Meta-awareness and posttraumatic stress disorder: An investigation of the characteristics and mechanisms of meta-awareness of trauma-related intrusions

By

Yu-Tung Jennifer Sun
BA (Hons)

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ABSTRACT

Trauma-related intrusions are a key symptom type that is thought to lead to the development and maintenance of posttraumatic stress disorder (PTSD) (Ehlers & Clark, 2000). The typical method of assessment to index intrusion severity in both clinical practice and research is through trauma-exposed individuals self-reporting the frequency of intrusions. Nevertheless, recent studies have discovered that individuals are not always aware of their trauma-related mental content (*labelled as meta-awareness failure*; Nixon et al., 2021; Takarangi et al., 2014). Moreover, high-PTS individuals tend to experience more unaware intrusions, suggesting trauma-exposed individuals might underreport the actual frequency of intrusions (Nixon et al., 2021). Even though such phenomenon has been reported, the current literature lacks coherent information around characteristics and processes underpinning unaware intrusions, as our knowledge of PTSD intrusions has for the most part been based on studies where individuals were explicitly aware of their intrusion experience. For example, we know intrusions in these studies are vivid and accompanied with sensory impressions and strong emotion, but we have little idea whether this is the same for unaware intrusions. Hence, this thesis explored these issues, studying these and other characteristics and processes that might explain differences in the phenomenology of how such intrusions are experienced (e.g., alexithymia and maladaptive cognitive processes), whether these variables moderate the predicted effects of PTSD on meta-awareness, and whether a strategy commonly used by sufferers of PTSD (thought suppression) could cause changes in meta-awareness.

Study 1 examined the characteristics of aware and unaware intrusions by capturing the first intrusion that occurred while participants were reading scientific articles. Using a self-report questionnaire, the results show that aware and unaware intrusions shared similarities in terms of modality (imagery vs verbal thoughts), meaningfulness, accessibility, and other characteristics (e.g., distress). Study 2 aimed to replicate and extend Study 1, by using a meta-awareness task that captured *multiple* intrusions. Using a semi-structured interview, evidence showed that intrusions

accompanied by imagery, and which represented more meaningful aspects of the trauma to the individual were more likely result in meta-awareness, however aware and unaware intrusions were not different in terms of accessibility (i.e., ease of recall).

Study 3 investigated possible mechanisms underlying the PTSD–meta-awareness relationship by examining the moderation effect of alexithymia, trait rumination, state rumination, and thought suppression. Moreover, the study compared the effect of meta-awareness on those who experienced criterion A type trauma to those who experienced non-criterion A type trauma. The results showed that alexithymia and trait rumination did not moderate the proposed relationship. However, trauma-exposed individuals who ruminated on their trauma or suppressed their trauma-related thoughts were more likely to experience intrusion with meta-awareness. Moreover, all trauma-exposed individuals experienced unaware intrusions for events, even when such events did not constitute a criterion A trauma.

Study 4 sought to replicate the moderation results of Study 3, and to extend those findings by manipulating thought suppression to establish a causal relationship between thought suppression and meta-awareness. In addition, it was expected that the ability to be mindful and aware of one's emotional and physical state (i.e., mindfulness) would be a moderator in the predicted causal relationship. However, there was no evidence that thought suppression caused changes in meta-awareness, although conclusions were tempered by less-than-optimal impact of the thought suppression manipulation. Mindfulness did not moderate the predicted relationship. However, the results replicated Study 3 findings in that alexithymia was not a moderator in the PTSD–meta-awareness relationship, but thought suppression did moderate the proposed relationship in a similar fashion as seen in Study 3. Nevertheless, trauma-specific rumination was not identified as a moderator. The theoretical and clinical implications of Studies 1-4 are further discussed in the concluding chapter.

DECLARATION

I certify that this thesis:
1. does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university
2. and the research within will not be submitted for any other future degree or diploma without the permission of Flinders University; and
3. to the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.

Signed.....Yu-Tung Jennifer Sun
Date.....29/01/2023

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CHAPTER 1 – OVERVIEW

Overview

Posttraumatic stress disorder (PTSD) is a psychological disorder that can occur in individuals who have experienced trauma, and its symptoms are usually assessed by self-report. Recently, however, the accuracy of this assessment method has been questioned given findings from research on 'mind-wandering'. Mind-wandering describes the phenomenon of when individuals unintentionally shift their attention to think about topics that are unrelated to their current task, often by inadvertently retrieving some other internal information such as another memory (Smallwood & Schooler, 2006). Takarangi et al. (2014) further extended this concept with the study of intrusive thoughts, a key feature of PTSD, that has some similarity to components of mind-wandering (i.e., inadvertent cognition that is not task oriented). Takarangi and colleagues used a trauma film to induce intrusions among non-clinical participants, finding that intrusions can be experienced without overt awareness, leading participants to fail to spontaneously report their occurrence (labelled meta-awareness failure). Although an intriguing finding and an important first study in this area, a limitation of Takarangi et al. (2014) was its generalisability to understanding the phenomenon of meta-awareness in those with PTSD, as participants were from a non-clinical population and the traumatic experience was an analogue stressor (intrusions were evoked using a trauma film). Another study (Nixon et al., 2021), which addressed this limitation by recruiting real-life trauma-exposed individuals, confirmed that meta-awareness failure did occur in relation to intrusions of real-life traumatic events. Moreover, the failure occurred more often in individuals with high levels of PTSD symptoms. Although there is evidence that intrusions can be underestimated due to meta-awareness failure from these and other studies (e.g., Green et al., 2016; Takarangi et al., 2017; Zedelius et al., 2015), we still know very little about important features of the relationship between meta-awareness failure and PTSD. For

example, how might meta-awareness failure influence PTSD development? Is it a negative or positive phenomenon for PTSD sufferers, if one considers not always being aware of intrusion might have positive consequences? Given research in this area is still in its infancy, the present program of research focused on important initial questions by conducting a series of studies that: (a) examined the characteristics and possible differences between aware and unaware intrusions, (b) tested proposed factors underlying the PTSD and the meta-awareness failure relationship, and (c) investigated the possibility that individuals could be guided to improve meta-awareness of intrusions.

Studying these phenomena has important conceptual and clinical implications. Conceptually, addressing these research questions will assist in testing, and likely refining, current models of PTSD that do not fully account for meta-cognitive processes in their explanations of intrusive symptoms. Refinement of current theory can contribute to applied or clinical advances in the field. For example, the present program of research will likely result in recommendations for clinicians given that current assessment methods may underestimate the frequency with which clients experience intrusive symptoms. Furthermore, findings from the studies undertaken have the potential to identify important mediating and moderating relationships of the variables under investigation. This could pave the way for future testing of new techniques or interventions to reduce PTSD symptoms in sufferers, as well as determining potentially critical factors that may influence the degree to which meta-awareness is experienced.

In the following sections of this chapter, I first summarise the relevant literature in relation to PTSD and meta-awareness failure to provide a general overview of the field. In the following chapters I present detailed rationale, methodology, results, and discussion of a series of studies designed to answer the critical questions posed earlier that are relevant to this topic.

A Cognitive Model of Posttraumatic Stress Disorder

Posttraumatic stress disorder (PTSD; *Diagnostic and Statistical Manual of Mental Disorders* 5th ed., text revision; DSM-5-TR; American Psychiatric Association, 2022) is experienced following exposure to significant trauma (e.g., physical and/or sexual assaults, car accident etc.). Common symptoms are re-experiencing memories and/or thoughts (comprising intrusions and nightmares), avoidance of reminders of the trauma, alterations in cognition and mood (e.g., development of self-blame and guilt), and hyperarousal that can include hypervigilance, problems with concentration and sleep (American Psychiatric Association, 2022). These symptoms cause distress and significant impairment to sufferers. The cognitive model of PTSD proposed by Ehlers and Clark (2000) details several factors that maintain and reinforce PTSD (Figure 1) and represents one of the most dominant accounts of PTSD to date (building on previous influential theories such as those of Brewin et al., 1996, and Foa et al., 1986; 2006). Relevant to my research, Ehlers and Clark argue that cognitive processes and behaviours intended to control or manage PTSD symptoms such as intrusions play a key role in their maintenance. Relevant aspects of this model will be more fully expanded upon in later chapters (e.g., thought suppression and rumination in Chapter 4, Study 3). Based on this cognitive model, my research investigates a key symptom of PTSD, intrusions. According to Ehlers and Clark, intrusions have a reciprocal role with other PTSD symptoms and thus make a significant contribution to the maintenance of the disorder (see also Figure 1). As will be discussed in the following pages and later chapters, this model (and previous theories) has been based on the premise that such intrusions are always obvious or accessible to sufferers. Evidence suggesting this is not always the case will be presented, in conjunction with additional theories that provide some explanation for the occurrence of unnoticed/noticed thoughts.

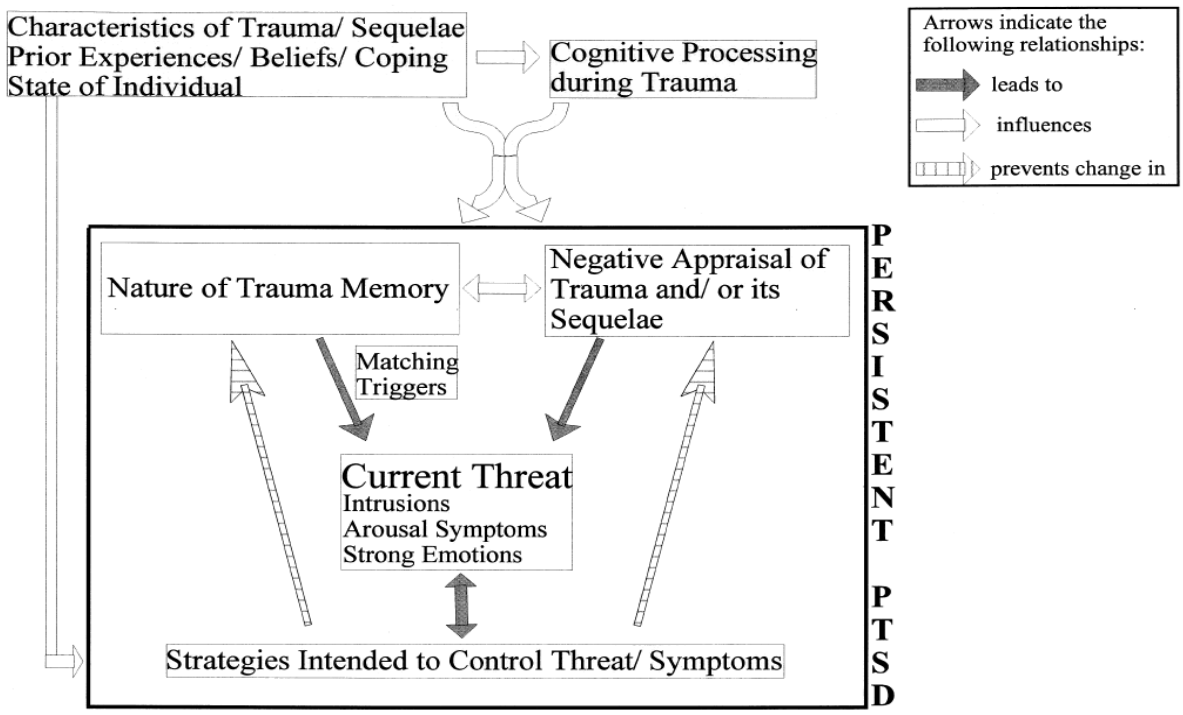

Figure 1. The cognitive model of PTSD from Ehlers and Clark (2000).

Intrusions as a clinical symptom

Unwanted and distressing thoughts and memories of the traumatic event (intrusions) are a key feature of the disorder and are thought to contribute significantly to the overall dysfunction seen in PTSD. Most importantly, they play a maintaining role in the disorder (Bryant et al., 2017; Lawrence-Wood et al., 2016; Magee et al., 2012;). When intrusions occur, trauma-exposed individuals usually mentally 'see' their traumatic events vividly, which sometimes involves sensory impression and emotions. Because of this vividness, sufferers tend to experience these past memories as if they were happening to them again, described as a sense of 'nowness' by Ehlers and Clark (2000), which contributes to individuals finding it difficult to treat these as memories of a past autobiographical event. These experiences not only cause significant distress, they also engender a sense of threat for the individual, that leads to behaviours to control or manage this (e.g., trying not to think about them, avoiding cues or reminders) which paradoxically increase the likelihood of

intrusion occurrence (e.g., the thought suppression rebound effect, Wegner, 1994). This also prevents adaptive re-appraisal (e.g., *this is just a memory, it can't hurt me, it is a past event*), thus these maladaptive behaviours and ongoing intrusions result in further functional impairment (Mark et al., 2018). The most common way to assess the frequency of intrusions, which is also how clinicians assess severity of PTSD, is via self-report. Nevertheless, the accuracy of such self-reporting of mental content has been questioned in light of recent research developments in the study of 'spontaneous thoughts'.

Intrusions as spontaneous thoughts

'Spontaneous thoughts' is an umbrella term describing the phenomenon of people effortlessly having thoughts on their mind. Typically, spontaneous thoughts involve people's attention being shifted away from a current task or one's environmental surrounding to something else, often internal cues or personal memories (Marchetti et al., 2016). PTSD intrusions are often considered 'involuntary memories', which is a sub-category of spontaneous thoughts, referring to when thoughts or memories of actual experiences appear without deliberate or conscious retrieval (Marchetti et al., 2016; Green et al., 2016). On the other hand, mind-wandering, which is another sub-category of spontaneous thought, shares similar characteristics of intrusions. Mind-wandering describes the phenomenon of when individuals unintentionally shift their attention to think about some thoughts that are unrelated to their current task, often by inadvertently retrieving some other internal information such as another memory or future plans (Smallwood & Schooler, 2006; 2015). The empirical evidence from mind-wandering research has shown that individuals can be unaware of their mental content, which raises questions the about the validity of the assessment of PTSD intrusions. As mentioned earlier, the most common assessment method of intrusions is for an individual to self-report their frequency. In the following paragraphs I discuss the findings of

mind-wandering research, theory of meta-awareness, and their implications for PTSD intrusions research.

Mind-wandering and meta-awareness

Mind-wandering is a process when people's attention drifts to internal thoughts or memories that are completely task-unrelated. This type of spontaneous thought occurs frequently during the day and can be triggered deliberately as well as unintentionally (Killingsworth & Gilbert, 2010; Smallwood & Schooler, 2006). In fact, our mind can easily wander without explicit regulation of mental content. Indeed, researchers now view meta-awareness as an ability to self-regulate mind-wandering and involuntary thoughts (see Etherton, 2021). Smallwood and Schooler (2006) theorise that our mind tends to wander if (a) we have intention to avoid certain triggers, (b) we have unfulfilled goals, (c) or have had enough practice to decrease the attention a task requires. Indeed, automatic tasks such as driving and reading, which require low cognitive load, often stimulate involuntary mind-wandering (McVay & Kane, 2010). Crucially, individuals can lack awareness of this shift in attention (termed *meta-awareness failure*), thus are not always overtly conscious of the contents of their mind (Schooler et al., 2004; Smallwood et al., 2007; Smallwood & Schooler, 2015). This lack of initial awareness can occur with neutral or positive events (e.g., when you remember that you have to buy milk on the way home, or if you start to think of a previous holiday), as well as negative events (e.g., thinking about an unwanted memory, Baird et al., 2013). Several minder-wandering studies using meta-awareness task and fMRI methodologies reveal meta-awareness as intermittent mental state (Chin & Schooler, 2010; Christoff et al., 2009; Smallwood et al., 2007, 2008). In other words, unintentional spontaneous thoughts should be highly prone to meta-awareness failure when they first come into consciousness. At a certain point as time progresses, meta-awareness then occurs when an individual realizes they are thinking about task-unrelated thoughts (i.e., this cognition has 'broken through', as it

were, into awareness) (Schooler et al., 2011). The next paragraph explain 'why' meta-awareness is intermittent.

Theory of Meta-awareness

To understand meta-awareness failure, we should first understand why individuals are meta-aware of their thoughts. According to Winkielman and Schooler (2011), mental content lies between three different levels: unconsciousness, basic consciousness, meta-consciousness (see Figure 2). When mental content is unconscious, an individual does not know that he/she knows something. "Experientially consciousness" or basic consciousness refers to an experience that has not been explicitly reflected upon. For instance, people may be aware of a wall that is full of pictures, but not be able to spontaneously reflect or report what each picture represents. For "meta-conscious" (or meta-aware) mental content, individuals are able to reflect and verbalise their experience and answer questions like, "just now, what are you thinking".

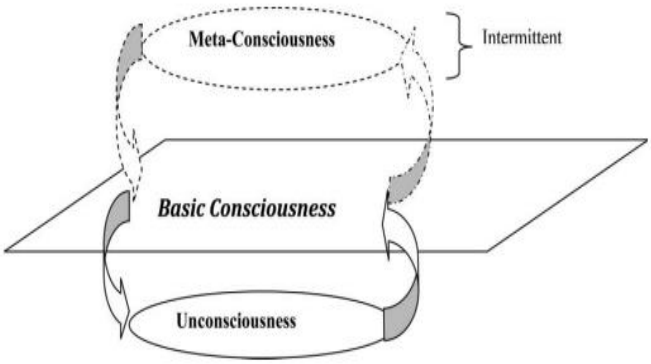

Figure 2. Relationship of different levels of awareness from Winkielman and Schooler (2011)

As meta-consciousness occurs only intermittently, unless people periodically question or explicitly examine their mental content (e.g., "what am I thinking?"), it is very likely we encounter meta-awareness failure before we notice our mental content. Consequently, researchers (including Schooler) suggest that meta-awareness is actually triggered by

directing the "orientation" of thought into itself. For example, the need to communicate one's mental content would be one of the first triggers to meta-awareness. Second, this orientation triggers meta-awareness if the mental content is able to link with working memory content such as current goals that involves cognitive load to process. Third, increased self-awareness also triggers meta-awareness. If none of the aforementioned processes occur, meta-awareness failure is the likely consequence. Theories and models of both mind-wandering and meta-awareness have largely been developed from the study of benign thought content; however, it does raise the question of whether these processes occur or are relevant when such content is particularly negative or traumatic in nature. The following sections illustrate how the relationship between PTSD and meta-awareness failure is established.

Intrusions and meta-awareness failure

To my knowledge, no one had previously studied the meta-awareness of intrusions in clinical samples of individuals with PTSD, with Takarangi et al. (2014) the first researchers to directly examine the relationship between meta-awareness and trauma-like intrusions in an analogue design, paving the way for this type of research. Specifically, Takarangi and colleagues used a film of traumatic content to mimic a traumatic experience in two experiments, after which participants read passages of scientific text (which served as the meta-awareness task). During the reading task participants indicated with a keyboard press whenever they had an intrusion of the film. These 'self-caught' intrusions represented occasions participants were (meta-)aware of their mental content (the 'self-caught' label reflects the typical method that intrusion studies have had participants self-report their intrusions). Half the participants were randomized to a condition that also received intermittent probes on the computer screen during the reading task. Probes would randomly appear asking if the participants were thinking about thoughts caused by the film. The main finding of the study was that participants were often "caught" by probes in the act of having

thoughts of the film without being aware their attention had shifted from the reading task. Specifically, in Experiment 1 participants reported this occurred for 28.86% [CI_{95}: 22.16, 35.57] of the probes, indicating meta-awareness failure for a substantial proportion of these thoughts. Following the meta-awareness task, a reading comprehension test was administered for the content that was read during task, with the observation that meta-awareness failure negatively correlated with comprehension performance (r = -.51), while no significant relationship was demonstrated between the self-caught group and reading task performance (r = .06). The findings suggest that unnoticed intrusions (evident by meta-awareness failures) might tax individuals' cognitive resources and in this study, thus worsened their reading performance. It is also worth noting a potential confound of the study design - whether the use of probes artificially increased the frequency of intrusions or self-caught rates. However, Experiment 2, which included separate conditions that varied the number and timing of probes, indicated that the probes did not meaningfully increase the degree to which intrusions were experienced (self-caught or probe-caught).

Takarangi and colleagues have replicated the meta-awareness failure effect in subsequent analogue studies (Green et al., 2016; Takarangi et al., 2017). In Green et al., a more refined methodology was employed which better distinguished whether the probe-caught intrusions were *continuations* of previously reported thoughts or whether they were *new* thoughts, to examine whether there was potentially a 'doubling up' in counts of meta-awareness failure. It was observed that these instructions resulted in lower rates of meta-awareness failure compared with the original study, although not by much (e.g., 18.99% vs. 28.66% in Takarangi et al., 2014). Although Takarangi and colleagues' work demonstrated consistent findings of meta-awareness failure of negative memories, intrusions regarding real-life trauma had yet to be explored. As recognised by Takarangi et al., the effects that trauma films induce are likely not as distressing or severe as the effect that real trauma produces, with the authors

cautious as to whether these findings would generalize to individuals with PTSD. Nonetheless, the work of Takarangi and colleagues provided foundational evidence that some trauma-related thoughts can occur without early explicit awareness by the individual.

