitochondria. These are the cells' power stations and there are about a thousand of them in a typical cell, though the number varies considerably depending on what a cell does and how much energy it requires. You may recall from an earlier chapter that the mitochondria are thought to have originated as captive bacteria and that they now live essentially as lodgers in our cells, preserving their own genetic instructions, dividing to their own timetable, speaking their own language. You may also recall that we are at the mercy of their goodwill. Here's why. Virtually all the food and oxygen you take into your body are converted into a molecule called adenosine triphosphate, or ATP.

You may or may not have heard of ATP, but it is what keeps you going. ATP molecules are essentially little battery packs that move through the cell providing energy for all the cell's processes, and you get through a lot of it. At any given moment, a typical cell in your body will have about one billion ATP molecules in it, and in two minutes every one of them will have

been drained dry and another billion will have taken their place. Every day you produce and use up a volume of ATP equivalent to about half your body weight. Feel the warmth of your skin. That's your ATP at work.

Appendix 7: Study 4 probe-caught intrusion text

Please respond to this question as quickly as possible

Just now (immediately before this screen appeared) what were you thinking about?

Press ‘1’ if you were thinking about the film clip.

Press ‘2’ if you were only thinking about the article you were reading.

Press ‘3’ if you were thinking about something else.

Immediately following your response (e.g., 1, 2 or 3) PRESS THE DOWN ARROW KEY to return back to the article.

Appendix 8: Study 4 overview

Session 1: Lab

Informed Consent

Demographic Information

Questionnaires

CBM ($CBM_{Control}$ vs $CBM_{Metacog}$)

Encoding Recognition Task

Trauma Film

Free memory recall

Mind-wandering Task: Self-caught only vs self-caught-plus-probes

Questionnaires
(MCQ/BAMQ/RIQ)

Intrusion Diary Instructions

Session 2 (7 days later): Lab

Intrusion Diary

Encoding Recognition Task

Free memory recall

Questionnaires
MCQ
BAMQ
RIQ
DASS-21
IES-R

Appendix 9: Central and peripheral detail coding template

Free Memory Recall – coding template

Thematic centrality – definition. Central information was **'any element pertaining to the basic story that could not be changed or excluded without changing the basic story line'** (Heuer & Reisberg, 1990, p. 499). The basic story line is outlined below (central details) agreed for 3 judges – victims are seen as emotionally and thematically central to the story- so identifying them is seen as central. However, fine specific details about them (e.g., colour hair, clothes wearing) is seen as peripheral as it is not essential to the basic story – that is, the story would not change is those details were not reported. Therefore, anything which falls outside of these details is classified as peripheral.

Possible central details to be reported, 1 point for each correct reported detail, (1/2 point where correct but not as specific):

- Girls in main car (1 point)
- Driver texting (1 point) or saying "girls texting / on the phone" ½ point.
- Girls crash into oncoming car (1 point)
- Second car then crashes into them (1 point)
- Girls are hurt / blood / cut
- Driver conscious (1 point)
- 2 passengers are unconscious (1 point)
- A man gets out his car to help (1 point)
- Man tells people to phone for ambulance (1 point)
- Man tries to open the door but can't (1 point)
- Emergency services arrive (mentioning ambulance / police / fire) 1 point for each one mentioned.

- Passengers in 2nd car identified (1 point for saying family, 2 points for saying all members e.g. parents, toddler and baby)
- Passenger in 3rd car – man (1 point)
- Wellbeing of other passengers accurately described (e.g. parents / old man/ toddler, baby all unresponsive) 1 point each one correctly mentioned, 0 points if do not mention their wellbeing.
- Helicopter lands (1 point)
- Car door cut off girl's car (1 point) girl pulled out (1)
- Girl taken away / to hospital via helicopter/ air ambulance (1 point)

Possible peripheral details to be reported, 1 point for each correct reported detail (1/2 point where correct but not as specific):

- Main car descriptions (e.g. Silver/ grey (1 point; Ford KA (1 point)
- The actual number of girls in the car – three (1 point)
- Texting a boy (1 point) called James (1 point) about friend fancying him (1 point)
- Any correct descriptions of girls (e.g. names, clothing, hair colour) all 1 point each
- Girls thrown around in the car following the crash (1 point) airbags pop open (1 point) neck cracking (1 point)
- Driver screaming repeatedly (1 point)
- Glass smashing in car from the crashes (1 point)
- Any descriptions of other passengers (e.g. names, clothing, hair colour) all 1 point each

- Any descriptions man who helped (e.g. names, clothing, hair colour) all 1 point each
- Positioning of the girls in car (e.g. 1 girl in the backseat, 2 in the front) 1 point
- Toddler asking mummy and daddy to wake up (1 point)
- Ambulance asking if driver has any pain in her neck (1 point) and friend's names in the back (1 point)
- Girl driver has oxygen mask (1 point) put on a stretcher (1 point) head brace (1 point)
- Helicopter hovering above (1 point)
- Description of location (e.g. Wales / main road/ motorway) 1 point each
- Background details of scene (e.g. police tape, bystanders on the road) 1 point each
- Music playing throughout (1 point)

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