Recent work has extended the above findings to individuals who have experienced real life trauma. To investigate whether such failures occur among individuals who had experienced actual trauma, I and others replicated the methodology of Takarangi et al. (2014) (Nixon, Roberts, Sun, & Takarangi, 2021[1]). Participants had experienced a range of trauma types (e.g., assault, childhood physical and/or sexual abuse, motor vehicle accidents), with PTSD severity assessed with an established measure, the PTSD Checklist (PCL-5; Weathers et al., 2013). Participants were assigned to a probable-PTSD group (n = 24, having scored above an established cut-off on the PCL-5) and a non-PTSD group (n = 35). The results indicated little difference in the number of self-caught intrusions between the groups (non-PTSD: M = 5.03, SD = 6.70; PTSD: M = 7.75, SD = 8.10, p = .77). However, meta-awareness failures occurred more frequently in the PTSD group compared to the non-PTSD group (non-PTSD: M = 15.87%, SD = 13.34%; PTSD: M = 25.81%, SD = 18.83%, p = .007). Across the whole sample, 22.47% of the probes caught participants thinking about their trauma without awareness, with this percentage significantly different from zero (p < .001). As well as replicating the work of Takarangi et al., and importantly, documenting the phenomenon of meta-awareness failure in a clinical sample with real trauma exposure, my findings had clinical relevance for clinicians, highlighting that it appears clients with PTSD can underestimate the frequency of their intrusions. However, although the work of Takarangi and colleagues and my own research has been important in establishing the meta-awareness phenomenon in the context of trauma thoughts and memories, the field is still in its infancy. For example, at present we lack a basic understanding of the characteristics of these

[1] This published paper contains parts of my honours project results

intrusions, such as whether the trauma-related thoughts associated with meta-awareness failure are qualitatively different from thoughts that are easily detected by individuals. Nor do we have a good understanding of the mechanisms underlying meta-awareness failure. Although current models of PTSD address the role of intrusions in their explanation of the onset and maintenance of the disorder, this is based on research in which individuals have been aware of and reported on their intrusions. If unnoticed or 'unaware' intrusions also play a critical role in the development and maintenance of PTSD, these models will require refinement. These issues and the focus of the current thesis are outlined next.

Characteristics, mechanisms, and is meta-awareness failure harmful?

The importance and influence of meta-awareness failure on PTSD remains unclear. However, there are several reasons why it merits study. First, we have evidence that meta-awareness failure may increase cognitive load which worsens people's performance on reading task (Takarangi et al., 2014; 2017). Moreover, a previous study has shown that PTSD individuals are more vulnerable to meta-awareness failure in relation to intrusions than those without PTSD (Nixon et al., 2021). It is possible meta-awareness failure contributes to individuals' compromised daily functioning (e.g., compounding attention and concentration problems, a symptom of PTSD). It is also possible that meta-awareness failure could worsen working memory problems which have documented following trauma (see El-Hage et al., 2006; Schweizer & Dalgleish, 2011). Second, there is currently no PTSD model or theory that considers the role of meta-awareness failure of intrusions. As a result, the PTSD–meta-awareness failure relationship remains somewhat unclear, including the potential for a bi-directional relationship. Nevertheless, there are some PTSD-related factors that could potentially influence one's awareness levels of trauma-related memory have not yet been studied. For example, maladaptive cognitive process and inability to identify emotion might decrease the chance for trauma-exposed individuals to recognize intrusion episodes as these

PTSD-related factors increase the frequency of intrusions (Moulds et al., 2020; Sopp et al., 2019). Third, developing a PTSD model that takes meta-awareness failure into account could be beneficial for PTSD treatment. For example, clinicians might need to know that there is a higher likelihood that a PTSD sufferer might underestimate their actual intrusions frequency if they tend to avoid thinking about their trauma and/or ruminate over it. Furthermore, if the current project demonstrates that improving meta-awareness ability (e.g., identifying intrusions more quickly/easily) will help PTSD sufferers recover faster, it could drive further investigation of optimal methods to treat PTSD. Hence, my thesis comprised of four studies to improve our understanding of meta-awareness failure in the context of PTSD.

In Study 1 (Chapter 2), participants who had been exposed to trauma were recruited and completed the study via online methods (due to the occurrence of COVD-19). Given the online nature of the meta-awareness task which precluded extensive questioning of the nature and characteristics of intrusions associated with meta-awareness failure, participants were only required to answer questions about these intrusions on the first occasion a probe caught the participant having a trauma-related memory/thought. In Study 2 (Chapter 3), which was conducted face-to-face, participants completed the meta-awareness task in line with the methodology of Green et al. (2016) which used multiple intermittent probes. Detailed questionnaires and a semi-structured interview were used to index the characteristics of both aware and unaware intrusions (e.g., whether the intrusion was experienced as a thought versus imagery, the interpretation, significance and/or meaning of the intrusion, whether it was accompanied by a sense of 'nowness' etc.).

Study 3 (Chapter 4) addressed the second aim of the current research, that is, to begin to shed a light on potential factors underpinning the PTSD and meta-awareness failure relationship. As touched upon earlier and expanded in more detail in the relevant chapter, there is grounds to think that difficulties with awareness and experiencing of emotions and

cognition (i.e., alexithymia) might play a role in the relationships of interest. Models of PTSD such as that of Ehlers and Clark (2000) highlight the key roles that cognitive processes and emotion play in the persistence of PTSD, including intrusive symptoms. Specific maladaptive cognitive processes among PTSD sufferers such as rumination and avoidance (e.g., thought suppression) might also increase the occurrence of intrusions which consequently results in further occasions of meta-awareness failure to occur as well. Accordingly, Study 3 examined whether these variables moderated the degree to which PTSD symptom severity was associated with meta-awareness failure. Using a new sample, Study 3 adopted the same online design as Study 1 but also indexed participants' levels of alexithymia, rumination, and avoidance to examine this proposal.

Study 4 (Chapter 5) extended Study 3 findings and aimed to identify whether engaging in a maladaptive cognitive process would alter meta-awareness; the study also addressed whether mindfulness, training in which is gaining popularity in PTSD interventions, might protect an individual from the negative effects of maladaptive cognitive process on meta-awareness. Specifically, I conducted a face-to-face experiment study that involved a 5-minute thought suppression manipulation. Participants who experienced a negative event a month prior to participation were eligible for the study. In addition to baseline measures, participants completed the meta-awareness task before and after the experimental manipulation. The experiment results allowed conclusions to be drawn about the role of cognitive avoidance in the PTSD–meta-awareness relationship. As cognitive processing is an essential part to PTSD treatment, the results also underscore how individuals with PTSD tend to experience intrusions (with or without meta-awareness), and how this and mindfulness might influence their PTSD symptoms (enhance or alleviate PTSD symptoms).

CHAPTER 2 – STUDY 1: CHARACTERISTICS AND INFLUENCES OF META-AWARENESS FAILURES[2]

Chapter Abstract

This chapter examines potential differences between (meta-)aware and unaware intrusion characteristics to further understand why certain intrusions are not immediately apparent to an individual. Trauma-exposed participants (*N* =78) recruited from online crowd-sourcing platforms completed an online meta-awareness task. During a reading task, participants were intermittently probed to index the occurrence of unreported (i.e., unaware) trauma-related intrusions. If participants indicated trauma-related intrusions occurred, they then completed a questionnaire that indexed intrusion characteristics. Although unaware intrusions did occur in a subset of the sample, there were no fundamental differences between aware and unaware intrusions in terms of modality of experience (imagery vs. non-imagery), meaningfulness, accessibility, or other characteristics (e.g., vividness). The findings suggest that unaware and aware intrusions show more commonality than not in their characteristics, with further research required to improve our understanding of the mechanisms leading to meta-awareness or lack of in PTSD.

Introduction

Despite evidence that meta-awareness failure occurs to trauma-related intrusions (Nixon et al., 2021; Takarangi et al., 2014), to date, there has been a paucity of research on why some trauma-related cognition appears more noticeable to individuals than others. One possibility is that aware intrusions have higher levels of particular intrusion characteristics (e.g., distress, vividness, intense emotions) than unaware intrusions. The current study, therefore, examines whether intrusions associated with meta-awareness versus meta-

[2] This chapter is currently under review for publication; Sun, Y. T. J., Takarangi, M. K. T., & Nixon, R. D. V. Exploring intrusions without awareness: Characteristics and influences of meta-awareness failures.

awareness failure differ from one another in specific features, for example, their modality, meaningfulness, and accessibility.

Previous literature shows intrusions can be experienced in different modalities; for example, they can appear as intrusive *memories* or intrusive *thoughts*. Intrusive memories usually occur with sensory impressions, including 'seeing' the image or 'film' of one's trauma (Ehlers et al., 2002; Michael et al., 2005). Due to the vividness of these images, individuals with a PTSD diagnosis tend to feel as if the trauma is happening again (Ehlers, 2010). Intrusive thoughts tend to reflect an individual's appraisal of the trauma or rumination, such as thinking 'why me?' type questions (Ehlers et al., 2004; Hackmann et al., 2004). There is some debate in the literature about whether intrusive *thoughts* are a form of intrusion since the experience of intrusive thoughts appears to be less intense than intrusive memories (Ehlers et al., 2002; Ehlers & Steil, 1995). Nevertheless, previous research has failed to consider the effect of meta-awareness failures in general on intrusion intensity. It is possible that intrusive memories are experienced with higher intensity due to individuals being explicitly aware of their mental content given vivid mental experiences are prone to meta-awareness (Dehaene et al., 2005; Winkielman & Schooler, 2011). In line with the idea from previous literature that intrusive thoughts may be experienced as less intense than intrusive memories, it is plausible that unaware intrusions are more prone to meta-awareness failures.

Although somewhat speculative, based on the broad field of memory and consciousness (Conway & Bekerian, 1987; Gardiner & Richardson-Klavehn, 2000; Wegner et al., 1990), as well as the prominent role that avoidance of trauma memories has on maintaining PTSD symptoms according to PTSD models (Ehlers & Clark, 2000), it is possible that the *meaningfulness* of an intrusion might alter intrusion awareness levels. Here, I define meaningfulness as how important a memory is to an individual. Factors involved in a traumatic memory's meaningfulness include whether that memory has a significant impact on

an individual's life, or whether it evokes special sentiment for an individual including significant emotions such as fears. Because a traumatic event typically arouses significant distress and fear, trauma-exposed individuals tend to remember the 'hotspots' of a traumatic event, referring to the moment that aroused their greatest emotion (Holmes et al., 2005). In fact, some studies have reported that approximately 80% of intrusions include hotspots (Grey & Holmes, 2008; Holmes et al., 2005). Because hotspots tend to occur as intrusions, they might be more prone to awareness due to the high levels of emotion associated with them. In addition to strong emotions such as distress, intrusions usually contain significant trauma-related content, for example, the face of a perpetrator. Trauma-exposed individuals tend to cognitively and behaviourally avoid such memories (Ehlers & Clark, 2000); however, avoidance can also result in individuals being hypersensitive to those specific memories (Wegner, 1994; Wenzlaff & Wegner, 2000). If individuals tend to avoid meaningful intrusions (e.g., hotspots and other distressing trauma-related memories), it is possible that the meaningfulness of cognitive content might play a role in individuals' awareness of intrusions and that the more meaningful a memory is, the more likely that an individual will detect its presence in consciousness.

Another factor that might affect meta-awareness is the *accessibility* of memory. Although prior research has not explicitly examined this issue in the context of trauma and meta-awareness, it seems plausible that the accessibility of trauma-related memories might be altered due to several factors, and thus influence an intrusion's awareness level. Rehearsing certain events strengthens and maintains both short-term and long-term memory for those events (Dark & Loftus, 1976; Greene, 1987; Parle et al., 2006). It is therefore likely that rehearsing certain trauma-related memory aspects (e.g., the colour of a perpetrator's clothes) through repeated recall or in some cases, communications with others (e.g., police, therapist, family) increases the accessibility of trauma-related memories. However, researchers have

suggested that a lack of communication or discussion about an event (e.g., a consequence of avoidance of trauma-related information) could result in a memory being more prone to meta-awareness failure (Schooler, 2001). For trauma-exposed individuals then, it is likely that greater awareness may occur when the event has been rehearsed over time. Indirect support for this proposition comes from research showing trauma-related memories and narratives sometime lack coherence and can be reported by individuals as 'fragments' and 'snapshots' of the experience (Bedard-Gilligan & Zoellner, 2012; Ehlers & Clark, 2000; Lynn et al., 2012). Individuals vary in terms of how accessible a particular memory (or aspect of an experience) is (Ehlers & Clark, 2000; Halligan et al., 2002; van der Kolk & Fisler, 1995). It is possible that intrusions that reflect components of a memory lacking in coherence may be less likely to be discussed or rehearsed by trauma-exposed individuals, thus contributing to these components not being as readily accessible to self-report.

In summary, the characteristics of unaware 'real-life' intrusions have not yet been comprehensively documented given that to date the field has primarily studied intrusions that individuals experienced with meta-awareness. For example, it is possible that when individuals experience intrusions of lesser intensity, this may be accompanied with meta-awareness failure, i.e., the failure to self-report these types of intrusions. To address this gap, the current study examined the characteristics of intrusions accompanied by meta-awareness failure, with specific focus on their modality, meaningfulness, and accessibility. Using a modified version of the meta-awareness task (Takarangi et al., 2014; Nixon et al., 2021), I employed an online study method to test my hypotheses in 78 trauma-exposed individuals. I hypothesized that unaware intrusions, relatively to aware intrusions, would be less likely to occur as intrusive memories (compared to intrusive thoughts), were considered less meaningful, and felt less accessible when deliberately recalled.

Method

The study was pre-registered on the Open Science Framework (https://osf.io/c2gk9) Flinders University's Social and Behavioural Research Ethics Committee granted ethics approval.

Participants

Participants were recruited from Flinders University and online crowd-sourcing websites[3]. Inclusion criteria were that participants had been exposed to a Criterion A trauma (exposure to actual or threatened death, serious injury, or sexual violence; American Psychiatric Association, 2022), were over the age of 18, and fluent in English. Participants received 2 course credits or payment as reimbursement of participation ($AUD10 for Australian participants, $USD4.50 for North American participants).

Of the 200 participants who initiated the study, 122 were excluded (n = 81: did not experience any intrusions; n = 34: noncompliant with task instructions; n = 6: discontinued the online experiment; n = 1: failed attention check questions). The final sample comprised 78 participants aged between 18 to 60 (M = 32.68, SD = 11.09), with the majority female (75.6%) and identifying as White in ethnicity (66.7%).

An a priori power calculation was used to determine the sample size for a chi-square test analysis (for the modality hypothesis) by using G*Power (Faul et al., 2014). The calculation was set to detect a medium effect (Cohen's d = 0.5) with alpha level = .05, and power at .80 with 1 degree of freedom. This calculation determined that a minimum number of 88 participants in total was needed to detect a medium effect between groups (those demonstrating meta-awareness vs. meta-awareness failure). The proposed pre-registered sample size (N = 128) was planned to account for missing/un-useable data but unfortunately underestimated the proportion of participants who experienced no intrusions. Recruitment

[3] I used Prolific to recruit Australians for my sample (n = 31), and Amazon Mechanical Turk to recruit North American participants (n = 30).

was halted after 200 participants due to resource restrictions. A sensitivity analysis with G*Power revealed that the obtained sample size would reliably detect a large between-group effect size (Cohen's $d = 0.9$ and above).

Measures and Tasks

Online Meta-awareness Task (adapted from Takarangi et al., 2014) (see Appendix A). Participants read 10 non-fiction articles online using their personal computing devices. Each article contained a 'probe' (screen), which popped up while participants were reading. Probes were set to pop up at 30, 45 or 60 seconds once a participant began a new article.

On each probe, participants chose the statement that best corresponded with their mental content the moment before the probe appeared. The options were as follows: *Option 1 - I was thinking about my trauma. Option 2 - I was thinking about the reading task. Option 3 - I was thinking about something else. Option 4 - I was not thinking about anything*. If Option 1 was not selected, participants were directed to a new article and continued reading with further probes until Option 1 was selected. After receiving the 10th probe, the online survey ended if a participant never experienced a trauma-related thought during the reading task.

If Option 1 was selected, participants were directed to a question asking about the modality and the awareness levels of the trauma-related memory. The options were as follows*: 1. Yes, I was fully aware of my trauma-related memory/thought. It felt like a flashback (i.e., to some degree I had a sense of reliving it again or I was 'back' there). 2. Yes, I was fully aware of my trauma-related memory/thought. It was a memory/thought but I didn't have a sense or feeling of reliving the event again. 3. No, I was NOT aware of my trauma-related memory/thought. It felt like a flashback (i.e., to some degree I had a sense of reliving it again or I was 'back' there). 4. No, I was NOT aware of my trauma-related memory/thought. Although it was a memory/thought, I didn't have a sense or feeling of reliving the event again.*

Participants were instructed to select the statement that best corresponded to their intrusion experience. The meta-awareness task finished after their response to this question. As a reminder, meta-awareness characteristics were thus only assessed for one intrusion. Capturing the characteristics of the first intrusion reported was thought to reflect an accurate index of typical intrusions, with this intrusion less likely to be a product of deliberate recall or continuation of any previous intrusions (compared with prior studies that have attempted to capture multiple intrusions throughout the task; e.g., Takarangi et al., 2014). Previous versions of the meta-awareness task also incorporated a reading comprehension test at the end, but this test was omitted in the present study for both participant burden reasons and to better mimic the normal experience of reading (i.e., without the expectation of being tested on it).

Intrusions Characteristics (see Appendix B1). Involuntary Cognitions Questionnaires (ICQ; modified from Krans et al., 2015). The ICQ was adapted for the specific aims of the present study. The first part of the questionnaire consisted of 17 statements asking participants to rate their experience of having intrusive memories during the meta-awareness task. The statements covered various characteristics of intrusions including levels of involuntariness, effort to bring those memories to mind, how unwanted those memories were, and levels of distress, vividness, and emotions. The response for each statement (e.g., “I deliberately tried to bring the trauma-related memories/thoughts to mind”) ranged from 1 = “Not at all” to 7 = “completely accurate”. In the second part of the questionnaire, participants were asked to briefly describe the content of the intrusion and rate the meaningfulness and accessibility of the intrusions. I also asked how frequent the captured intrusion was on a weekly basis. Items relevant to the key hypotheses were selected as indices for modality, meaningfulness, and accessibility.

Modality. Intrusions were dichotomized as either primarily a memory or thought.

Intrusions endorsed as either a still image, moving images, or both image and movement were coded as memories. Intrusions endorsed as verbal thought only were coded as thoughts. Participants could also describe their experience using a textbox to provide further details; this description was used in a minority of cases to classify modality.

Meaningfulness. Three ICQ items were summed to index meaningfulness scores (incorporating the intensity of emotion associated with the intrusion, how meaningful the memory was to the participant, and how meaningful to their lives).

Accessibility. Two ICQ items were summed to index accessibility of the intrusion (difficulty in bringing the memory back to mind and the likelihood they would have or recall this intrusion if asked to describe their traumatic event). Difficulty of recalling the memory in daily life was reversely scored when analysing accessibility, making the higher total score indexing greater likelihood and easiness to recall the particular intrusion in their daily life.

Symptom measures (see Appendix B3–5). The Posttraumatic Stress Disorder Checklist (PCL-5; Weathers et al., 2013) consists of 20 self-report items that measure symptoms of PTSD experienced over the past month according to DSM-5 criteria. Five items were added to the PCL-5 to index complex PTSD symptoms (available on request, although findings were not altered when these were included in analyses). The PCL-5 provides a measure of PTSD severity and uses a five-point continuous rating scale (0 = “not at all” to 4 = “extremely”). The PCL-5 has good psychometric properties with test-retest reliability, r = .84, and internal consistency, α = .94 (Bovin et al., 2016), and demonstrated a good internal consistency in the current study, α = .94. In conjunction with the PCL, the Life Events Checklist (LEC) was used to document the number of traumatic event types participants had experienced in their lifetime. The Depression Anxiety and Stress scale (DASS-21; Lovibond & Lovibond, 1995) was used to index the severity of depressive symptoms. Respondents report on the experience of symptoms in the past 2 weeks through a four-point continuous scale (0 = not at all to 3 =

most of the time), with higher scores indicating more severe levels of symptoms. The internal consistency for the depression subscale was α = .93. The White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994) was used to index thought suppression levels. Participants were instructed to respond according to how they have been coping with their thoughts since their trauma occurred based on a 5-point-scale (1 = strongly disagree; 5 = strongly agree). Scores range from 15 to 75 with higher score indicating a participant being more prone to engage in thought suppression. The internal consistency for WBSI is α = .93.

Procedure

Following informed consent, participants first completed a demographic questionnaire and symptoms measures. Following the questionnaires, participants read the instructions for the meta-awareness task and started the task when ready. If participants responded 'Option 1' to the probe (i.e., they were thinking about the trauma when the probe appeared) they also responded to questions regarding awareness and reliving experiences. Participants then received the Involuntary Cognitions Questionnaires (ICQ), which obtained more detailed information of the characteristics of their intrusions. The online survey finished after the completion of the ICQ. If they did not have an intrusion, participants ended the survey after the reading task. Participants were then thanked and debriefed.

Results

Participants were allocated to the meta-awareness (n = 60) or meta-awareness failure group (n = 18) depending on their response to the probe. There were no significant differences between the two groups in terms of age, gender, ethnicity, years of education received, symptom severity or deliberation to recall intrusions (see Table 1 for descriptive data). To address the research questions under study, I conducted a series of Fisher's exact tests (FET)

and t-tests to examine potential differences between groups in relation to characteristics of the intrusion experienced during the meta-awareness task.

My expectation that participants who had an unaware intrusion would be more likely to report it as an experience of a memory (i.e., with sensory aspects, imagery) versus a thought was not supported (p = .235, two-tailed, effect size [Φ] = .149, FET). As seen in Table 2, both meta-awareness failures and intrusions associated with meta-awareness tended to occur as memories (i.e., intrusions with imagery or visualisation).

I also hypothesized that unaware intrusions would be experienced with less meaningfulness and less accessibility. Table 3 illustrates that there were no significant differences in meaningfulness and accessibility between the aware and unaware groups, with small effects. Although I did not explicitly hypothesize differences in other intrusion characteristics, to confirm whether meta-awareness levels differed in intensity, I documented the characteristics that likely contribute to this intensity (e.g., vividness, level of distress caused) (see also Table 3).

Table 1

Mean (and Standard Deviations) or Cell Size (and Percentage) of Demographic and Symptom Scores, and Statistical Significance for Meta-awareness and Meta-awareness Failure groups

Variables	Meta-awareness (n = 60) *M* (*SD*) or *n* (%)	Meta-awareness failure (n = 18) *M* (*SD*) or *n* (%)	*p*	Effect Sizes
Age	32.12 (10.59)	34.56 (12.75)	.417	0.21
Years of education	15.44 (3.01)	15.61 (3.33)	.838	0.05
Gender				
Female	43 (71.7)	16 (88.9)	.211	0.17
Ethnicity				
White	39 (65)	13 (72.2)	.868	0.13
PTSD	33.73 (17.14)	33.06 (19.51)	.887	0.04
Depression	17.17 (12.14)	19.44 (14.53)	.507	0.17
Anxiety	16.03 (11.41)	16.82 (12.96)	.808	0.06
Stress	20.54 (9.86)	22.77 (12.98)	.438	0.19
Deliberate recall of intrusions	2.27 (1.39)	2.06 (1.35)	.571	0.15

Note. Depression, Anxiety and Stress reflect subscales from the Depression Anxiety Stress Scale (DASS-21). Effect sizes were Phi (Φ) for gender and ethnicity or Cohen's *d* for other variables.

Table 2

Modality of the Experience of Intrusions with and without Meta-awareness (N = 78).

Modality	Meta-awareness (*n* = 60)	Meta-awareness failure (*n* = 18)
Intrusive memory	89.7%	77.8%
Intrusive thought	10.3%	22.2%

Table 3

Mean (and Standard Deviations) of Key Intrusions Characteristics, Inferential Statistics, and Cohen's d for Aware and Unaware Groups

	Meta-awareness				
Variables	Meta-awareness (*n* = 60) *M* (*SD*)	Meta-awareness failure (*n* = 18) *M* (*SD*)	*t*(76)	Cohen's *d*	95% Confidence Interval
Meaningfulness	14.23 (4.08)	13.72 (3.21)	0.49	0.14	[-1.58, 2.60]
Accessibility	11.48 (2.38)	11.17 (2.26)	0.50	0.13	[-0.94, 1.57]
Distress	4.27 (1.47)	4.50 (1.65)	-0.57	0.15	[-1.04, 0.58]
Threateningness	3.03 (1.78)	3.61 (1.91)	-1.19	0.31	[-1.55, 0.39]
Vividness	5.63 (1.55)	5.17 (1.65)	1.10	0.29	[-0.38, 1.31]
Emotion Intensity	4.27 (1.70)	4.50 (1.76)	-0.51	0.13	[-1.15, 0.68]

Note. Range of potential scores for Meaningfulness (0–21), range of potential scores for Accessibility (0–14). All comparisons nonsignificant (*p*s > .24).

I conducted exploratory follow-up analyses in an effort to understand the unexpected null findings. Given that I previously argued that those intrusions that have high levels of intensity were more likely to be experienced with meta-awareness, it is possible that whether an intrusion had 'flashback' characteristics was more important than whether an intrusion was a memory versus a thought. However, when I examined this possibility, I detected a small and nonsignificant differences of flashbacks in different meta-awareness levels (p = .123, two-tailed, Φ = .185, FET) (see Table 4). Given I speculated that individuals would avoid meaningful intrusions and have lower levels of accessibility for those intrusions due to avoiding communications around trauma, I examined the strength of the relationship between thought suppression and meaningfulness and accessibility ratings. Only small and nonsignificant effects of thought suppression were detected with meaningfulness (r(78) = .176, p = .12) and with accessibility (r(78) = .132, p = .25).

Finally, I considered a methodological issue. Because the method used in the study only examined the characteristics of the *first* intrusion that occurred during the meta-awareness task, it could be questioned whether these intrusions were significant to the individual or at least representative of typical intrusions in the participant's daily life. However, further analysis confirmed these intrusions were representative (while failing to demonstrate significant differences between intrusions with and without awareness on additional characteristics, as follows). Specifically, participants rated how likely they were to recall the captured intrusion if they were asked to describe their negative experience by other people in their daily life. There was no significant difference between groups in relation to this recall, with higher ratings on a 7-point-likert scale indicating that all participants were likely to bring up this intrusion when being asked about their trauma (meta-aware group: M = 5.80, SD = 1.57; meta-failure group: M = 5.61, SD = 1.72, t(76) = 0.44, p = .663). Such findings imply the captured intrusions were representative of participants' trauma, with

participants indicating these intrusions reflected their typical intrusions and appearing to contain content associated with their memory of the traumatic experience. Similarly, the groups did not significantly differ on reporting of the weekly frequency of these particular intrusions, with both the aware and unaware groups indicating the intrusion typically occurred twice a week (median = 2, range = 0-150, Mann-Whitney U test $p = .401$). In summary, the first intrusions that occurred during the task appeared to represent an 'iconic' intrusion for that participants in relation to their identified trauma, contained similar accessibility and meaningfulness for the individuals who recalled it with awareness or without awareness. In other words, the comparableness between aware and meta-awareness failures was not explained by intrusions in the meta-awareness task being atypical for one of the groups.

Table 4

Flashbacks of Intrusions with and without Meta-awareness (N = 78).

Intrusion flashback level	Meta-awareness (n = 60)	Meta-awareness failure (n = 18)
Relieving feeling	20.0%	38.9%
No relieving feeling	80.0%	61.1%

Discussion

A key goal of this exploratory study was to understand the possible differences between aware and unaware real-life trauma-related intrusions. To my knowledge, this is the first meta-awareness study to assess the characteristics of trauma-related intrusions in response to real-life trauma. Although the results should be interpreted with caution due to the modest sample size in the unaware group, the current study provides important information regarding aware and unaware intrusions. My findings demonstrated no fundamental difference between the characteristics of aware and unaware intrusions. Intrusive *memories* were the dominant modality of intrusions regardless of meta-awareness. Furthermore, unaware intrusions were reported by participants to be as meaningful and accessible as aware intrusions. As expanded upon below, my preliminary findings have implications for current conceptualisations of meta-awareness in relation to trauma-related intrusions, justifying the need for further investigation.

My study informs the field of trauma-related intrusion research by extending its study to unaware intrusions. First, my findings support prior work that most intrusions are imagery-based (Ehlers & Steil, 1995; Marks et al., 2018), and now show that although these intrusive images can be vivid and clear, individuals still can lack awareness of such mental content. Second, in addition to replicating previous analogue studies that found similar levels of distress from both meta-aware and unaware intrusions (Takarangi et al., 2014; Keeping et al., 2022) my study also shows participants experience similar degrees of threat (see Table 3) about their intrusions, regardless of level of meta-awareness. Given a sense of threat and distress from intrusions are predictors of PTSD and its maintenance (Ehlers & Clarks, 2000, Michael et al., 2005), my findings suggest that unaware intrusions have the potential to be as problematic for individuals as the intrusions people are explicitly aware of. It remains an

empirical question whether improving individuals' meta-awareness to intrusive content may have a beneficial impact on their adjustment.

Although I found no evidence in line with my prediction that degree of accessibility to the trauma-related intrusions would influence meta-awareness, accessibility remains a potentially important characteristic. Meta-awareness may play an important role in whether individuals perceive information as being accessible or not. For example, although in some contexts accessibility of mental content can be automatic, in other circumstances it has been argued that meta-awareness can facilitate recalling "lost" memories for trauma-exposed individuals (see case study discussed by Schooler, 2001). To my knowledge, mine is the first study to investigate the role of accessibility in meta-awareness of intrusions in the context of a meta-awareness task. At present, there is not a gold-standard method of measuring accessibility. One explanation of my null finding is that asking individuals how 'difficult' it is to recall the intrusion right after they received a probe about their intrusion might not truly reflect accessibility of the memory. When prior research has documented individuals becoming aware of trauma-related memories they did not initially have overt meta-awareness of (e.g., Schooler, 2001), this has been in the context of triggers of trauma-related cues (e.g., exposed to information about sexual assault). In contrast, my study exposed participants to scientific articles during the meta-awareness task, which might have minimized the chance of triggering less accessible trauma-related memories. Finally, clinical research reveals that individuals with PTSD can report trauma-related memories in disorganized fashion, which is thought to reflect lack of memory consolidation that has implications for ease of retrieval (e.g., Bedard-Gilligan & Zoellner, 2012). However, the severity of PTSD symptoms in my sample was generally low (the group mean only just passed the clinical cut-off), thus it is possible that my sample was better at intentionally recalling trauma-related memories than a clinical sample with greater symptom severity, explaining why aware and unaware intrusions

both were highly accessible. Hence, memory accessibility and its role in meta-awareness of intrusions require further study.

My study sought to bridge current theories of mind-wandering and meta-awareness by extending these accounts (largely developed by studying benign thought content) to trauma-related intrusions. Although intense and vivid mental experiences more easily break into consciousness and become "globally available" to attention (see Dehaene et al., 2005; Mangan, 2001), the similarity of modality and meaningfulness of aware and unaware intrusions in my sample seems to conform with the idea that strength and clarity only *facilitate* triggering meta-awareness (Winkelman & Schooler, 2011). According to Winkelman and Schooler (2011), meta-awareness is more likely to be triggered by an individuals' ability and/or desire to connect with mental content. In other words, even though trauma-related intrusions can be intense flashbacks, intrusive memories, or meaningful intrusions such as hotspots, individuals are still prone to meta-awareness failure if they are not engaged with their internal mental content (e.g., by not asking themselves "what am I thinking?") (see Winkelman & Schooler, 2011).

My results also provide some insight into methodological processes for future research. Unlike previous meta-awareness studies that indexed multiple intrusions in the experiment (Green et al., 2016; Nixon et al., 2021; Takarangi et al., 2014), my method focused on the first intrusion participants had to minimize the impact from other continuous intrusions (see Schwartz, 2007). My meta-awareness task is similar to a recent study that reported several small significant correlations between meta-awareness and the *first* film-related intrusion characteristics (e.g., distress) (Keeping et al., 2022). Although my results did not show these same associations between meta-awareness and intrusions characteristics, it should be emphasized that my sample consisted of 'real-life' trauma-exposed individuals (compared to acute intrusions that were film-induced). As mentioned earlier, the first

intrusions that occurred in my study participants were iconic intrusions for them, that is, they were representative of their typical intrusions. My participants reported that their intrusions typically occurred twice a week, thus, this weekly retrieval might reinforce and strengthen the intrusions in long-term memory (Dark & Loftus, 1976), making them more accessible, regardless of meta-awareness level. Moreover, these first intrusions tended to contain significant meaning about trauma for the person, including information considered to contribute to such intrusions being viewed as 'hotspots' and warning signals (Ehlers, 2010; Holmes et al., 2005; Mark et al., 2018). Although I aimed to capture first intrusions to be a representative index of unintentionally recalled intrusions, it is possible that analysis of a single intrusion was not sensitive enough to differentiate between intrusion types (aware vs. unaware) on the characteristics of interest, resulting in some of my null findings. Alternatively, the influence of these characteristics might differ with respect to real-life vs. film-induced intrusions. Future studies that investigate these characteristics across multiple intrusions will shed further light on these processes.

In terms of the clinical implications of my findings, as mentioned above, the *initial* intrusions that occurred in my study could mostly be 'typical' intrusions for trauma-exposed individuals. Even though these iconic intrusions tended to occur as intrusive memories and were meaningful and accessible, they could also still occur without explicit awareness for some individuals. As highlighted in previous research, this lack of awareness could result in trauma-exposed individuals underestimating the actual frequency of intrusions (Nixon et al., 2021). Moreover, the intensity and vividness accompanied by unaware intrusions were the same as aware intrusions. This seems in contrast to the argument that intrusions with intense emotion should highlight the saliency of the memory in the long-term memory retrieval system (Marks et al., 2018) as my findings showed intrusions with intense emotions could still occur without explicit awareness. Future research could attempt to better understand

whether other variables (e.g., derealisation) interact with the intensity and vividness of unaware intrusions in ways that minimize or increase their likelihood of subsequent recall.

My study comes with limitations. I omitted a reading comprehension test at the end of the experiment, normally conducted in meta-awareness research, to better mimic the normal experience of reading. Yet the reading task was disrupted, by design, as participants were directed to the next article once they received a probe. With this disruption and omission of the reading comprehension test, it is possible that participants' engagement and attention levels in the current study might be lower compared with previous studies. Given that unintentional spontaneous thoughts are more likely to occur when cognitive resources are taxed by other tasks (i.e., the reading task in the current study) (see McVay & Kane, 2010), my method potentially minimized meta-awareness failure, resulting in the small cell size for this subgroup. Also, individuals with PTSD typically have multiple daily intrusions; thus, future research should capture multiple intrusions to enable between-subject (e.g., aware vs. unaware intrusion across the sample) and within-subject (e.g., aware vs. unaware intrusions from a participant) comparisons to better understand the difference between meta-awareness and meta-awareness failure. Finally, my study modified Takarangi et al.'s (2014) approach to index meta-awareness using a categorical measure, whereas continuous measure to index meta-awareness has recently begun to gain popularity (Keeping et al., 2022; Vannucci et al., 2019). Although use of a continuous measurement approach might simply index how confident people are in their meta-awareness (Kane, 2021), future studies could consider employing such methodology for meta-awareness in trauma-exposed individuals to explore the validity of the methodology.

In summary, although the current study observed no significant differences in intrusion characteristics between aware and unaware groups, examination of these variables in real-life trauma exposed individual could assist future investigations that seek to advance both

theoretical and clinical applications of these findings. This is still a relatively new area of research, with much work to be undertaken to understand the mechanisms underlying meta-awareness of intrusions to better investigate this phenomenon in trauma-exposed and PTSD populations.

CHAPTER 3 – STUDY 2: A DETAILED INVESTIGATION OF THE CHARACTERISTICS AND INFLUENCES OF META-AWARENESS FAILURES

Chapter Abstract

This chapter investigates potential factors underlying varying levels of awareness of intrusions to assess the phenomenological characteristics of aware and unaware intrusions. Trauma-exposed participants (N = 87, 78.2% female, mean age = 25.38) were recruited. Using a modified meta-awareness task, which appeared as a reading task, participants self-reported any trauma-related thoughts while intermittingly receiving probes that indexed trauma-related thoughts participants experienced without explicit awareness. Next, a semi-structured interview was conducted to explore the characteristics of aware and unaware intrusions that were noted during the meta-awareness task. Aware intrusions appeared to be associated with visual imagery and higher levels of meaningfulness for the participants relative to unaware ones. Both aware and unaware intrusions reflected memories of the trauma that individuals considered easily recalled. In conclusion, there are more commonalities than differences between aware and unaware intrusions although intrusions experienced with awareness were accompanied by more intensive, negative emotions.

Introduction

Study 2 was designed to replicate the findings of Study 1, with some modifications to the methodology to address some limitations of the earlier study. As highlighted in earlier chapters, importantly, we currently know very little about the factors that influence meta-awareness failures. Given the importance of awareness of cognitive content for engagement with therapies for posttraumatic stress, especially those that specifically address trauma memories and thoughts (e.g., Ehlers et al., 2010, for cognitive therapy; Foa, 2011, for

prolonged exposure; Resick et al., 2017, for cognitive processing therapy), there is a need to address this gap. I have reason to believe certain intrusion characteristics—such as the level of distress they invoke, their meaningfulness to an individual, and even how they are experienced (e.g., as images versus thoughts)—might play an important role in the meta-awareness process.

To date, research has focused on intrusions that individuals were actively 'aware' of. These findings indicate that characteristics such as vividness, sensory impression, level of emotion, involuntariness, lack of context, and a sense of "nowness" to intrusions are either associated with more severe PTSD symptoms or distinguish the memories of those with PTSD and without PTSD (Ehlers & Clark, 2000; Marks et al., 2018; Michael et al., 2005). For example, intrusions can be experienced with a sense of "here and now" or reliving, often with a sense of distorted time or place. This is argued to reflect that individuals have been unable to place these memories in normal autobiographical memory and experience them as a memory of a past events, for example recall them deliberately when desired and/or experience with less emotion when reminded of them (Brewin et al., 2010). Relatedly, intrusions also often lack context, with individuals experiencing disjointed and sometimes random 'snapshots' of their trauma (Ehlers et al., 2004; Sachschal et al., 2019). Nevertheless, there is a lack of evidence as to whether the aforementioned characteristics of intrusions occur when the intrusion is experienced with meta-awareness failure. For example, individuals might be immediately aware of an intrusion as it occurs and experience it with a sense of "nowness", yet we do not know whether unaware intrusions are experienced with similar effect. Hence, the current study aimed to observe whether intrusions characteristics were different depending on the level of meta-awareness. Some of the literature discussed next was presented in the previous chapter with reference to Study 1, however it is reviewed here with specific reference to its relevance to the roles of intrusion modalities, meaningfulness, and

accessibility which are under investigation in Study 2 with the design of the study focused on instances of *multiple* intrusions.

It is documented that aware intrusions can occur with two types of modalities. Intrusions can be experienced as intrusive memories or intrusive thoughts (Hackman et al., 2004). Intrusive memories can be accompanied by vivid sensory impressions and clear mental images, and often involve a 'replaying' key moments of the trauma (Ehlers et al., 2002). In contrast, intrusive thoughts typically represent more abstract recollections of the event. These types of intrusions are often associated with a ruminative thinking style (e.g., "why me" type of questions) and negative evaluation of the traumatic experience (Reynold & Brewin, 1999). Individuals involuntarily revise how things could have done better and/or why the trauma happened to them when such thoughts occur (Reynolds & Brewin, 1999; Murray et al., 2002). In studies of consciousness and cognition (e.g., Dehaene et al., 2005; Mangan, 2001), researchers of spontaneous thought theorise that meta-awareness is more likely to be invoked when individuals experiencing a clear and strong mental image compared to abstract or vague memories (Winkelman & Schooler, 2011). Following this logic, I expected that intrusive thoughts may be more vulnerable to meta-awareness failure than intrusive memories that are experienced in more detail or associated with sensory impressions.

Important or salient components of a traumatic experience that have significant meaning for an individual appear to play a role in intrusions. Previously, PTSD researchers, influenced by eyewitness studies on emotion and stress, proposed that traumatised individuals would be more likely to recall the central spatial aspect of trauma while missing other peripheral details due to narrowing of attention (see Foa & Riggs, 1993; Christianson, 1992). For example, individuals might focus on the weapon of the perpetrator during trauma, hence, find it hard to recall the perpetrator's clothes after trauma. However, subsequent research has suggested that the meaning or appraisal of critical elements of the trauma are more related to

intrusions than simple spatial focus during trauma. The scenes that arouse the greatest emotional reaction during a traumatic event (labelled “hotspots” by clinicians) frequently become the content of many intrusions (Ehlers et al., 2002; Hackmann et al., 2004; Holmes et al., 2005). They are often associated with high levels of threat. For example, instead of the actual onset of a traumatic event, the moment an individual believed that he/she/they might die could become the most frequently experienced later intrusion. Therefore, intrusions are rarely just random images of the trauma, rather, they frequently contain specific meaning to individuals. We would thus expect these types of intrusions to be particularly salient when they break into consciousness. This is consistent with the prevailing theory of thought suppression (e.g., Wegner et al., 1990; Wenzlaff & Wegner, 2000), which highlights that this maladaptive coping strategy (commonly seen in those with PTSD, Ehlers et al., 1998; Shipherd & Beck, 2005) paradoxically heightens an individual’s awareness of their mental content.

There is considerable debate in the trauma field as to whether traumatic events are encoded differently from other events and whether processes of their recall operate at simple or multiple levels (for varying views see Brewin et al., 1996; Ehlers & Clark, 2000; McNally, 2003; Brewin et al., 2010). Although mixed findings exist, individuals with PTSD have reported that intrusive memories sometimes represent fragments of the experience, accompanied by strong emotions and pieces of scenes, which can emerge spontaneously and involuntarily, and that some aspects are difficult to intentionally retrieve (Halligan et al., 2002, Reynolds & Brewin, 1999; van der Kolk & Fisler, 1995; but see also Brewin 2007, Berwin, 2016; Bray et al., 2018, and Pacheco & Scheeringa, 2022). In fact, observations of sexual abuse victims showed that memories relating to the negative events could be interpreted as ‘inaccessible’ (or forgotten) when there was an apparent failure of intentional retrieval despite evidence the individuals had memory of these events in other periods of their

life (Schooler, 2011). Nevertheless, Schooler argued that meta-awareness of unintentional retrieval may help recollection of seemingly 'inaccessible' trauma-related memories or components. In other words, meta-awareness facilitates individuals access to memories that may not be explicitly at the front of one's consciousness. Schooler also highlighted that discussion of abuse-related information can increase the meta-awareness of trauma-related memories/thoughts when such memories/thoughts occur. Relatedly, this theory supposes that awareness of specific mental content (not specific to trauma) increases when that content is ready to be communicated (Winkielman & Schooler, 2011). From a clinical perspective, if an individual has communicated aspects of the trauma to others (e.g., a clinician or a friend), or has ruminated on specific elements of their experience, those trauma-related memories may be more likely to occur with the person's awareness. It is thus possible that when meta-awareness failures occur it is because, in part, these intrusions reflect content that is not as readily accessible, and relatedly, in certain circumstances, may not reflect as salient or distressing elements of the person's experience.

In summary, previous studies have shown that intrusions can occur without being noticed by trauma-exposed individuals. Nevertheless, our understanding of the underlying mechanisms and variables that influence meta-awareness failure in trauma populations remains poorly understood. The current study improved on Study 1 by modifying the meta-awareness task that was employed in previous research (e.g., Takarangi et al., 2014; Nixon et al., 2021) to better understand some plausible candidate variables that might influence individuals' meta-awareness of trauma-related intrusions. To address the limitations of Study 1, the current study included a reading comprehension test to increase participants' engagement and attention levels to better tax their cognitive resources, hence, allowing more unintentional spontaneous thoughts to occur during the experiments (see McVay & Kane, 2010). Moreover, the meta-awareness task in Study 2 allowed individuals to receive multiple

probes so that multiple intrusions could be examined. Furthermore, the current included the use of a semi-structured intrusion interview which enabled the researcher to clarify abstract concepts (e.g., accessibility, meaningfulness) with participants to prevent misunderstandings.

I had several predictions. First, I hypothesized that intrusive memories are more likely to be noticed (i.e., self-reported) when they are vivid, clear, and represent a visual 'replay' of the trauma, compared to intrusive thoughts that are more abstract and lack the aforementioned features. Second, I expected that trauma-related intrusions an individual deems important or meaningful are more likely to catch the individual's awareness when they pop into that individual's head. Third, unaware intrusions might be harder for individuals to spontaneously detect when the intrusions' contents have not been encoded fully or represent tangential or peripheral aspects of the event, thus reflecting lower levels of accessibility. To test these predictions, I employed an established meta-awareness task (Takarangi et al., 2014) with 87 individuals who had been exposed to trauma sufficient to cause PTSD.

Method

The study was pre-registered on the Open Science Framework (https://osf.io/qwck2). Flinders University's Social and Behavioural Research Ethics Committee granted ethics approval.

Participants

A total of 90 participants[4] were recruited from Flinders university campus. Inclusion criteria were that participants had been exposed to trauma that reflects a Criterion A trauma (exposure to actual or threatened death, serious injury, or sexual violence; American

[4] The participants in the current study did not overlap with Study 1 (and more than half of the Study 1 participants were recruited from online crowd-sourcing platforms). Although both Study 1 and Study 2 recruited participants from Flinders university, the chief investigator set up a restriction in the registration system to ensure that those participated in Study 1 could not participate in Study 2. All potential participants were aware of the restriction on the Flinders University participation pool webpage.

Psychiatric Association, 2022), were over the age of 18, and fluent in English. Participants received $20 AUD or course credit as reimbursement for participation. Three participants' data were excluded (2 = failed to follow task instructions, 1 = withdrew from the experiment). The final sample comprised of 87 participants aged between 18 to 55 (M = 25.38, SD = 9.72), who had received education for 13.99 years (SD = 2.66) on average. The majority of the sample identified themselves as female (78.2%) and White (63.2%).

An a priori power calculation was used to determine the sample size for two-tailed paired t-tests using G*Power (Faul et al., 2014). The calculation was set to detect a medium effect (Cohen's d = 0.5) with alpha level = .05, and power at .80. A minimum number of 27 participants was needed to detect observed effects between intrusion awareness type (meta-awareness, meta-awareness failure). An additional calculated indicated that 84 participants were required to detect a medium effect size from anticipated correlational analyses such as relationships between PTSD severity and intrusion characteristics (r = 0.3, α = .05, power =.80).

Measures and Tasks

Meta-awareness Task (Baird et al., 2013; Takarangi et al., 2014) (see Appendix A). The task required participants to read articles on scientific topics during which they self-reported any intrusions and responded to probes that asked whether they were having a thought about their trauma at that moment (to determine meta-awareness failures). While reading text on computer monitor participants were asked to press the 'X' key on the computer keyboard whenever they found themselves having intrusive thoughts or memories related to their trauma during the reading task. This resulted in the documentation of the total number of occasions participants were (meta-) aware that they had an intrusion in their mind (also known as 'self-caught' intrusions). Participants also received computer-generated probes

intermittently during the reading task to catch unnoticed intrusive thoughts. These probes would appear on the screen and ask, "Just now (immediately before this screen appeared), were you thinking about the trauma?" Participants then pressed number keys on the keyboard to indicate their experience. The options were as follows: *If you were thinking about the trauma when the blue screen appeared but already reported this memory/thought with the x key, please select option 1. If you were thinking about the trauma when the blue screen appeared and were aware of it, please select option 2. If you were thinking about the trauma when the blue screen appeared and but were NOT aware of it until you saw the screen, please select option 3. If you were focusing on the reading task when the blue screen appeared, please select option 4. If you were thinking about something else at that moment, please select option 5*. Option '3' reflected how often participants were "caught" failing to be (meta-)aware of their intrusions. Meta-awareness failure data were presented as a percentage of failures relative to the total number of probes administered (up to 25). This was because participants did not all take the same time to complete the reading task, making the number of probes they received variable (past data indicated the range of probes was typically 18-25; Takarangi et al., 2014; 2017).

The reading task (adapted from Takarangi et al., 2014) consisted of three non-fiction science articles. Participants were expected to read them under 15 minutes on a computer monitor but without knowing that there was a time limit. After reading, they completed a multiple-choice test about the content of the three articles (i.e., a comprehension test). They were informed in advance of the comprehension test to ensure they remained attentive to the reading task.

Cue words (see Appendix B6). During the task participants were instructed to write down a single cue word each time they had an intrusion (noticed by self-report or unnoticed by probe caught). This was so that questions specific to the different intrusions could be asked

following the task as part of a structured interview by the researcher. A single cue word was selected to serve as a memory aid for the participant while being brief so as not to minimize distraction from the reading task. Participants could choose whichever cue words they thought relevant as long as the cue words reminded them of the content of the intrusions. Participants were asked to use the same cue word for intrusions that were essentially the same as a previous intrusion, and a different cue word(s) if the intrusion was noticeably different. Participants were aware that these cue words would be used to assist the subsequent intrusion interview.

Symptom measures. The Posttraumatic Stress Disorder Checklist (PCL-5; Weathers et al., 2013) was used in conjunction with the Life Events Checklist (LEC) to measure the severity of PTSD symptoms and document the number of traumatic event types participants had experienced in their lifetime. The Depression Anxiety and Stress scale (DASS-21; Lovibond & Lovibond, 1995) was used to index the severity of depressive symptoms.

Intrusions Characteristics. *Involuntary Cognitions Questionnaires* (ICQ; adapted from Krans et al., 2015) (see Appendix B2). A modified version of the ICQ was used to capture a general experience of having self-reported and probe-caught intrusions (the order was counter-balanced). Each questionnaire consisted of 12 statements asking participants to rate their experience of having intrusive memories/thoughts during the meta-awareness task. The statements covered various characteristics of intrusions including the levels of involuntariness, participants' effort to bring those memories to mind, and levels of distress, vividness, and emotions associated with the intrusion. The response scale for each statement ranged from 1 to 7 (1 = "Not at all"; 7 = "completely accurate"). An example item is "How intense were the emotions you felt when the trauma-related memories/thoughts came to mind". Participants were encouraged to refer to the cue word sheet when responding to the questionnaires.

Structured Intrusion Interview (see Appendix B7). The interview involved questions for up to four specific intrusion episodes that occurred during the reading task. The interview was specifically designed for the study and adapted some questions from the intrusion characteristic interview in Michael et al. (2005). Part 1 involved open-ended questions including indexes of modality and meaningfulness. For example, "How is the intrusion trauma-related?" Responses were coded to document the main themes of intrusions, see Table 9. In Part 2, participants responded to questions about intrusion qualities by rating their agreement on a seven-point scale (1 = "not at all" to 7 = "extremely agree"). For example, "How unwanted was this thought/memory when you noticed it?". Other characteristics indexed included sense of threat, degree of reliving, and depersonalisation. Characteristics for which I had specific hypotheses were as follows.

Modality. Modality was indexed by the question, "Did you see image or movement when this thought/memory occurred at that moment, or it was just a verbal thought?". Intrusions with visual components were coded as intrusive memories (= 1). Intrusions without visual elements were coded as intrusive thoughts (= 0). For this variable, findings were reported as the proportion of intrusions characterised by visual elements.

Meaningfulness. Meaningfulness was indexed with an interview question, "What is the meaning of this thought/memory to you? (e.g., is it important or does it mean something to you that you've had this memory, and if so what/why?)". The scale indexed meaningfulness on a range from 0 (= not sure) to 4 (= very important). Given potential subjectivity of these ratings, a coding rule was developed and responses coded by three different coders. All responses were coded by the researcher, with 74.4% and 25.6% by the other two coders. Overall agreement between the first author and independent coders was 94%, with the remainder resolved following discussion and consultation with the third author/PhD supervisor.

Accessibility. Accessibility was indexed with three questions using a seven-point scale (1 = "not at all" to 7 = "extremely agree"). Questions were "How difficult is it to deliberately recall this thought/memory during this interview without noting down the cue words previously?", "How difficult is it to recall this memory in your day-to-day life?", "How likely would you think of this specific memory if someone asked you to describe your negative experience?". The last question was reverse scored. The average of the three questions was the index of accessibility with higher scores indexing greater difficulty of intentional recall.

Procedure

Participants individually attended a single, 60 min session in the lab. Following informed consent, they completed a demographic questionnaire and symptoms measures on a computer. By completing the PCL-5 (which asked participants to report on symptoms of a significant trauma), participants were somewhat primed to think about their trauma during the meta-awareness task. Following the questionnaires, participants were instructed to report any thoughts/memories related to the negative events they described in the previous questionnaires during the meta-awareness task. After instructions about the meta-awareness task and cue word noting sheet, participants completed the 15-minute reading task while noting cue words of their trauma-related thoughts (if applicable), and then the task ended with a multiple-choice comprehension test on the reading material. In the final phase, participants completed the two ICQs. The experimenter then selected the cue words to use for the semi-structured interview (up to four intrusions could be examined). If identical intrusions occurred both with and without meta-awareness during the task, these were prioritised for questioning with the intrusion interview. If such a pattern of intrusions did not occur, I selected the most frequent intrusions that occurred either with or without meta-awareness. If none of these

scenarios occurred, I randomly selected any intrusions in the cue word sheet up to a maximum of four. After the completion off the interview, participants were thanked and debriefed.

Results

Table 5 documents the demographic, trauma, symptom, and intrusion characteristics of the sample. To address the research questions under study, a series of paired-sample t-tests were conducted to examine potential differences between type of intrusion (with or without meta-awareness) in relation to the characteristics of interest.

Table 5

Means and Standard Deviations (or Percentages) for Descriptive Statistics

Variables	*N* = 87
Age	25.38 (9.72)
Gender (% female, *n*)	78% (68)
Education (years)	13.99 (2.66)
Trauma type (%, *n*)	
Interpersonal	48% (42)
Accident/other	52% (35)
PCL-5	32.64 (17.11)
Above clinical cut-off (≥ 31) (%, *n*)	48.3% (42)
DASS-D	13.66 (10.77)
Intrusions	
Self-caught (number)	6.39 (4.86)
Continuous (%)	14.56 (15.69)
Aware (%)	10.03 (10.65)
Unaware (%)	10.60 (10.70)
Unrelated (%)	7.11 (9.40)

Note. Interpersonal trauma (e.g., sexual assault, physical assault); PCL-5 = Posttraumatic Stress Disorder; DASS-D = Depression Anxiety and Stress Disorder – Depression subscale

General Experience of Aware and Unaware Intrusions

In terms of those who experienced both aware and unaware intrusions, a series of paired t-tests showed these were generally experienced in a similar fashion (see Table 6). Although there were no significant differences between the intrusion types on these characteristics, the presence of several small-to-medium effect sizes (without statistical significance) highlights the possibility of power issue in these analyses.

As demonstrated in Table 7, consistent with the hypotheses, aware intrusions contained significantly more visual components and meaningfulness than unaware intrusions across the sample. Moreover, the captured intrusions were easy to intentionally recall regardless of meta-awareness. Table 7 also documented other intrusion characteristics. Although the results support my argument that awareness of intrusions is most likely when they are experienced as vivid imagery (versus abstract thought), predicted differences in ease of accessibility and perceived threateningness (e.g., due to hotspots) were not observed.

Table 6

Self-reported General Experience of Aware and Unaware Intrusions Across the Sample

Variables	Aware *M* (*SD*)	Unaware *M* (*SD*)	*t*(df)	Cohen's *d*	95% Confidence Intervals
Deliberate recall	2.00 (1.28)	1.77 (1.04)	1.39 (64)	0.20	[-0.07, 0.42]
Intention to recall	1.82 (1.03)	1.58 (0.86)	1.74 (64)	0.25	[-0.03, 0.46]
Intrusiveness	4.49 (1.48)	4.20 (1.50)	1.85 (64)	0.19	[-0.02, 0.48]
Spontaneousness	4.62 (1.66)	4.68 (1.78)	-0.35 (64)	0.03	[-0.29, 0.20]
Effortlessness	4.80 (1.69)	4.77 (1.70)	0.19 (64)	0.02	[-0.22, 0.27]
Easiness to recall	4.46 (1.62)	4.31 (1.67)	0.83 (64)	0.09	[-0.14, 0.34]
Tried hard to recall	1.60 (1.03)	1.68 (1.02)	-0.51 (64)	0.08	[-0.31, 0.18]
Distress	4.13 (1.49)	3.84 (1.46)	1.92 (63)	0.20	[-0.01, 0.49]
Vividness	4.61 (1.64)	4.42 (1.55)	1.26 (63)	0.12	[-0.09, 0.40]
Unwantedness	5.38 (1.51)	5.31 (1.50)	0.46 (63)	0.05	[-0.19, 0.30]
Emotion intensity	4.19 (1.48)	4.09 (1.46)	0.76 (63)	0.07	[-0.15, 0.34]
Positivity of intrusions	2.19 (1.05)	2.34 (1.10)	-1.69 (63)	0.14	[-0.46, 0.04]

Notes. Ranges of variables (1–7). Higher numbers indicate participants agreed with the statement describing the experience of having aware/unaware intrusions the intrusions. For example, higher scores mean that the intrusions were easier to recall, more involuntary, more positive etc.

Table 7

Intrusion Characteristics as Assessed by Interviewers as a Function of Meta-awareness Across the Sample

Characteristics	Aware *M* (*SD*)	Unaware *M* (*SD*)	*t*(df)	Cohen's *d*	95% Confidence Intervals
Modality (%)	0.77 (0.35)	0.58 (0.38)	3.64 (61)**	0.52	[0.29, 0.72]
Meaningfulness	2.99 (0.73)	2.69 (1.01)	2.18 (61)*	0.34	[0.33, 0.66]
Accessibility	2.73 (1.13)	2.81 (1.13)	-0.49 (59)	0.07	[-0.32, 0.19]
Unwantedness	5.25 (1.60)	4.93 (1.48)	3.26 (59)	0.21	[-0.06, 0.45]
Distress	4.35 (1.54)	4.12 (1.44)	1.36 (59)	0.15	[-0.08, 0.43]
Threateningness	3.30 (1.58)	3.02 (1.44)	1.61 (59)	0.19	[-0.05, 0.46]
Vividness	5.22 (1.38)	4.70 (1.51)	2.85 (59)*	0.36	[0.11, 0.63]
Involuntariness	5.26 (1.49)	5.52 (1.48)	-1.33 (59)	0.18	[-0.43, 0.08]
Reliving Feeling	3.92 (1.63)	3.85 (1.47)	0.41 (59)	0.05	[-0.20, 0.31]
Depersonalisation	3.93 (2.12)	3.91 (1.90)	0.06 (59)	0.01	[-0.25, 0.26]
Derealisation	4.00 (1.83)	3.78 (1.66)	1.26 (59)	0.13	[-0.09, 0.42]
Lack of context	4.82 (1.57)	4.61 (1.60)	0.93 (56)	0.13	[-0.14, 0.38]

Note. Range of potential scores for Modality 0–100 (%), Meaningfulness (0–4). Range of potential scores for the rest variables (1–7).

*$p < .05$, **$p < .001$.

Exploratory Analyses for Accessibility Findings

Given my initial observation of differences in accessibility was not supported, I was in a position to examine possible explanations for this finding. First, because I had asked participants how often they typically experienced these particular intrusions, I could look at whether intrusions experienced with meta-awareness during the experimental session were more likely to be experienced in day-to-day life. However, a chi-square test revealed no significant association between usual frequency of the intrusions and meta-awareness level, $\chi^2(4) = 3.47$, $p = .482$, two-tailed, effect size [Φ] = .110 (see Table 8). Next, it is possible that salient components (e.g., hotspots) of a traumatic experience or traumas that had been communicated about with others are more prone to meta-awareness. Accordingly, we coded the descriptions from the intrusion interview in which participants provided information about their intrusion (refer to Method for details) to identify content that related to hotspot experiences or indication of communication with others to understand accessibility and meta-awareness. Nevertheless, there was no significant association between the intrusion contents and meta-awareness level, $\chi^2(8) = 8.19$, $p = .416$, two-tailed, effect size [Φ] = .174 (see Table 9 for details). Finally, I also examined correlations between posttraumatic (PTS) scores and accessibility, given previous research has suggested that difficulty in intentional recall is linked with PTSD severity. However, the results revealed small and nonsignificant negative correlations between PTSD severity and accessibility for aware intrusions, $r(81) = -0.13$, $p = .245$, and unaware intrusions, $r(64)$, $p = .563$.

Table 8

Frequency of Aware and Unaware Intrusions in Day-to-Day Life

Frequency	Aware	Unaware
Never	9.6%	4.6%
Less than a month	9.6%	12.3%
Monthly	24.2%	24.6%
Once to twice a week	23.6%	27.7%
Multiple times a week	33.1%	30.8%

Table 9

Main Themes of Aware and Unaware Intrusions

Main theme	Aware	Unaware
Descriptions of trauma	52.2%	48.2%
Hotspots	11.5%	8.9%
Current emotion	7%	8.0%
Ruminative thoughts	7%	3.6%
Verbal appraisals	7.6%	7.1%
Aftermath of trauma	4.5%	12.5%
Solving process of trauma	3.2%	2.7%
Other	5.7%	8.0%
Not interpretable	1.3%	0.9%

Comparing the Same Intrusions that Occurred with and without Meta-awareness

Of the 87 participants, 23 participants (26%) had the same intrusions occurred with and without meta-awareness during the experiment. Capturing 30 episodes of such experiences using the interview method, I observed a greater proportion of meta-aware intrusions experienced as intrusive memories (modality = visual, 93.3%) versus unaware intrusions (73.3% had visual elements), however, such differences of the proportion was not statistically significant (p = .080, two-tailed, effect size [Φ] = 0.27, Fisher's Exact test, FET). Table 10 shows other characteristics of aware and unaware intrusions when comparing the same intrusion when it was experienced with and without awareness.

Table 10

Observation of Differences of Characteristics in The Same Aware and Unaware Intrusions (n = 30)

Characteristics	*Aware* *M* (*SD*)	*Unaware* *M* (*SD*)	*t*	Cohen's *d*	95% Confidence Intervals
Unwantedness	5.30 (1.52)	5.17 (1.80)	0.38	0.08	[-0.29, 0.43]
Distress	4.97 (1.38)	4.65 (1.41)	1.13	0.23	[-0.16, 0.57]
Threateningness	3.60 (1.85)	3.40 (1.92)	0.76	0.11	[-0.22, 0.50]
Vividness	5.43 (1.33)	5.00 (1.51)	1.47	0.30	[-0.10, 0.63]
Involuntariness	5.17 (1.68)	6.05 (1.20)	-2.88*	0.60	[-0.90, -0.14]
Reliving Feeling	4.50 (1.66)	4.07 (1.86)	1.37	0.24	[-0.12, 0.61]
Depersonalisation	4.90 (2.25)	4.30 (2.22)	2.10*	0.27	[0.00, 0.75]
Derealisation	4.50 (1.61)	3.88 (1.70)	2.66*	0.37	[0.10, 0.86]
Lack of context	5.60 (1.54)	4.97 (1.92)	2.28*	0.36	[0.40, 0.78]

Note. Range of potential scores for the variables (1–7).

*$p < .05$.

Post Hoc Analysis

As part of the pre-registration of the study, I planned to test whether high or low PTSD status moderated any findings in an exploratory approach should sufficient cell sizes allow such an analysis. Of the 34 repeated measure ANOVAs conducted to examine this issue, only two analyses showed statistical significance. The results showed that when experiencing intrusions with meta-awareness failure, the low-PTS group reported making strong efforts to bring back awareness of intrusions compared to high-PTS group. Meanwhile, when experienced with meta-awareness, these intrusions tended to occur with higher levels of

vividness in the high-PTS group compared to low-PTS group. The results are not reported in the main thesis given the strong possibility such significance could happen by chance (see Appendix C for the significant results).

Discussion

The current study extends previous work by investigating the differences between aware and unaware intrusions in real-life trauma-exposed individuals to better understand the characteristics of intrusions whose frequency is underestimated by those experiencing them (Takarangi et al., 2014; Nixon et al., 2021). Key findings were that different aspects of trauma-related memories tended to occur with different levels of meta-awareness. Modality (imagery components) and greater levels of meaningfulness differentiated meta-aware intrusions from those not spontaneously identified (i.e., those I classified as not meta-aware). However, intrusions were generally easy to recall regardless of meta-awareness levels, with most other characteristics also comparable. Moreover, although less likely to occur, the same intrusion could also be experienced at both levels of meta-awareness. Compared with unaware intrusions, aware intrusions had greater levels of depersonalisation, derealisation, lack of context, and less levels of involuntariness. Generally, when comparing the same intrusions that occurred with and without meta-awareness, I observed effects in the small-to-medium range in the absence of statistical significance, suggesting power issue played a role in these findings (due to analysis only appropriate for the subset of participants who experienced the same intrusion with and without awareness). To my knowledge, the current study is the first to complement questionnaire-based assessment with interviewing to compare the characteristics of intrusions that occurred with difference meta-awareness levels.

Expanding the trauma-related intrusions literature, the study results suggest meaningful and imagery-based intrusions were prone to be self-reported. One explanation for this pattern is that individuals are less hypersensitive to self-report or be meta-aware of less representative

(or less meaningful) content of unaware trauma-related intrusions. That is, intrusions that lack strong saliency or meaningfulness may require a probe or prompt that leads an individual to examine their mental content, at which point the unaware intrusion becomes apparent (see Baird et al., 2013; Schooler & Schreiber, 2004). For example, memory of a trauma scene might appear as an intrusive memory that is a vivid and clear mental image that is salient to meta-awareness. However, an intrusion of the same scene might also occur without meta-awareness and not be self-reported because that particular intrusion was not associated with a visual aspect (e.g., perhaps associated with a 'smell' from the trauma scene or reflected an abstract thought of the consequence of that part of the trauma). Further research of these speculative explanations will help improve our understanding of previous research that suggests that intrusive thoughts are less intensely experienced than intrusive memories (Ehlers et al., 2002; Ehlers & Steil, 1995). Indeed, building on my research, one explanation of why intrusive thoughts might be less intense compared to intrusive memories is that individuals might be less likely to be aware of such intrusions.

Accessibility was not associated with meta-awareness levels, contrary to prediction. The results suggest that people were good at intentionally recalling their intrusions even when those intrusions occurred with meta-awareness failure. One explanation was that my sample is quite familiar with all aspects their intrusions/trauma memories. Although the meta-awareness task captured a few intrusions that had never occurred in participants' daily life, most intrusions participants reported on in the task all were regularly experienced (more than twice a week on average), indicating individuals were highly familiar with their intrusions. Consequently, meta-awareness failure did not impact the intentional recall of intrusions with the assistance of cue word noting. Another explanation could be that having an intrusion that had never occurred before is a profound experience (labelled as "discovered memory"; Schooler, 2001) that aroused emotions, leading an individual to become meta-aware of that

intrusion. Although whether trauma-related memories can be forgotten remains a debate (see Otgaar et al., 2019), it is plausible that meta-awareness facilitates individuals' memories around intrusions. In the current study, it might be that after 'inaccessible' intrusions were probe-caught, thus highlighting to the participant they had had an unaware intrusion, such individuals might find it easier to intentionally recall such memories/thoughts in the future. Although the current study results suggest that meta-awareness failure was not linked with perceived intentional recall ability, it remains possible that some aspects of memories remain inaccessible if they occur without meta-awareness failure in real-life situations (i.e., without probes prompting one to check one's mental content). Future studies could explore the effect of accessibility with clinical samples given much of the experimental research into such phenomenon has been done with clinical samples.

Given that benign or non-trauma spontaneous thoughts have often been the foci in prior meta-awareness research (see Seli et al., 2017; Vannucci et al., 2019), my results extend the applicability of current meta-awareness theory to trauma-related mental content. Research around benign spontaneous thoughts and experiences conceptualises meta-awareness as intermittent. A weak and flash-type experience (e.g., a quick flash of mental imagery, or brief 'noise') tends not to enter meta-awareness until they gain individuals' attention. Moreover, without explicitly checking one's mental content or orienting one's thinking toward the thought itself, meta-awareness failure can also occur even when one's mental content is clear and strong (see Winkielman & Schooler, 2011). However, my results suggest that intrusive memories that were associated with high vividness levels tended to break through into consciousness, resulting in meta-awareness. In addition, aware intrusions were more likely to be characterised by dissociative features (e.g., depersonalisation, lack of context) than unaware ones when comparing the same intrusions that occurred with and without meta-awareness. Thus, for trauma-related content, vivid and clear mental images seem to play a key

role in influencing content coming to one's meta-awareness. In other words, trauma-exposed individuals might not need to deliberately attend their mental content to trigger meta-awareness if intrusive *memories* occur. Although future studies are required to support such speculation, perhaps trauma-related mental images are more intense and distressing, hence, more prone to meta-awareness than benign spontaneous thoughts.

The present study also has clinical implications with regard to the usual self-report method of PTSD intrusion assessment. Intrusions experienced with and without meta-awareness shared more commonalities in their characteristics than not, yet even unaware intrusions were associated with clinical characteristics considered psychologically harmful to individuals (e.g., distress, unwantedness). Such findings suggest the need for clinicians to be aware that meta-awareness failures occur, and not to underestimate the potentially negative impacts of such intrusions. Although requiring empirical study, perhaps future clinical practice should consider improving meta-awareness of unaware intrusions to assist individuals engaging in adaptive coping strategies (e.g., grounding techniques; Paulik et al., 2020) when intrusions occur (see Baird et al., 2013; Konjedi & Maleeh, 2021). Although I did not explicitly recruit individuals diagnosed with PTSD, it has been observed that those with clinical diagnosis of PTSD symptoms have higher meta-awareness compared with those who were not clinically diagnosed into PTSD (Nixon et al., 2021). Further investigation is required to understand whether there is a role of meta-awareness (or its failure) on the treatment of PTSD, especially given psychological interventions that require some degree of insight into one's experience of intrusive symptoms. If better meta-awareness has a positive influence on therapeutic outcomes, we will also need to understand how to improve meta-awareness in high PTS individuals to increase their accuracy in self-reported intrusion frequency, especially for intrusive thoughts as they are more prone to meta-awareness failure.

The current study had limitations. First, the intrusion characteristics were accessed after completion of the meta-awareness task. It is difficult to determine whether the characteristics I captured reflected the feelings at the moment individuals had the intrusion or the moment after they became meta-aware of the thought (i.e., after processing and interpreting the intrusions) (Keeping et al., 2022). For example, perhaps participants had less distress when an intrusion occurred without meta-awareness but felt distressed after being probe-caught having an unaware intrusion. There is a possibility that people artificially amplified intrusion characteristics in the interview (e.g., intrusions became more vivid during the interview since individuals started recalling them). Nevertheless, my methodology was the most used and well-known way to capture meta-awareness failure (probe-caught method; see Weinstein, 2018) and there are disadvantages of interrupting meta-awareness tasks to assess details of the intrusion just experienced. Second, as the first study investigating unaware intrusions with a semi-structured interview, there were no gold-standard guidelines to index the key features of interest. For example, instead of assessing the difficulty to intentional recall right after the meta-awareness task, I speculate that the effect of accessibility might be stronger if participants are re-interviewed after a longer period of time (e.g., 24 hours) (see Strange & Takarangi, 2012). Thirdly, although it is recognised that the processes and effects of trauma occur on a continuum (Boals et al., 2020), my use of a non-clinical/non-PTSD sample means the generalisability of the findings need to interpret cautiously. Finally, although the results of the post hoc analyse shed some light on the interaction between PTSD severity and meta-awareness, future research with larger samples is required to both replicate the observed findings as well as to avoid potential Type 1 errors.

In summary, my findings found that modality and meaningfulness are associated with meta-awareness of intrusions. Although meta-awareness failure might lead to underestimation of the actual intrusion frequency, meta-awareness failure might not be more harmful than

meta-awareness for individuals. This new area of research still requires further investigation and will lead to an increased understanding of the role of meta-awareness in PTSD and recovery from this disorder.

CHAPTER 4 – STUDY 3: DO ALEXITHYMIA AND MALADAPTIVE COGNITIVE PROCESSES INFLUENCE AWARENESS OF TRAUMA MEMORIES?

Chapter Abstract

Research on being overtly aware of trauma-related thoughts and memories (i.e., meta-awareness) has shown that trauma-exposed individuals can lack awareness of such mental content. Nevertheless, we do not fully understand the factors underlying this phenomenon. This chapter examines the potential role of alexithymia, thought suppression, and rumination on meta-awareness in those who had experienced a range of negative events, including experiences capable of causing posttraumatic stress disorder (PTSD). Participants (N = 161) completed questionnaires and a meta-awareness task online. The task appeared as a reading task, during which participants received intermittent probes checking if they were thinking about their negative event and level of awareness of their mental content. The results revealed that trauma-specific rumination moderated the relationship between meta-awareness and PTSD symptom severity. Specifically, at higher levels of PTSD symptoms, individuals who tended to ruminate about their traumatic event were more aware of their intrusions. Alexithymia and trait rumination were not observed to moderate PTSD severity and meta-awareness, whereas trauma-specific rumination did moderate this relationship. Meta-awareness was not influenced by negative experience type. I suggest that ruminating over traumatic event is likely to make individuals hypersensitive to intrusions, hence, increase meta-awareness of intrusions.

Introduction

As reviewed in earlier chapters, despite observations that individuals may underestimate the actual frequency of their intrusions, we know very little about the factors

that underlie the PTSD–meta-awareness failure relationship. This study examined the potential role of alexithymia as well as maladaptive cognitive processes on meta-awareness in those who had experienced a range of negative events, including experiences capable of causing PTSD (i.e., criterion A trauma; American Psychiatric Association, 2022).

One factor that may be relevant to this phenomenon in PTSD is alexithymia. Alexithymia refers to a personality construct that involves deficits in recognizing, experiencing, and processing emotion (Lambie & Marcel, 2002; Sopp et al., 2019). Alexithymia is highly associated with PTSD, with a large meta-analysis (12 studies, N = 1,555) demonstrating large effects (Cohen's d) ranging between 0.8-1.2 (Frewen et al., 2008). It has been theorised that the strong correlation between alexithymia and PTSD might be a result of PTSD impeding sufferers' emotional-processing capacity (Zlotnick et al., 2001). According to the cognitive model of PTSD (Ehlers & Clark, 2000), another reason that might explain the high correlation could be that individuals with PTSD tend to engage in emotional numbing as a problematic coping strategy to regulate PTSD symptoms (e.g., unwanted intrusions). Due to difficulties in identifying and expressing emotion, it is possible that those high in alexithymia might also have difficulties in detecting thoughts, memories, or even abstract feelings that are normally associated with high affect (e.g., trauma-related thoughts or memories), hence fail to self-report or not be overtly aware of the occurrence of intrusions.

Currently there is very little empirical literature to support this proposition directly, but some researchers have observed relationships between alexithymia and meta-awareness of intrusive experiences. For example, in an analogue trauma film study, those in the high-alexithymia group experienced more film-related intrusions on the first day of monitoring intrusions over a 4-day period relative to those in the low-alexithymia group (Sopp et al., 2019). Similarly, in a sample of North Korean refugees, alexithymia was significantly correlated with intrusions, and alexithymia moderated the relationship between the number of

traumatic events and PTSD symptoms (Park et al., 2015). Although these studies demonstrate relations between alexithymia and typical, self-reported intrusions, they have not studied intrusions for which individuals were not overtly aware.

There is slightly more research regarding maladaptive cognitive processes that might relate to meta-awareness failure compared with the alexithymia work reviewed earlier. Both cognitive models of PTSD (e.g., Ehlers & Clark, 2000) and empirical reviews of intrusive memory to negative events (e.g., Marks et al., 2018) underscore how cognitive processes such as thought suppression and rumination maintain PTSD symptoms, including intrusions. Thought suppression is a common coping strategy for individual with PTSD to avoid negative emotion and/or unwanted intrusions (Magee et al., 2012). Nevertheless, thought suppression can produce the rebound effect, in that active thought suppression often leads to suppressed thoughts to come back to mind (see Ironic Process Theory, Wegner, 1994; Wenzlaff & Wegner, 2000). A positive relationship between thought suppression and frequency of intrusions has been established, with a number of studies demonstrating the rebound effect in PTSD samples (e.g., Shipherd & Beck, 1999; Beck et al., 2006; Vázquez et al., 2008). Although initially it may seem contradictory, it is possible that thought suppression increases the likelihood of meta-awareness failure, as discussed next.

Although the current literature has not examined the effect of thought suppression on meta-awareness failure of real-life intrusions, some findings indirectly support the role of thought suppression in PTSD–meta-awareness failure relationship. Baird and colleagues (2013) investigated thought suppression effects on meta-awareness by instructing participants to recall a prior romantic relationship and then suppress thoughts of the relationship throughout the experiment, including while undertaking a meta-awareness task. The results demonstrated that high suppressors had significantly more meta-awareness failure compared with low suppressors. In another study which recruited participants based on their beliefs

about the importance of controlling intrusions, Takarangi et al. (2017) showed participants a trauma film to induce trauma-like intrusions and complete a meta-awareness task. They found that people with stronger beliefs engaged in thought suppression more than those with weaker beliefs. Moreover, the stronger beliefs group experienced significantly more film-related intrusions both with and without meta-awareness compared to the weaker beliefs group. In line with Wegner's theory of thought suppression (Wegner, 1994; Wegner & Zanakos, 1994) and these two studies, I speculated that the cognitive processes proposed to monitor and then suppress to-be-suppressed material might similarly increase the mental content in one's mind that is nonetheless not immediately obvious to the individual (until probed). The final cognitive processing style that I suggest is relevant for consideration in the PTSD–meta-awareness failure relationship, rumination, is discussed next.

Rumination is a past-oriented thinking style commonly observed in both depression and PTSD, which is not unsurprising given approximately 50% of those with PTSD also have depression (Angelakis & Nixon, 2015; Marchetti et al., 2016). Rumination impairs one's adaptive cognitive processing by narrowing down the range of types of thinking available to the individual. For example, this can lead a person to only ask abstract, self-focused questions, such as 'why did this occur to me', rather than thinking more broadly about the problem, which could result in more concrete solutions to a particular issue (Ehring & Watkins, 2008; Joormann et al., 2006). Experiencing unexpected intrusions and failed avoidance attempts (e.g., thought suppression) are suggested to be major causes of triggering individuals with PTSD to ruminate about their intrusive thoughts (Kubota et al., 2015). Consequently, rumination has the potential to worsen one's mood and maintain PTSD symptoms (Kubota et al., 2015). As negative mood could increase mind-wandering and trauma-like intrusions (Marchetti et al., 2016; Takarangi et al., 2017), it is likely that

rumination enhances the PTSD–meta-awareness failure relationship by increasing intrusions and mind-wandering, leading to additional opportunities for meta-awareness failure.

Partly supporting this argument are the findings of Nayda and Takarangi (2021). They used the Sustained Attention to Response Task (SART; see Deng et al., 2014) to index meta-awareness of mind-wandering, after which participants were asked to describe their worst life event, and rated how much they were bothered by trauma intrusions. They found that brooding, a specific thinking style in rumination, was significantly and positively correlated with meta-awareness failure. However, they did not observe a significant relationship between trauma intrusions and aware or unaware mind-wandering. It is worth noting that the sample was drawn from the general population who may not have been through a negative event that was emotionally bothering them at the time they participated in the experiment. The meta-awareness task in the study also did not differentiate mind-wandering from the experience of a trauma-related intrusion without awareness, as the probe simply asked, "Was your attention focused on the task just now?". Despite these caveats, the findings of Nayda and colleagues suggest that rumination could potentially influence meta-awareness.

A final area of interest was whether meta-awareness failure can occur for any type of negative events, even those experiences not considered sufficient to cause PTSD (i.e., non-criterion A type events that are required by the DSM-5 diagnostic system). This interest was driven by the fact that such events can induce PTS symptoms too (Hyland et al., 2021) and to date, meta-awareness failure has been restricted to the study of those following trauma-analogues (i.e., trauma films, Green et al., 2016; Takarangi et al., 2014; 2017) or criterion A trauma-exposed individuals (Nixon et al., 2021).

In summary, I examined in the current study the moderating effect of alexithymia, thought suppression, and rumination on the PTSD–meta-awareness failure relationship. Specifically, I hypothesised that the positive relationship between PTSD severity and meta-

awareness failures would be most pronounced at higher levels of trait alexithymia, thought suppression, and rumination. Additionally, it was hypothesised that those who had experienced stressful non-criterion A trauma would also have intrusions with meta-awareness failure.

Method

The study was pre-registered on the Open Science Framework (https://osf.io/6xz7g) and ethical approval was granted by the Flinders University's Social and Behavioural Research Ethics Committee.

The measures and task were identical as Study 1 unless otherwise specified.

Participants

Participants were recruited from Amazon Mechanical Turk (MTurk), a crowd-sourcing platform based in North America. MTurk has been shown as a reliable resource for research (Casler et al., 2013), and with samples demonstrating similar prevalence of mental disorder to the general population (Shapiro et al., 2013). To ensure I screened out "bots" (Stokel-Walker, 2018), participants were required to pass a captcha and an English proficiency test. I also excluded participants who failed all three attention checks to minimise work inattention (Mellis & Bickel, 2020).

Of the 1,049 participants[5] who initiated the study, 888 were excluded (n = 399: were not bothered by any negative event or did not wish to participate the full survey; n = 201: withdrew from the survey; n = 145: noncompliant with task instructions; n = 11: failed 3 attention check questions; n = 132: did not experience any intrusions). The final sample

[5] Participants received 50 cents for initial screening and could choose to receive a bonus, which was based on a rate of 10 cent USD per minute, if they were emotionally bothered by a negative event at the time when they completed the survey. On average, participants received $4.5 USD as reimbursement for participation.

comprised 161 participants[6], were aged between 18 to 80 (*M* = 35.11, *SD* = 10.67), and had undertaken 16.79 (*SD* = 3.59) years of education on average. More than half of the sample identified as female (52.8%) and White in ethnicity (53.7%).

Measures and Task

Online Meta-awareness Task (adopted from Baird et al., 2013; Takarangi et al., 2014). In addition to the original instructions that were specified in Study 1, when participants indicated they were having an intrusion, they also selected an option that best corresponded to their intrusion experience. These options reflect categorical indices of meta-awareness (either meta-awareness or meta-awareness failure) as well as whether intrusion would be classified as a 'flashback'. The options were as follows*: 1. Yes, I was fully aware of my trauma-related memory/thought. It felt like a flashback (i.e., to some degree I had a sense of reliving it again or I was 'back' there). 2. Yes, I was fully aware of my trauma-related memory/thought. It was a memory/thought but I didn't have a sense or feeling of reliving the event again. 3. No, I was NOT aware of my trauma-related memory/thought. It felt like a flashback (i.e., to some degree I had a sense of reliving it again or I was 'back' there). 4. No, I was NOT aware of my trauma-related memory/thought. Although it was a memory/thought, I didn't have a sense or feeling of reliving the event again.* A second difference to Study 1 methodology was that, after their response, they rated their awareness levels of the intrusion on a scale of 1 (= not aware of my trauma-related thought at all) to 6 (= fully aware of my trauma-related thought), which served as a continuous measure for meta-awareness. The meta-awareness task finished once this question had been answered. As a reminder, the modified version of meta-awareness task

[6] An a priori power calculation was used to determine the sample size for a linear multiple regression by using G*power (Faul et al., 2014). The calculation was set to detect medium-sized effect (f^2= .15) with alpha level = .05, and power at .95. The analysis reported that a minimum number of 89 participants was needed to detect the desired probability of significant moderation relationship between PTSD – meta-awareness failure among all participants.

could only capture the first intrusion of each participant.

Symptom measures. The Posttraumatic Stress Disorder Checklist (PCL-5; Weathers et al., 2013) and the Life Events Checklist (LEC) were used to index the severity of PTSD symptoms and participants' traumatic event types that had been experienced in a person's lifetime. As the LEC asked participants to describe their worst events, this allowed coding of whether the event would be considered a Criterion A type trauma. The Depression subscale from the Depression Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995) was used to index the severity of depressive symptoms.

Trait and state rumination (see Appendix B8–9). The Repetitive Thinking Questionnaire (RTQ; McEvoy et al., 2010) and its state version (RTQ-S) were used as measures of trait rumination and trauma-specific rumination, respectively. Following McEvoy et al., the RTQ that was used to measure trait rumination was preceded by 10-item Positive and Negative Affect Scale – Negative affect subscale (PANAS-N; Watson et al., 1988) which captures the severity of 10 negative emotions occurred to participants at the time when they felt especially upset. Each RTQ comprises 31 statements with two sub-scales, absence of repetitive thinking (e.g., "T*here was nothing more I could do about the situation, so I didn't think about it anymore*") and repetitive negative thinking (e.g., "*You had thoughts or images about the situation that occurred over and over again, that resulted in your feelings getting worse and worse*"). Participants responded how true a statement was in relation to their thinking style on a 5-point-scale (1 = not at all; 5 = very true). The internal consistency for RTQ and RTQS are both $\alpha = .93$.

Thought suppression. The White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994) was used to index thought suppression. Participants responded accordingly on how they coped with their thoughts since the negative event occurred based on a 5-ponit-scale (1 = strongly disagree; 5 = strongly agree). The outcome score ranges from 15 to 75 with

higher score indicating higher tendency to engage thought suppression. The internal consistency for WBSI is α = .91.

Alexithymia (see Appendix B10). The Toronto Alexithymia Scale (TAS-20; Bagby et al., 1994) was used to measure trait alexithymia**.** The scale is a 20-item instrument and the response for each question ranges from 1 (= strongly disagree) to 5 (= strongly agree). Difficulty describing feelings (DDF; e.g., *"It is difficult for me to find the right words for my feelings*"), difficulty identifying feeling (DIF; e.g., *"I am often confused about what emotion I am feeling"*), and externally-oriented thinking (EOT; e.g., *"I prefer to analyse problems rather than just describe them"*) are the three subscale comprises TAS-20. The total score of TAS-20 ranges from 20 to 100. Scoring 52 to 61 is recognized as subthreshold for alexithymia, scoring above 61 is considered as clinical levels for alexithymia. The internal consistency for TAS is α = .87.

Procedure

After informed consented, participants completed online a demographic questionnaire (e.g., age, gender etc.) and trauma history check (LEC) in the first phase of the study. The survey ended if participants were not emotionally bothered by a stressful event, or they chose not to progress further.

If participants were emotionally bothered by a stressful event and willing to complete the full survey to receive a bonus payment, they then completed the PCL, RTQ-S, and WBSI. As these questionnaires were to be answered indexed to the negative event described in the LEC measure, their order was not randomised. The remaining questionnaires were given in a randomised order (TAS-20, RTQ, DASS). After questionnaire completion, participants completed the meta-awareness task. The study finished after the reading task (meta-awareness task) if participants did not experience any intrusions. If a probe captured an intrusion,

participants answered an additional question regarding their awareness level and the modality of the intrusion. All participants were thanked and debriefed after completion of the study.

Results

Of the total sample, 32 participants indicated they had unaware intrusions on the categorical measure (i.e., pressed Option 3 or 4 on the task). On average, when reporting their levels of awareness on the continuous scale (responses could range from 1 to 6), participants appeared to be generally aware of their intrusion. As expected, most of the key variables under study were correlated with one another but not at levels that suggested multicollinearity was an issue (see Table 11). To address the specific research questions under study, a series of multiple linear regression analyses were conducted to examine potential moderators between PTSD–meta-awareness failure relationships. Furthermore, Fisher's exact tests (FET) and t-tests were also employed to explore the influence of non-criterion A trauma on variables of interest.

Multiple linear regression analyses were performed by using model 1 in PROCESS (Hayes, 2018) to test the moderation effect of alexithymia, thought suppression, and rumination (trait rumination and state rumination). All variables were centred for interpretation purposes. Alexithymia, thought suppression, trait rumination, and state rumination were individually entered as moderators in PROCESS. Table 12 summarised the regression findings for each proposed moderator. Contrary to prediction, alexithymia and trait rumination were not moderators in the PTSD–meta-awareness failure relationship. In addition, although state rumination was a significant moderator (and thought suppression showed a nonsignificant trend), these interactions were in the opposite to that expected.

To illustrate the unexpected nature of the PTSD–state rumination interaction, Figure 3 was plotted at different levels of state rumination. The findings indicated that those being low

in state rumination appeared to experience a lower level of meta-awareness as PTSD symptoms increased. Moreover, those reporting high levels of state rumination appeared to experience a higher level of meta-awareness as PTSD symptoms increased.

Table 11

Means, Standard Deviations, Correlations (95% Bootstrap CIs) Between Key Variables

Variable	Mean (SD)	Meta-awareness	PCL	Depression	Alexithymia	Thought suppression	Trait rumination	State rumination
Meta-awareness	4.45 (1.33)	-						
PCL	36.96 (15.46)	.10 [-0.8, 0.26]	-					
Depression	10.90 (6.39)	.00 [-1.7, 1.7]	.63** [.53, .73]	-				
Alexithymia	57.26 (15.01)	-.02 [-.19, .14]	.46** [.33, .57]	.60** [.48, .71]	-			
Thought suppression	59.39 (10.50)	.03 [-.15, .22]	.56** [.44, .65]	.53** [.42, .64]	.44** [.29, .57]	-		
Trait rumination	92.08 (24.41)	.09 [-.09, .25]	.46** [.31, .58]	.53** [.41, .63]	.36** [.18, .52]	.53** [.38, .67]	-	
State rumination	84.32 (21.31)	.09 [-.10, .25]	.70** [.62, .78]	.61** [.49, .71]	.43** [.29, .57]	.69** [.60, .77]	.61** [.47, .73]	-

Note. PCL = PTSD Checklist. **$p < .01$.

Table 12

Summary of Regression Predicting Meta-Awareness Failures of Intrusions from PTSD Severity levels, Alexithymia, Thought Suppression, and Rumination

Predictors	*b*	SE_b	*p*	95% CI
Moderation Effect of Alexithymia in PTSD–Meta-awareness Failure Model				
Constant	4.4115	.1153	<.0001	[4.1839, 4.6392]
PTSD	.0120	.0077	.1223	[-.0033, .0272]
Alexithymia	-.0067	.0079	.3973	[-.0224, .0089]
PTSD*Alexithymia	.0005	.0005	.2808	[-.0004, .0015]
Total R^2 = .02, F(3, 156) = 1.12, p = .341				
Moderation Effect of Thought Suppression in PTSD–Meta-awareness Failure Model				
Constant	4.3643	.1169	<.0001	[4.1333, 4.5953]
PTSD	.0079	.0083	.3417	[-.0085, .0243]
Thought Suppression	.0058	.0130	.6559	[-.0199, .0316]
PTSD*Thought Suppression	.0010	.0006	.0946	[-.0002, .0023]
Total R^2 = .03, F(3, 157) = 1.75, p = .158				
Moderation Effect of Trait Rumination in PTSD–Meta-awareness Failure Model				
Constant	4.3981	.1189	<.0001	[4.1630, 4.6331]
PTSD	-.0086	.0077	.2666	[-.0067, .0240]
Trait Rumination	-.0027	.0050	.5862	[-.0072, .0127]
PTSD*Trait Rumination	.0002	.0003	.4098	[-.0003, .0008]
Total R^2 = .02, F(3, 151) = 1.04, p = .379				
Moderation Effect of State Rumination in PTSD–Meta-awareness Failure Model				
Constant	4.2859	.1314	<.0001	[4.0263, 4.5455]
PTSD	.0022	.0100	.8304	[-.0177, .0220]
State Rumination	.0044	.0072	.5445	[-.0098, .0186]
PTSD*State Rumination	.0007	.0003	.0449	[.0000, .0013]
Total R^2 = .04, F(3, 150) = 1.95, p = .124				

Note. Unstandardised coefficients reported.

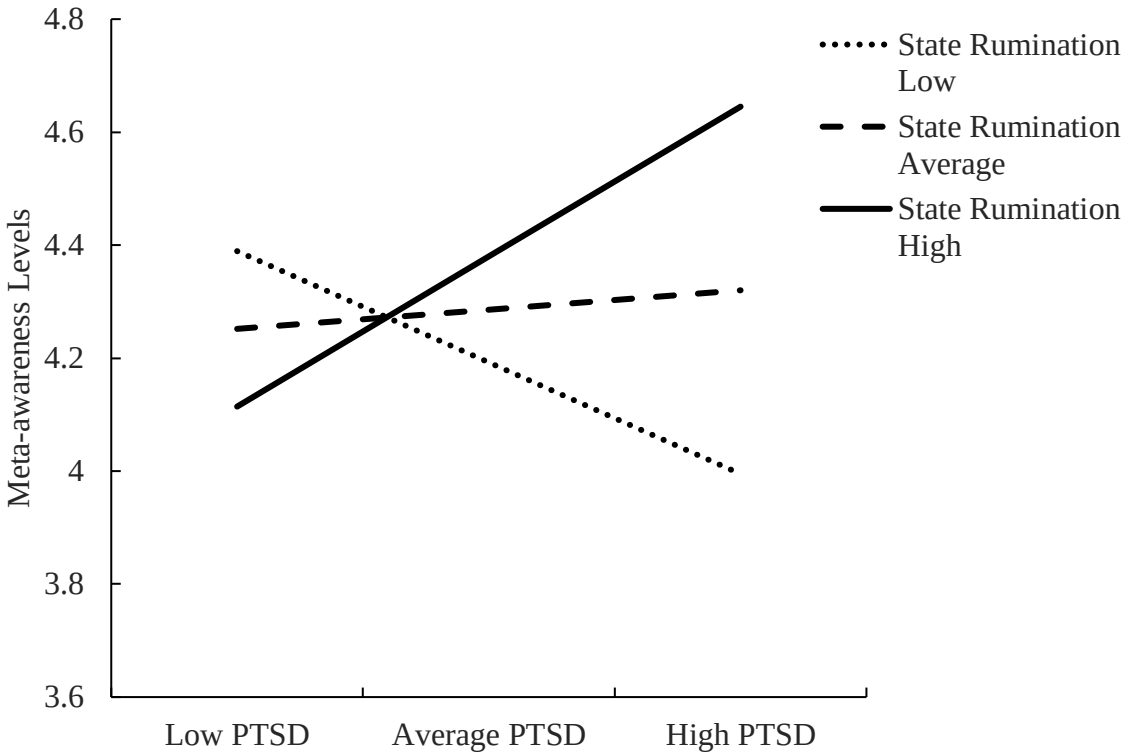

Figure 3. The moderating effect of state rumination on the relationship between meta-awareness failure level and PTSD symptom severity. Meta-awareness scores ranged from 1 (not aware of the trauma-related thought at all) to 6 (fully aware of the trauma-related thought); PTSD severity is plotted at levels representing low (1 *SD* below the *M*), average (*M*), and high (1 *SD* above the *M*) scores.

I also examined whether individuals with non-criterion A trauma would experience intrusions with meta-awareness failure. After excluding five participants who declined to disclose their worst experience, 23% of events identified as the participant's worst event constituted non-criteria A experiences (e.g., financial distress, romantic relationship breakup). When analysing meta-awareness as a continuous variable, the results showed no significant difference of meta-awareness level between those who reported a criterion A (M= 4.36, SD= 1.40) versus non-criterion A event (M= 4.70, SD= 1.08), $t(64.147)= 1.50$, $p= .138$. I also did not find a substantial difference between the groups when meta-awareness level was dichotomised ($p = .586$, two-tailed, effect size [Φ] = .06, Fisher's Exact test, FET), with 15.2% of the non-criterion A group reporting meta-awareness failure relative to 21.1% of those who had experienced a criterion A event.

I then examined potential differences between non-criterion A (n = 33) and criterion A trauma

(*n* = 123) exposed individuals on symptom levels (see Table 13). Interestingly, the average PTSD symptom score of both groups was higher than a commonly used clinical cut-off for PTSD (≥ 31-33), and both groups had a tendency for high levels of thought suppression and rumination. Moreover, the non-criterion A group scored significantly higher in depression and alexithymia than the criterion A group. After excluding 20 participants who declined to disclose their negative events and/or did not provide units (e.g., months) of how long ago the event happened to them, I analysed time since trauma to understand whether time since trauma explained differences on depressive symptoms (i.e., higher depressive symptoms as a function of chronicity). However, time since trauma (in years) for the criterion A group (*n* = 111, *M* = 9.99, *SD*= 9.55) was not significantly different from the non-criterion A group (*n* = 30, *M* = 7.20, *SD*= 7.95).

Table 13

Mean (and Standard Deviations) of Symptom Scores, Inferential Statistics, Cohen's d, and 95% Confidence Intervals for the Non-criterion A and Criterion A Groups

	Groups				
Variables	Non-criterion A *M* (*SD*)	Criterion A *M* (*SD*)	*t*(df)	Cohen's *d*	95% CI
PTSD	42.06 (14.37)	35.60 (15.57)	1.82 (154)	0.43	[-0.48, 11.40]
Thought Suppression	61.76 (8.59)	58.88 (11.03)	1.39 (154)	0.29	[-1.21, 6.97]
Trait Rumination	94.39 (19.96)	91.42 (25.88)	0.61 (149)	0.13	[-6.64, 12.60]
State Rumination	84.19 (22.39)	84.30 (21.40)	-0.03 (148)	0.01	[-8.62, 8.40]
Alexithymia	61.70 (14.97)	55.85 (14.92)	2.00 (153)*	0.39	[0.57, 11.63]
Depression	12.88 (6.82)	10.30 (6.21)	2.08 (154)*	0.40	[0.12, 5.03]

* $p < .05$.

The direct effects from the moderation analyses demonstrated there were few significant relationships between my variables of interest (e.g., thought suppression, alexithymia) and meta-awareness levels. However, I reported descriptive values and inferential statistics between those who reported being aware of their trauma intrusion when probed and those who were not (see Table 14) so that this information can be used to guide further research (e.g., providing necessary information for future meta-analytic investigations).

Table 14

Mean (and Standard Deviations) of Symptom Scores, Inferential Statistics, Cohen's d, and 95% Confidence Intervals for the Aware and Unaware Groups

	Groups				
Variables	Aware (n = 129) M (SD)	Unaware (n = 32) M (SD)	t(df)	Cohen's d	95% CIs
PTSD	36.14 (15.54)	40.28 (14.89)	1.36 (159)	0.43	[-1.87, 10.15]
Thought Suppression	58.43 (10.81)	63.31 (8.15)	2.39 (159)**	0.29	[0.85, 8.92]
Trait Rumination	90.61 (24.17)	97.97 (24.88)	1.51 (153)	0.13	[-2.29, 17.00]
State Rumination	82.08 (20.28)	92.84 (23.25)	2.59 (152)**	0.01	[2.55, 18.97]
Alexithymia	56.81 (14.99)	59.06 (15.23)	0.76 (158)	0.39	[-3.62, 8.28]
Depression	10.44 (6.27)	12.75 (6.65)	1.84 (159)	0.40	[-0.17, 4.78]

**$p < .01$.

Discussion

The current study explored factors proposed to influence the PTSD–meta-awareness failure relationship by recruiting those who had experienced real-life negative events, including experiences capable of causing PTSD. Improving on prior research which simply investigated the frequency of meta-awareness failure (e.g., Nixon et al., 2021), the current study examined self-reported meta-awareness levels to understand potential factors contributing to the PTSD–meta-awareness failure relationship. I hypothesised alexithymia and maladaptive cognitive processes would be related to the severity of PTSD, thus, increasing the opportunity for meta-awareness failure. Trauma-specific rumination was the only moderator in the PTSD–meta-awareness failure relationship. The results suggested that as PTSD severity increases, those who engage in higher levels of rumination specific to their traumatic event tend to be 'better' at being aware of intrusions. Non-trauma-specific rumination and alexithymia, however, were not significant moderators, and thought suppression demonstrated a small effect that did not reach statistical significance. I observed that those exposed to non-criterion A trauma also experienced meta-awareness failure at relatively similar rates to criterion A trauma-exposed individuals. I now discuss the theoretical and clinical implications of these findings.

As part of the moderation hypotheses, I expected that as PTSD severity increased, and presumably also intrusion levels, I would see more meta-awareness failure. I did not see this as a direct effect and, in the opposite direction to my prediction, individuals with higher PTSD symptoms who ruminated about their traumatic event tended to be *more* aware of their intrusions. I speculate that the results relate to the saliency and distress of trauma-specific rumination. Trauma-specific rumination is associated with intense emotions and hopelessness (Ehlers & Clark, 2000). Consequently, trauma-specific ruminators might become more aware

of intrusions as PTSD symptoms worsen. Moreover, trauma-specific rumination often triggers further intrusions (Birrer & Michael, 2011; Michael et al., 2007; Speckens et al., 2007). It is plausible that the rumination 'mentally prepares' individuals to be meta-aware of intrusions as trauma-related content has been repeatedly rehearsed through ruminative thinking. However, *trait* rumination did not influence the PTSD–meta-awareness failure relationship in the same fashion as trauma-specific rumination. One explanation is that trauma-specific rumination may be associated with more distress than more general, trait rumination, because it triggers higher levels of threat, making these ruminative concerns more salient and leading to intrusions becoming prone to awareness as they enter consciousness. Researchers have recently hypothesised that trauma-related rumination in PTSD could be an automatic response to trauma and PTSD symptoms (Moulds et al., 2020). Although such assumption requires investigation, perhaps trait rumination is not as harmful as trauma-specific rumination, especially in regard to eliciting intrusions.

To my knowledge, the present study was the first research to examine the role of alexithymia in the PTSD–meta-awareness relationship, finding that alexithymia did not moderate this as expected. I had proposed such a relationship due to the characteristics of alexithymia, for example, difficulties with noticing and recognising emotion changes that potentially co-occur with intrusions. However, I found that there was no significant difference between the aware and unaware groups in reported alexithymia. Despite alexithymia reflecting difficulties attending to and appraising emotions (Preece et al., 2017), most intrusions occur as mental images followed by emotion changes, rather than just pure emotion (Ehlers & Steil, 1995; Marks et al., 2018), possibly explaining the small and inconsequential effect of alexithymia on meta-awareness of intrusions. The results suggest that, although previous studies show a positive relationship between alexithymia and self-reported intrusions frequency (see Park et al., 2015; Sopp et al., 2019), alexithymia may not

distinguish (or be relevant) to whether intrusions are experienced with or without meta-awareness. The nature of my study design (cross-sectional) and assumption of alexithymia playing a moderating role means that an alternative pathway, namely that alexithymia might be a driver (mediator) in the PTSD–meta-awareness relationship, remains to be tested.

Although the moderation results for thought suppression were nonsignificant, the pattern of findings was in the same (unexpected) direction as those for the significant trauma-specific rumination findings. While needing to exercise caution in over-interpreting this null finding, this moderation pattern replicates that observed in an unpublished study (Sun, 2018[7]). That study recruited only criterion A trauma-exposed individuals, captured multiple intrusions with a meta-awareness task (modified from Takarangi et al., 2014), and measured avoidance (including thought suppression) with the relevant subscale from self-report PTSD measure (the PCL-5). Together with the current results, it is possible that the findings indicate that meta-awareness might *increase* in certain circumstances as individuals become hypersensitive to intrusions despite efforts to cognitively avoid trauma-related memories and thoughts. Consistent with this proposal, previous thought suppression studies demonstrate that individuals became hyper-alert to forbidden thoughts (Wegner et al., 1987; Wegner et al., 1990). With thought suppression maintaining PTSD severity (Ehlers & Clark, 2000) and having its own rebound effect (Wegner, 1994), intrusions might become more distressing and salient, resulting in greater meta-awareness.

My final goal was to understand meta-awareness for varying types of negative event memories. The intrusions for criterion A and non-criterion A events showed similar levels of meta-awareness. My findings show that meta-awareness failure occurs to everyday negative events that emotionally bother individuals, not just trauma-analogues (Green et al., 2016; Takarangi et al., 2014; 2017) and criterion A trauma/PTSD inducing experiences (Nixon et

[7] The unpublished thesis is available on request.

al., 2021). Despite the non-criterion A group reporting higher levels of alexithymia and depression, these differences did not influence meta-awareness of intrusions. This clinically relevant finding adds to the work of others (e.g., Hyland et al., 2020) which illustrates with a range of events can result in high PTS-like symptoms, as well be associated with thought suppression and rumination in the same fashion as those who experienced criterion A events.

The current study has some limitations and caveats. First, unlike previous meta-awareness studies (Takarangi et al., 2014; Nixon et al., 2021), my meta-awareness index relied on single intrusion. Although I improved the sensitivity of meta-awareness assessment by measuring it on a continuum, I acknowledge that different intrusion experiences may occur with different levels of meta-awareness and such measurement might index how confident people are in their meta-awareness levels instead of measuring the meta-awareness itself (see Kane et al., 2021). Second, my results are based on the first intrusion a participant experienced. This of course prevented the frequency of meta-awareness failure to be assessed (as in prior research). Although it could be questioned whether this initial intrusion experience was representative of a participant's usual type of intrusion, in a similar study design, participants reported that intrusions obtained this way were quite representative of typical intrusions they experienced outside of the laboratory context (see Chapter 2, Study 1 results). Third, although I found primary evidence that meta-awareness was higher at higher levels of thought suppression and trauma-specific rumination, further experimental research is needed to test both the potential causal nature of this relationship and thus clinical implications (e.g., is reducing or increasing meta-awareness a harmful or helpful factor in PTSD). Finally, although I recruited participants with a range of negative experiences, my sample comprised primarily of those with criterion A type trauma. Capturing only one intrusion and having a disproportionate trauma group size may potentially have impeded the ability to detect the influence of my variables of interest on meta-awareness performance.

Although my sample makeup is not unexpected (many individuals are likely to be more emotionally bothered by criterion A type traumas than non-criterion A type traumas), future studies that recruit more of the latter group are likely to be in a position to more comprehensively investigate nuanced differences between these groups.

In summary, the present study adds to our understanding of meta-awareness in the context of trauma, finding a possible role of trauma-specific rumination. My observation of meta-awareness failure in both potentially PTSD-inducing events as well as non-criteria A events illustrates that relying on overt reporting of intrusions may underestimate the actual frequency of intrusions (Takarangi et al., 2014; Nixon et al., 2021). I made recommendations for future avenues of research that I hope will shed further light on what appears less than straightforward relationships between variables highly associated with PTSD, namely alexithymia, rumination, and suppression.

CHAPTER 5 – STUDY 4: THE EFFECT OF THOUGHT SUPPRESSION ON THE META-AWARENESS OF TRAUMA-RELATED INTRUSIONS

Chapter Abstract

This chapter focusses on altering meta-awareness by using an experimental design to investigate the causal relationship between thought suppression and meta-awareness. Further, it provided an opportunity to replicate the moderation results observed in Chapter 4. The role of mindfulness was also examined as a potential moderator between the proposed causal relationship. Thus, 33 participants who indicated they were emotionally bothered by negative events were recruited (63.6% female, M_{age} = 27.3). Participants completed questionnaires and a pre-intervention meta-awareness task. Participants then were randomly allocated into a thought suppression group or a control group, with a five-minute manipulation used to induce suppression in the intervention condition. The experiment ended after a completion of the post-intervention meta-awareness task. Contrary to predictions, there was no interaction between time (pre-intervention meta-awareness, post-intervention meta-awareness) and group (thought suppression, control). Moreover, mindfulness did not moderate between trait thought suppression and meta-awareness. Nevertheless, the results replicated the Chapter 4 finding that thought suppression moderates the PTSD – meta-awareness relationship. Future research could examine more complex relationships such as the potential moderating role of mindfulness in the PTSD, thought suppression, and meta-awareness relationship.

Introduction

As reported in Study 3 (Chapter 4) highlighted the potential causal roles of trauma-specific rumination and thought suppression in the PTSD–meta-awareness failure relationship. The current study employed the meta-awareness task used in Study 2 (Chapter

3), to try and replicate the moderation findings for alexithymia and cognitive processes. Moreover, the current study also investigated whether thought suppression impacted meta-awareness. Thought suppression is often targeted in psychological therapies for PTSD. As reviewed in Chapter 1, people experiencing PTSD typically suppress trauma-related mental content to prevent the distress caused by trauma, trauma-related emotions and symptoms (e.g., intrusions; Ehlers & Clark, 2000). However, thought suppression is harmful as it maintains negative appraisals of trauma and trauma-related memories. For example, suppressing trauma-related emotions prevents individuals from learning their capability to tolerate strong affect, compared to processing the distressing emotions (Foa & Koza, 1986). As thought suppression is a key feature in PTSD, the current study examined the variable to highlight its influence on meta-awareness in PTSD, which has implications for the treatment of PTSD. Furthermore, mindfulness is increasingly being used as a technique help people become more aware of their psychological state including awareness of trauma reactions with a view to improve PTSD symptoms (Boden et al., 2012; Stephenson et al., 2017). Therefore, the role of mindfulness in the thought suppression–meta-awareness relationship was also examined in this study. In the following paragraphs, I discussed relevant literature on thought suppression, mindfulness, and meta-awareness.

Ironic Process Theory remains the dominant model to explain the processes and outcomes of thought suppression (Wegner, 1994). Wegner conceptualised thought suppression as a dual-process system: one being a conscious and effortful process (labelled as the *operating* system), with the other being an unconscious and automatic process (labelled as the *monitoring* system). While the operating process maintains the mental content without the influence of unwanted intrusions, the monitoring process subconsciously stays “vigilant” and detects unwanted intrusions before they enter awareness. When individuals suppress while engaging in cognitively demanding tasks (e.g., a reading task or under dual task demands),

the operating process can be disrupted and compromised by the monitoring process which continues to be on the alert for unwanted thoughts (Wenzlaff & Wegner, 2000). Consequently, those who effortfully suppress unwanted intrusions are at risk of experiencing more intrusive thoughts. Such rebound effect describes where an individual would experience more intrusions after ceasing suppression relative to if they had not initially suppressed. Several reviews over the years have summarised this effect (see Abramowitz et al., 2001; Magee et al., 2012; Purdon, 1999; Wang et al., 2020), with more recent work also replicating the finding in relation to novel target stimuli (for example, thoughts about picturing oneself in the past or future; see del Palacio-Gonzalez & Berntsen, 2019).

Although the evidence is robust for the influence of thought suppression on intrusions frequency, especially that of negative or traumatic content (e.g., Shipherd & Beck, 1999, 2005), the literature only offers limited insight on the potential causal role of thought suppression on meta-awareness. As reviewed in earlier chapters, there is evidence that those who had stronger beliefs about the importance of controlling thoughts and engaging in thought suppression experienced significantly more film-related intrusions, both with and without meta-awareness, compared to those who did not hold these beliefs as strongly (Takarangi et al., 2017). However, without the manipulation of thought suppression, such correlational findings fail to demonstrate possible causation between thought suppression and meta-awareness. More relevant to the current study, Baird and colleagues (2013) investigated thought suppression by instructing participants to suppress thoughts about prior romantic relationships. Although it was observed in the study that 16–20% of the probes caught participants thinking about the suppressed thoughts, the study did not assess meta-awareness levels before and after participants engaged in thought suppression, nor did the study include a control group. Also, neither Baird et al. (2013) nor Takarangi et al. (2017) explicitly recruited a trauma-exposed population. Hence, the present study aimed to determine a

potential causal role of thought suppression on meta-awareness among real-life trauma-exposed individuals. Together with the literature and the moderation pattern observed in Study 3 (Chapter 4), and consistent with Ironic Process Theory, it seemed plausible that individuals might experience more meta-awareness after engaging in thought suppression because individuals might become hypersensitive to unwanted thoughts. In the following section, the role of mindfulness in thought suppression–meta-awareness relationship is discussed.

To date, no study had assessed the role of trait mindfulness in the relationship between thought suppression and meta-awareness of trauma-related intrusions. Mindfulness refers to "paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn, 1994, p. 4). Practicing mindfulness can increase levels of attention and awareness to one's subjective experience, and greater acceptance and tolerance of unwanted thoughts and emotions, resulting in less distress and engagement in maladaptive strategies (Brown & Ryan, 2003; Roemer et al., 2015; Leyland et al., 2019). Relevant to the present study is the finding that in trauma-exposed individuals, mindfulness was significantly associated with lower engagement in thought suppression and PTSD symptoms (Garland & Roberts-Lewis, 2013). In other words, consistent with prior research thought suppression can increase the occurrence of intrusion, however, mindfulness might buffer the effect of thought suppression on intrusions frequency (although this was not experimentally manipulated in Garland and Roberts-Lewis, 2013). As reviewed in Chapter 4, it has been documented in mind-wandering research that mindfulness is negatively correlated with meta-awareness failure and trauma intrusion frequency (Deng et al., 2014; Nadya & Takarangi, 2021). Furthermore, a mind-wandering study comparing a mindfulness intervention, focused-breathing strategy (FBS) to a thought suppression strategy, focused-distraction strategy (FDS), showed that mindfulness was more effective than thought suppression in decreasing

intrusions and mind-wandering (Ju & Lien, 2016). Although not tested explicitly in the study, the authors suggested that mindfulness could increase one's meta-awareness of mental content, thus, making it more likely one would detect and reduce mind-wandering and consequently, intrusions. This may have occurred in Ju and Lien's (2016) study as participants in the FBS group were more able to focus on the content of their mental state. While the harmfulness of meta-awareness in trauma-related intrusions remains unknown; investigating the role of mindfulness in the thought suppression–meta-awareness relationship potentially leads to a better understanding of the mechanisms of adaptive coping strategies for individuals with PTSD. For example, using mindfulness interventions to increase meta-awareness of intrusions may buffer individuals from the distress associated with thought suppression rebound effects.

In summary, the present study aimed to understand the causal relationship between thought suppression and meta-awareness as well as the effect of mindfulness in the proposed relationship. Based on Study 3 results (Chapter 4), due to the rebound effect and the distressing content of trauma-related intrusions, thought suppression could highlight the saliency of intrusions when they break into consciousness. Consequently, I expected the rate of meta-awareness to significantly increase following the manipulation for thought suppression group relative to the control group, which was expected to show negligible change. Moreover, mindfulness was predicted to moderate the proposed interaction between thought suppression and meta-awareness. Specifically, those who had higher levels of mindfulness would be more sensitive to (or aware of) intrusions during thought suppression, thus demonstrating higher levels of meta-awareness following thought suppression than those lower in mindfulness. Consistent with Study 2 (Chapter 3), meta-awareness was indexed by self-reported intrusions frequency while meta-awareness failure was indexed by probe-caught unaware intrusions in the present study.

Method

The study was pre-registered on the Open Science Framework (https://osf.io/kbphe) Flinders University's Social and Behavioural Research Ethics Committee granted ethics approval

The measures and methods were identical to prior chapters unless specified otherwise.

Design

I employed an experimental mixed-subjects design. Participants were randomly allocated into thought suppression or control condition using a 6-block randomisation method generated within Excel. The key variables were pre- and post-intervention meta-awareness of intrusions, and mindfulness.

Participants

A total number of 45 participants were recruited from flyers around Flinders University campus as well as the Posttraumatic Stress Unit Facebook page. Inclusion criteria were that participants had been exposed to a range of negative events, including experiences of criterion A type trauma (APA, 2022), which were still emotionally distressing at the time they participated in the study. All participants were over the age of 18 and were fluent in English. Participants received $20 AUD or course credits as reimbursement for their participation. The final sample comprised 45 people, who were aged between 18 to 63 (M = 27.76, SD = 11.52), and received a mean of 15.24 years of education (SD = 4.44). Most participants identified as female (66.7%) and White (53.3%).

An a priori power calculation was used to determine the sample size for a within-between repeated measures ANOVA by using G*power (Faul et al., 2014). The calculation was set to detect medium-sized effect (d = 0.5) with alpha level = .05, and power at .80. The

analysis reported that a minimum number of 34 participants was needed to detect the desired probability of significant interaction effect of thought suppression. G*Power was also used for an a priori power calculation to determine the sample size for a multiple linear regression to be used for testing predictors/moderators (when analysed as *continuous* variables). The calculation was set to detect medium-sized effect ($f = 0.15$) with alpha level = .05, and power at .80. The analysis reported that a minimum number of 55 participants was needed to detect a significant increase in variance on the dependent variable of interest (i.e., changes of meta-awareness), thus these analyses were underpowered due to the study being halted due to end of the PhD candidature period.

Measures and Tasks

Meta-awareness task (modified from Baird et al., 2013; Takarangi et al., 2014) (see Appendix A). The task instructions were identical to the task in Study 2 (Chapter 3). The task had two versions (A and B), and each consisted of 3 articles and a different set of reading comprehension tests at the end of the task. Task A was the same task used in Study 2. Task B consisted of a new set of articles, although it had slightly less content (two paragraphs) than Task A. The order the task versions was counterbalanced.

Five-minute thought suppression intervention (modified from Broadbent & Nixon, 2007). In the thought suppression condition, participants were instructed to "try really hard not to think about the trauma-related memories/thoughts for 5 minutes". In the control condition, participants were instructed to "let your mind wander for 5 minutes". All participants were then instructed to close their eyes, lift index finger whenever they had trauma-related memories/thoughts came into mind, and put the finger down once they stopped thinking about the memories/thoughts. The intervention phase started once

participants closed their eyes while the frequency of intrusions was recorded during the five minutes.

After the intervention, participants completed a short post-intervention questionnaire (adapted from Oulton et al., 2016) that consisted of three statements and one open-ended question, which asked participants to describe their most frequent intrusions during the five minutes. The statements assessed participants' efforts to suppress the thought, how hard it was to suppress the intrusions, and how distressing the intrusions were. The response option for each statement ranged from 1 (= "not at all") to 7 (= "completely accurate").

Mindfulness (see Appendix B12). The Mindfulness Attention and Awareness Scale (MAAS; Brown & Ryan, 2003) is a 15-item self-report questionnaire indexing the tendency to pay attention to and be sensitively aware of the present moment. Using a 6-point-scale (1 = almost always; 6 = never), participants rated how frequently the described experiences occurred to them. An example question is "*I find it difficult to stay focused on what's happening in the present*". The final score of the measure is the mean of the 15 items, with higher scores indicating more dispositional attention and sensitive awareness. Internal consistency (Cronbach's α) for MAAS was = .90.

Symptom measures. Posttraumatic Stress Disorder Checklist (PCL-5; Weathers et al., 2013) was used to index 20 symptoms severity of PTSD over the past month according to the criteria of DSM-5. The Life Events Checklist (LEC) was also used to assess participants' trauma exposure in their lifetime. Participants also described their worst events in LEC, as this allowed coding of whether the event would be considered a Criterion A type trauma. The Depression subscale from the Depression Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995) was used to index the severity of depressive symptoms for descriptive purposes.

Cognitive process and Alexithymia. The White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994) was used to index the tendency of thought suppression. The State Repetitive Thinking Questionnaire (RTQ-S; McEvoy et al., 2010) was used as a measure of trauma-specific rumination. The Toronto Alexithymia Scale (TAS-20; Bagby et al., 1994) was used to measure trait alexithymia.

Procedure

Eligible participants individually attended a single 60-minute session in the laboratory. After informed consent, participants completed questionnaires that indexed demographic and trauma history details (LEC). The PCL, RTQ-S, and WBSI were completed in a fixed order as these questionnaires were to be answered indexed to the negative event described in the LEC. The remaining questionnaires (TAS, MAAS, DASS) were answered in a randomised order. After task instructions, participants completed the pre-intervention meta-awareness task. Participants then completed the 5-minute intervention (thought suppression, or control) phase. Following the completion of the post-intervention questionnaire, participants were reminded of the meta-awareness task instructions before starting the post-intervention meta-awareness task. All participants were thanked and debriefed after the task.

Results

Table 15 presents the descriptive sample and baseline data for the thought suppression group and the control group. There were no significant differences between the groups in terms of demographics, trauma, symptoms, trait thought suppression, nor mindfulness (*p*s > .05). There was no significant difference in the rate of criterion A trauma between the thought suppression and mind wandering group ($p = .065$). In terms of additional descriptive data, a correlation matrix between baseline and dependent variables of interest is located in Appendix D.

Table 15

Means and Standard Deviations (or Percentages) for Descriptive Statistics by Group

Variables	Thought Suppression (n = 22) *M* (*SD*)	Control (n = 23) *M* (*SD*)
Age	27.23 (11.09)	28.26 (12.13)
Gender (% female, *n*)	72.7% (16)	60.9% (14)
Ethnicity		
White (%, *n*)	54.5% (12)	52.2% (12)
Asian (%, *n*)	13.6% (3)	39.1% (9)
Other (%, *n*)	31.8% (7)	8.7% (2)
Education (years)	14.09 (3.85)	16.35 (4.76)
Trauma type (%, *n*)		
Interpersonal	86.4% (19)	78.3% (18)
Accident/other	13.6% (3)	21.7% (5)
Criterion A type trauma	77.3% (17)	47.8% (22)
PCL-5	33.77 (16.07)	30.87 (15.70)
Above clinical cut-off (≥ 31) (%, *n*)	50.0% (11)	47.8% (11)
DASS-D	15.45 (10.33)	12.52 (9.13)
WBSI	53.00(12.06)	48.22 (11.93)
MASS	3.20 (0.81)	3.60 (1.03)

Note. Interpersonal trauma (e.g., sexual assault, physical assault); PCL-5 = Posttraumatic Stress Disorder; DASS-D = Depression Anxiety and Stress Disorder – Depression subscale; WBSI = White Bear Suppression Inventory; MASS = Mindfulness Attention and Awareness Scale.

My primary interest was to investigate whether the thought suppression manipulation would alter meta-awareness. Thus, a manipulation check was conducted to ensure the thought suppression group reported significantly more effort in suppressing trauma-related intrusions than the control group. Unfortunately, the thought suppression group (M = 4.68, SD = 2.12) did not suppress more than the control group (M = 4.17, SD = 1.95), $t(43) = -0.84$, $p = .41$, $d = -0.23$. Given the strength of manipulation was lower than expected, it was decided to conduct some analyses on a subset of the sample by selecting criterion cases within each condition (i.e., participants who scored *below* the mid-point (= 4) on the manipulation check question in the control group, and participants who scored *above* the mid-point in the thought suppression group). Consequently, in this subsample the thought suppression group (n = 13) suppressed significantly harder (M = 6.23, SD = 0.93) during the intervention phase than the control group (n = 10, M = 2.30, SD = 0.95). Reporting of results from hereon will clearly distinguish when this subsample versus the whole sample was used for analysis.

As a reminder, after the 5-min manipulation period, in addition to the manipulation question (i.e., suppression effort), participants in both groups were asked two questions about difficulty in suppressing any intrusions and distress caused by the intrusions. They also reported throughout the 5-min task the number of intrusions experienced (this is not to be confused with intrusions reported as part of the meta-awareness tasks). For the subset of participants who appeared to follow the manipulation instructions, (i.e., reported high and low suppression effort), there were no differences between the groups in terms of these variables (ps > .05) (see Table 16). Although not reported here, there were no differences on these variables when the full sample was analysed (ps > .29).

Table 16

Intrusion Characteristics and Inferential Statistics between the Criterion Cases in the Control Group and the Thought Suppression Group

Variables	Thought suppression *M* (*SD*)	Control *M* (*SD*)	*t*(21)	*d* [CI_{95}]
Intrusion frequency	5.54 (2.63)	4.40 (6.85)	-0.55	4.91 [-1.06, 0.60]
Difficulty to suppress	3.92 (1.75)	3.30 (1.95)	-0.81	1.84 [-1.17, 0.50]
Distress	3.77 (1.69)	3.20 (1.67)	-0.80	1.69 [-1.16, 0.50]

Note. Ranges of variables (1 = not at all; 7 = extremely).

A series of repeated measures ANOVAs were performed to test the interaction between time (pre-intervention, post-intervention) and conditions (thought suppression, control) effect on meta-awareness. This was conducted on the subsample of participants who followed manipulation instructions (i.e., $n = 23$). Table 17 summarises these results. Contrary to my first hypothesis, there was no evidence that the though suppression group demonstrated improved meta-awareness of intrusions, whether through reporting of self-caught intrusions, or reporting of being aware of intrusions when probed. Similarly, there was no significant interaction for the meta-awareness *failure* variable. Although at time floor or ceiling effects might hinder detection of significant effects, as can be seen from the pre-intervention values, relative to the control group, the thought suppression condition appeared to have 'room' for putative effects of thought suppression to be demonstrated. That is, they had relatively low rates of meta-awareness and high meta-awareness failure at pre-intervention, but these did not change as a result of the manipulation. Although not documented in Table 17, there were

significant main effects of time for probe-caught continuous intrusions and task-related thoughts ($ps < .05$). However, there was no main effect of group for any outcome (see Appendix D for full summary).

Table 17

Means, Standard Deviations, and Inferential Statistics of Time x Group Interaction Effect on Meta-awareness.

	Thought suppression		Control				
Variables	Pre-intervention *M* (*SD*)	Post-intervention *M* (*SD*)	Pre-intervention *M* (*SD*)	Post-intervention *M* (*SD*)	*F*(1, 21)	*p*	partial η^2
Self-caught intrusions	8.31 (8.54)	10.08 (12.68)	5.20 (6.86)	2.50 (3.75)	3.13	.091	.130
Probe-caught intrusions							
Continuous (%)	12.97 (13.65)	8.06 (10.12)	9.60 (16.35)	1.60 (5.06)	0.26	.614	.012
Aware (%)	6.19 (7.45)	6.66 (10.87)	5.02 (6.83)	1.71 (3.08)	1.65	.213	.073
Unaware (%)	16.02 (19.00)	18.18 (26.58)	6.38 (9.98)	6.80 (11.78)	1.15	.707	.007
Non-trauma-related (%)	10.19 (10.13)	5.61 (6.83)	4.40 (8.32)	6.06 (13.87)	1.80	.195	.079
Task-related (%)	54.63 (31.19)	61.50 (35.65)	74.60 (11.92)	83.82 (18.37)	0.12	.733	.006

Note. *F* values reflect the interaction effect.

Given the apparent issues with the thought suppression instruction manipulation and the potential for low power to mask possible effects when analysing the smaller subsample, the hypothesised moderation effect of mindfulness was investigated by examining *trait* thought suppression using participants' responses on White Bear Suppression Inventory (WBSI) as the predictor variable (the WBSI was administered prior the pre-intervention manipulations and meta-awareness task). Change in meta-awareness were obtained by calculating the differences between post-intervention and pre-intervention self-reported intrusions frequency, and the probe-caught proportions of aware and unaware intrusions. For interest, Table 18 shows the correlations between the tested variables.

Model 1 in PROCESS (Hayes, 2018) was used to perform multiple linear regression analyses to examine the proposed moderation effect of mindfulness. All variables were centred for interpretation purposes. In sum, mindfulness was entered as moderator, with difference scores (post-intervention minus pre-intervention) for self-caught/reported intrusions and meta-awareness failure representing the outcome variables of interest. Table 19 documents these moderation results. Contrary to expectation, mindfulness did not moderate the relationship between thought suppression and change in meta-awareness.

Table 18

Means, Standard Deviations, Correlations (95% Bootstrap CIs) Between Key Variables used in Moderation Analyses

		Change in meta-awareness			
Variables	*Mean* (*SD*)	Self-reported Intrusions	Unaware Intrusions	Thought suppression	Mindfulness
Change in meta-awareness					
Self-reported intrusions	-0.58 (4.88)	-			
Unaware intrusions (%)	-1.80 (10.02)	.21 [-.10, .47]	-		
Thought suppression	50.56 (12.10)	.19 [-.11, .46]	.02 [-.27, .31]	-	
Mindfulness	3.40 (0.94)	.03 [-.27, .32]	.05 [-.25, .34]	-.49** [-.68, -.23]	-

Notes. Negative values in meta-awareness change scores reflect a decrease between pre- and post-intervention.

**$p < .001$.

Table 19

Summary of Regression Predicting Changes of Meta-Awareness of Intrusions from Trait Thought Suppression and Mindfulness

Predictors	*b*	SE_b	*p*	95% CI
Moderation Effect of Mindfulness in Thought Suppression–Self-reported Intrusions Model				
Constant	-18.0612	.13.4633	.1871	[-45.2513, 9.1289]
Thought Suppression	.2887	.2617	.2764	[-.2398, .8172]
Mindfulness	3.1897	3.6179	.3831	[-4.1169, 10.4964]
Thought Suppression *Mindfulness	-.0478	.0749	.5269	[-.1991, .1035]
Total R^2 = .32, F(3, 41) = 0.41, p = .527				
Moderation Effect of Mindfulness in Thought Suppression–Unaware Intrusions Model				
Constant	-3.6736	28.8554	.8993	[-61.9489, 54.6017]
Thought Suppression	-.0225	.5609	.9682	[-1.1552, 1.1102]
Mindfulness	-.1705	7.7542	.9862	[-15.8305, 15.4896]
Thought Suppression *Mindfulness	.0216	.1606	.8939	[-.3028, .3479]
Total R^2 = .01, F(3, 41) = 0.08, p = .972				

Note. Unstandardised coefficients reported.

My secondary aim was to see if the moderation results reported in Study 3 (Chapter 4) would be replicated which refer to the findings related to alexithymia, trauma-specific rumination, and trait thought suppression as moderators of the PTSD–meta-awareness relationship. These analyses were conducted in generally the same fashion as just described (using PROCESS). Alexithymia, trauma-specific rumination, and trait thought suppression was entered individually as moderators into the model. Given that there was no evidence that the thought suppression manipulation changed meta-awareness levels or frequency intrusions, and that there was no main effect of time on any intrusion variables, a single averaged score was created as an outcome variable for each intrusion variable of interest. That is, pre- and post-intervention probe-caught unaware intrusions (%) scores were averaged and used to index meta-awareness failure. Similarly, averaged pre- and post-intervention self-reported intrusion frequency scores reflected a measure of meta-awareness. Tables 20 and 21 summarise the moderation outcomes. The results somewhat replicated those observed in Study 3, in that alexithymia did not moderate the PTSD–meta-awareness/meta-awareness failure relationships, however thought suppression was not statistically significant as Study 3. There was however a discrepancy in relation to trauma-specific rumination where the nonsignificant result in the current data was at odds to the significant moderation finding in Study 3 (Chapter 4).

Table 20

Summary of Regressions Predicting Meta-Awareness Failures of Intrusions from PTSD Severity levels, Alexithymia, Thought Suppression, and Rumination

Predictors	*b*	SE_b	*p*	95% CI
Moderation Effect of Alexithymia in PTSD–Meta-awareness Failure Model				
Constant	-12.1481	32.2220	.7081	[-77.2226, 52.9265]
PTSD	.1332	.7512	.8602	[-1.3839, 1.6502]
Alexithymia	.2248	.6147	.7164	[-1.0165, 1.4662]
PTSD*Alexithymia	.0026	.0140	.8550	[-.0256, .0307]
Total R^2 = .17, F(3, 41) = 2.85, p = .049				
Moderation Effect of Thought Suppression in PTSD–Meta-awareness Failure Model				
Constant	23.9774	17.9205	.1883	[-12.2141, 60.1689]
PTSD	-.8127	.5682	.1602	[-1.9603, .3349]
Thought Suppression	-.5215	.3930	.1919	[-1.3152, .2723]
PTSD*Thought Suppression	.0217	.0111	.0567	[-.0007, .0441]
Total R^2 = .21, F(3, 41) = 3.74, p = .018				
Moderation Effect of Trauma-Specific Rumination in PTSD–Meta-awareness Failure Model				
Constant	1.4277	13.446	.9160	[-25.7280, 28.5834]
PTSD	-.0159	.5433	.9768	[-1.1132, 1.0814]
State Rumination	-.0008	.1930	.9966	[-.3905, .3889]
PTSD*State Rumination	.0031	.0059	.6072	[-.0089, .0150]
Total R^2 = .14, F(3, 41) = 2.27, p = .095				

Note. Unstandardised coefficients reported.

Table 21

Summary of Regressions Predicting Meta-Awareness of Intrusions from PTSD Severity levels, Alexithymia, Thought Suppression, and Rumination

Predictors	*b*	SE_b	*p*	95% CI
Moderation Effect of Alexithymia in PTSD–Meta-awareness Model				
Constant	6.1175	25.3902	.6931	[-24.9641, 37.1991]
PTSD	-.2213	.3588	.5408	[-.9459, .5033]
Alexithymia	-.0968	.2936	.7433	[-.6897, .4961]
PTSD*Alexithymia	.0063	.0067	.3495	[-.0072, .0198]
Total R^2 = .17, $F(3, 41) = 2.78$, $p = .053$				
Moderation Effect of Thought Suppression in PTSD–Meta-awareness Model				
Constant	5.9032	8.1723	.4742	[-10.6012, 22.4076]
PTSD	-.4255	.2591	.1083	[-.94882, .0979]
Thought Suppression	-.0729	.1792	.6863	[-.4349, .2891]
PTSD*Thought Suppression	.0096	.0051	.0655	[-.0006, ..0198]
Total R^2 = .28, $F(3, 41) = 5.34$, $p = .003$				
Moderation Effect of Trauma-Specific Rumination in PTSD–Meta-awareness Model				
Constant	-5.7455	6.4334	.3770	[-18.7381, 7.2472]
PTSD	.4283	.2600	.1071	[-.0967, .9533]
State Rumination	.0778	.0923	.4043	[-.1087, .2643]
PTSD*State Rumination	-.0033	.0028	.2484	[.0090, .0024]
Total R^2 = .14, $F(3, 41) = 2.14$, $p = .110$				

Note. Unstandardised coefficients reported.

Several post-hoc analyses were conducted due to observed baseline differences between groups, as well as in an attempt to account for some of the findings that were contrary to expectation. It is acknowledged in advance that these were limited in some cases as a result of the modest sample size and/or extremely small cell sizes in some analyses

First, although a nonsignificant trend between groups, it was felt it worth examining whether the index event causing intrusions was a Criterion A trauma or not was a moderator in changes in meta-awareness levels. Accordingly, a series of three-way repeated measures ANOVA were performed to examine the interactions between time (pre-, post-intervention), group (thought suppression, control), and trauma (criterion A, non-criterion A) on meta-awareness. Table 22 documents the inferential statistics of the interactions. Keeping in mind the risk of Type 1 errors, although of lesser interest (not related to awareness per se), the only significant three-way interaction observed was in relation to task-related thoughts, that is, thoughts about the reading task (see Appendix E). Those who experienced criterion A type trauma in the control group appeared to experience significantly more task-related thoughts when completed the meta-awareness task a second time whereas those who had experienced a non-criterion A type trauma tended to have negligible increase in task-related thoughts. For the thought suppression group, those who experienced criterion A type trauma tended to experience negligible increases in task-related thoughts while those experienced non-criterion A type trauma had significant increase in task-related thoughts.

Table 22

F values and Effect Sizes for the Main Effects of Time, Group, Trauma, and Their Interactions on Meta-awareness of Intrusions

	Self-caught intrusions		Probe-caught intrusions									
			Continuous		Aware		Unaware		Non-trauma-related		Task-related	
Effect	*F*	partial η^2	*F*	partial η^2	*F*	partial η^2	*F*	partial η^2	*F*	partial η^2	*F*	partial η^2
Time	1.37.	.032	4.21*	.093	0.27	.007	1.65	.039	0.28	.007	7.40*	.153
Group	0.71	.017	0.01	<.001	0.62	.015	0.88	.021	0.24	.006	0.89	.021
Trauma	0.29	.007	4.56	.100	3.45	.078	0.26	.006	0.21	.005	0.69	.017
Time x Group	0.82	.020	0.80	.019	1.87	.044	1.03	.025	1.07	.025	0.33	.008
Time x Trauma	0.68	.016	2.79	.064	1.33	.031	0.90	.021	0.13	.003	0.39	.009
Group x Trauma	0.67	.016	0.08	.002	1.54	.036	0.29	.007	0.27	.007	0.07	.002
Time x Group x Trauma	0.84	.020	1.69	.040	0.05	.001	2.13	.049	0.47	.011	4.75*	.104

Notes. Degree of freedom = 1, error = 41.

*$p < .05$.

The second post-hoc analysis was conducted with a view to explore what baseline and intrusion characteristics might be associated in differentiating those who actually showed changes in meta-awareness, that is, improvements in meta-awareness and/or reductions in meta-awareness failure between the pre- and post-intervention. I thus divided up the sample based on the subset participants who showed no such change or, instead, any changes (the two groups were formed after examining the distribution of the difference scores derived from percentage differences in probe-caught aware (or meta-awareness failure) between pre- and post-intervention (i.e., the thought suppression manipulation/control period). Those allocated to the little change group were those who demonstrated no change (i.e., a difference score of 0), with those showing improved meta-awareness defined as those who showed a difference score > 0, and similarly for reduced meta-awareness failure (i.e., a non-zero difference score). Then a series of t-tests were conducted to examine for possible differences between the groups on baseline measures of interest. The results suggested that those who improved, that is, showed increases in probe-caught *aware* intrusions, found intrusions were hard to supress compared to those who showed little change in probe-caught aware intrusions (see Table 23). The only significant differences between the groups when probe-caught *unaware* intrusions was that those reduced meta-awareness failure tended to experience their intrusions with higher levels of distress (see Table 24).

Table 23

Differences in Intrusion Frequency, Intrusion Characteristics, and Baseline Measures Between the Little Change (n = 25) and Improved Change (n = 4) Groups for Probe Caught Aware Intrusions

	Little change *M* (*SD*)	Improved *M* (*SD*)	*t*(27)	*d*	*d* CI_{95}
Observed Intrusion Frequency[a]	4.04 (4.67)	6.00 (2.94)	-0.81	4.42	[-1.49, 0.63]
Effort to suppress[a]	3.88 (2.01)	5.25 (2.21)	-1.25	4.55	[-1.74, 0.40]
Difficulty to suppress[a]	3.00 (1.41)	5.00 (1.63)	-2.58*	5.09	[-2.50, -0.26]
Distress of intrusions[a]	3.44 (1.94)	3.50 (1.73)	-0.06	6.05	[-1.09, 1.02]
PCL-5	27.20 (14.48)	35.00 (8.68)	-1.04	0.67	[-1.62, 0.51]
DASS-D	13.12 (7.60)	17.00 (12.49)	-0.87	1.38	[-1.53, 0.60]
TAS-20	53.84 (8.43)	58.25 (4.03)	-1.02	0.37	[-1.61, 0.52]
WBSI	47.36 (13.28)	55.50 (5.80)	-1.19	0.41	[-1.71, 0.43]
RTQS	70.20 (23.79)	74.60 (20.73)	-0.34	0.29	[-1.24, 0.88]
MAAS	3.63 (0.90)	2.70 (0.80)	1.93	6.56	[-0.06, 2.13]

Note. PCL-5 = Posttraumatic Stress Disorder; DASS-D = Depression Anxiety and Stress Disorder – Depression subscale; TAS-20 = Toronto Alexithymia Scale; RTQS = State Repetitive Thinking Questionnaire; WBSI = White Bear Suppression Inventory; MASS = Mindfulness Attention and Awareness Scale.

[a] Measured on a 1-7 scale.

*$p < 0.5$.

Table 24

Differences in Intrusion Frequency, Intrusion Characteristics, and Baseline Measures Between the Little Change (n = 26) and Reduced Change (n = 11) Groups for Probe Caught Unaware Intrusions

	Little change *M* (*SD*)	Reduced *M* (*SD*)	*t*(35)	*d*	*d* CI_{95}
Observed Intrusion Frequency[a]	4.50 (4.543)	4.45 (3.33)	0.30	3.35	[-0.69, 0.72]
Effort to suppress[a]	4.48 (2.14)	4.55 (1.81)	-0.22	3.32	[-0.78, 0.63]
Difficulty to suppress[a]	3.19 (1.83)	3.73 (1.55)	-0.85	4.32	[-1.01, 0.41]
Distress of intrusions[a]	2.92 (1.85)	4.45 (1.86)	-2.29*	3.99	[-1.55, -0.09]
PCL-5	28.65 (14.16)	34.64 (19.58)	-1.05	0.47	[-1.08, 0.34]
DASS-D	13.38 (10.85)	13.27 (8.82)	-0.30	1.13	[-0.69, 0.72]
TAS-20	53.35 (9.41)	55.19 (10.69)	-0.52	0.28	[-0.89, 0.52]
WBSI	50.12 (12.85)	50.72 (9.72)	-0.14	0.30	[-0.76 0.66]
RTQS	70.12 (21.99)	84.36 (24.66)	-1.74	0.19	[-1.34, -0.10]
MAAS	3.62 (0.84)	3.13 (1.17)	1.44	0.48	[-0.20, 1.23]

Notes. PCL-5 = Posttraumatic Stress Disorder; DASS-D = Depression Anxiety and Stress Disorder – Depression subscale; TAS-20 = Toronto Alexithymia Scale; RTQS = State Repetitive Thinking Questionnaire; WBSI = White Bear Suppression Inventory; MASS = Mindfulness Attention and Awareness Scale

[a] Measured on a 1-7 scale.

*$p < 0.5$

Discussion

The current study explored whether meta-awareness could be changed by manipulating thought suppression, as well as investigating a potential effect of mindfulness in conjunction with trait thought suppression and changes in meta-awareness. Unexpectedly, the experimental manipulation was not effective. After selecting extreme cases within the conditions (thoughts suppression vs. control) to analyse those who followed manipulation instructions, the results still failed to demonstrate a causal effect of thought suppression on meta-awareness. Mindfulness also did not moderate the proposed relationship. However, the results were consistent with findings from Study 3 (Chapter 4) showing that thought suppression moderated the relationship between PTSD and meta-awareness relationship. The following paragraphs explain these results and discuss their implications. Nevertheless, the interpretations should be treated with caution as the small sample size in the current study (and sub-analyses) likely reduced the statistical power of analyses.

To my knowledge, the current study was the first experimental study to manipulate thought suppression when studying the meta-awareness of trauma-related intrusions. However, thought suppression did not change meta-awareness of intrusions. According to mind-wandering research, meta-awareness serves as a self-regulation strategy in the monitoring mental content (Schooler, 2002). Perhaps when acting as a "monitoring-for-control" function (Ruimi et al., 2022), meta-awareness requires a longer period time to be influenced before its function is changed (i.e., more than the five-minute manipulation period used in the current study). For example, those who experience trauma-related intrusions might already have a certain amount of attentional resources allocated to monitoring of cognitive content (that would then trigger meta-awareness of daily intrusions). Therefore, a five-minute intervention might be too short (or weak) to subsequently influence such self-regulation ability. An alternative explanation was that the participants were not sufficiently motivated to suppress trauma-related intrusions (e.g., had relatively low distress or

negative feelings from intrusions), hence, thought suppression would not influence meta-awareness. Others have offered a similar explanation – for example Baird et al. (2013) suggested that those who experienced more meta-awareness failure might have had a greater motivation to suppress their desire to reconcile a prior romantic relationship that was linked with negative emotions. In line with such a view, anxiety and depressive symptoms associated with unwanted thoughts also tend to motivate chronic thought suppression (Wegner & Zanakos, 1994). However, on average, my study sample scored less than the mid-point in distress from their intrusions, suggesting their intrusions were not overly distressing (see Table 16). Although tentative, it maybe be that thought suppression would impact more on meta-awareness if participants were more motivated by negative emotions to suppress trauma-related intrusions. Finally, there is a possibility that the null finding was due to the design of intervention, this and other explanations are explored later when addressing the limitations of the study.

The current study was the first to explore whether mindfulness moderates the trait thought suppression–changes in meta-awareness relationship, with no such finding observed. Nevertheless, the current study expanded the meta-awareness of intrusion literature by offering preliminary evidence that there were some relationships (correlational) between mindfulness and variables of interest. For example, the negative correlations between mindfulness and probe-caught aware and unaware intrusions were consistent with prior studies that have investigated mindfulness and the meta-awareness of mind-wandering (e.g., Deng et al., 2014; Nadya & Takarangi, 2021). Given in the literature there is only one study that has reported an association between self-caught mind-wandering and intrusions (Mrazek et al., 2012). The current study adds to the meta-awareness research field by demonstrating a significant negative correlation between mindfulness and self-caught intrusions. These findings may reflect prior research that shows mindfulness trained individuals are able to focus on current tasks (e.g., Rahl et al., 2017; Mrazek et al., 2013; Tang et al., 2007) and possibly less prone to intrusions. Finally, I observed a strong negative correlation between trait thought suppression and mindfulness. The preliminary evidence is consistent with

previous argument that maybe mindfulness increases levels of acceptance of trauma-related intrusions, hence, decreases engagement in thought suppression. Possibly due to an unsuccessful manipulation, the current study did not observe a moderation effect of mindfulness in trait thought suppression and changes in meta-awareness. Given several of the observed correlational evidence in the present data, future studies are still required to investigate the role of mindfulness in thought suppression and meta-awareness of intrusions.

The current study somewhat replicated the moderation results of Study 3. Alexithymia was again shown not to moderate the PTSD–meta-awareness relationship. The mixed findings of trauma-specific rumination in the PTSD–meta-awareness relationship between Study 3 and 4 – significant trend in the former, and nonsignificant in the latter, suggest its influence is less robust. As previous postulated, trauma-specific rumination is associated with intense emotion and worsening mood (Birrer & Michael, 2011; Ehlers & Clark, 2000), thus could increase meta-awareness. It is possible that trauma-specific rumination showed little moderation effect due to the lower level of distress from intrusions in the current sample. Finally, the study replicated the moderation effect of thought suppression in the PTSD–meta-awareness relationship. Given the results were close to statistical significance, it is possible that suppressed trauma-related intrusions became more salient in individuals' mind (meta-awareness), hence, individuals with PTSD being hyper-alert to their occurrence (Wegner et al., 1987; Wegner et al., 1990). Although somewhat tentative, the pattern of moderation results demonstrates the interacting effect of trait thought suppression in individuals with higher PTSD severity who engaged in high suppression levels tended to self-report more intrusions when they suppress intrusions relative to those low in PTSD symptoms or reporting lower suppression. Moreover, the interaction between PTSD and thought suppression in PTSD–meta-awareness *failure* relationship in the current study was also close to statically significance. Given the current results might be hindered due to power issue, with the patterns in the current study, the role of thought suppression remains worth investigating further. Future studies should increase sample size to further understand the mechanism underlying the

PTSD–meta-awareness relationship. The following paragraph discusses methodological implications of these mixed findings.

The moderation results prompt consideration of methodological explanations. Study 3 employed a probe-caught *only* method to identify intrusion and indexed meta-awareness on a continuous scale whereas the current study used a broader probe-caught method (i.e., self-caught and probe-caught) to index meta-awareness (which was recorded categorically). A possible explanation for mixed findings between studies was that there is a distinction between those intrusions that are spontaneously self-caught and reported, versus those that participants reported they were aware of but were identified when probed. A recent systematic review of mind-wandering research suggests that the self-caught method reflects two different aspects or processes: (1) the frequency of mind-wandering and (2) the ability to self-report mind-wandering (Chu et al., 2023). In the probe-caught method, mind-wandering scholars suggest that some components of spontaneous thoughts are just not salient enough that probes trigger or remind an individual to check their mental content (see Baird et al., 2013; Schooler & Schreiber, 2004). Perhaps the reason the results only showed moderation between PTSD–meta-awareness relationship and did not see proposed moderators *decreasing* meta-aware failure in PTSD was because (a) the proposed moderators did not influence the meta-awareness of the intrusions because they require probes to help identify them in meta-awareness and/or (b) self-caught intrusions in the moderation analyses reflected frequency of intrusions instead of meta-awareness. Although it had been argued that self-caught designs are the best method to examine meta-awareness as it reflects individuals' explicit awareness of mental content in mind-wandering research (Chu et al., 2023), future studies investigating changes in meta-awareness of trauma-related intrusions should consider examining meta-awareness using the probe-caught method only to avoid confounds in intrusion frequency with the self-caught method.

The findings of the current study provide further implications. Although thought suppression showed a pattern of moderation effect in the PTSD–meta-awareness relationship,

thought suppression alone did not demonstrate a direct causal effect on meta-awareness. The significant three-way interaction between criterion A type trauma, time, and group effect might shed a light on the possibility of being able to change meta-awareness. Specifically, those who experienced criterion A type trauma tended to have significantly more unaware intrusions at the baseline yet those in the control group significantly reduced their level of unaware intrusions at post-intervention phase (i.e., awareness improved) relative to those in the suppression group (acknowledging that the control group consisted of a higher percentage of criterion-A-type trauma-exposed individuals). Although I explicitly selected participants who reported they were emotionally bothered by any types of negative event, perhaps awareness of intrusions connected to experiences that are considered sufficient to cause PTSD are more open to be changed when individuals are not exerting suppression. As thought suppression is highly relevant to negative mood and PTSD (Purdon, 1999), future research investigating the potential causal relationship between thought suppression and meta-awareness of intrusions could be improved if it were sufficiently powered to examine varying levels of PTSD severity in conjunction with these factors (e.g., criterion A type trauma).

The current study had several limitations. The small sample size reduced the power to detect effects. The manipulation of thought suppression was not as effective as anticipated which was somewhat surprising given this method has been widely used and effective in other thought suppression research (e.g., Broadnet & Nixon 2007). That said, comparisons between the current study and other research might provide explanations why the intervention did not work due to subtle differences in methods. First, the current study did not provide a one-minute interval for participants to think about their negative events before suppression or mind-wandering (i.e., the instructions for the control group) (see Broadnet & Nixon 2007; Nixon et al., 2007, 2008). Perhaps the one-minute window would have redirected participants' attention to follow the intervention instructions after they completed a cognition-demanding task (i.e., the reading comprehension test). Second, providing thought suppression training (e.g., Nixon et al., 2008) might increase the

compliance in the thought suppression group. Third, a study found that instructions to thought suppress and instructions to monitor intrusions *both* encouraged participants effort to suppress intrusions, whereas the control group (i.e., mind-wandering without monitoring intrusions) reported significantly less effort to suppress intrusions (Oulton et al., 2016). It is plausible that the intervention effect in the current study was hindered as both groups were instructed to monitor their intrusions. Future studies may investigate the use of several thought suppression methodologies to ensure better examination of the potential casual effect of thought suppression on meta-awareness.

In conclusion, I did not find evidence that thought suppression or mindfulness influences meta-awareness directly. Nevertheless, thought suppression was found to moderate PTSD–meta-awareness relationship, thus replicating the findings of Study 3 (Chapter 4). There was some preliminary evidence suggesting that the type of event associated with intrusions (criterion A vs not) may be implicated in ability to change meta-awareness. Recommendations were made for future studies, that included possible methodological improvements, to aid further investigations of the possible causal effect of thought suppression on meta-awareness. The broader implications of this and my earlier PhD studies are discussed in the following and final chapter.

CHAPTER 6 – GENERAL DISCUSSION

Overview

This PhD thesis investigated the phenomenon of meta-awareness failure of trauma-related intrusions in the context of trauma and posttraumatic stress disorder (PTSD). Study 1 and Study 2 examined the characteristics of how intrusions were experienced in trauma-exposed individuals and possible differences in their nature between intrusions that were experienced with or without immediate awareness. Study 1 showed preliminary evidence that intrusions with meta-awareness and with meta-awareness failure shared more commonalities than differences in terms of their characteristics. In Study 2, I found consistent but more nuanced results than what I observed in Study 1. For example, it was observed in Study 2 that both aware and unaware intrusions tended to be experienced in a similar fashion, however, vivid and meaningful visual mental images were more prone to meta-awareness. The study was also designed with an additional semi-structured interview, allowing a richer investigation of some of these intrusion qualities. Study 3 tested the potential factors underlying the relationship between PTSD and meta-awareness failure. The results ruled out alexithymia and trait rumination as moderators, but showed that individuals with higher levels of PTSD symptoms demonstrated greater meta-awareness of intrusions when engaging in trauma-specific rumination. Moreover, thought suppression had the potential to moderate the PTSD–meta-awareness relationship, showing a similar pattern of the trauma-specific rumination results. Study 4 was designed to experimentally test whether meta-awareness of intrusions could be altered by thought suppression, and if mindfulness might protect individuals from meta-awareness failure. The results demonstrated no causal relationship between thought suppression and meta-awareness. Mindfulness also did not moderate the relationship between trait thought suppression and meta-awareness. By integrating the results of all four studies and revisiting the context of these findings within a broader literature, this final chapter emphasises the theoretical implications and

clinical contributions of my PhD research. Limitations and recommendations for future research are also discussed.

Findings, Implications, and Future Research

The PhD thesis was guided by the theory of Ehlers and Clark (2000) on the crucial role of trauma-related intrusions in the development and maintenance of PTSD. They suggested that trauma-related intrusions can create a constant sense of threat through clear and vivid trauma-related mental imagery. Moreover, the reciprocal role of intrusions and other important variables (e.g., developing strategies to control the PTSD symptoms and negative appraisal of intrusions) together can contribute to certain 'outcomes'. Ironically, these outcomes created by intrusions become a source for intrusions themselves, forming a vicious cycle of maintaining PTSD. Although Ehlers and Clark (2000) considered all intrusions as apparent and accessible to PTSD sufferers, recent literature has reported meta-awareness failure in trauma-exposed individuals (Nixon et al., 2021). Thus Study 1 and 2 aimed to understand whether aware and unaware intrusions differed based on their modality, meaningfulness (appraisal), accessibility (difficulty to intentional recall), and other measured characteristics. Although the results of Study 1 should be treated with caution due to a power issue (as I encountered difficulties to recruit participants because of the impact of COVID-19), Study 1 and 2 together showed some interesting results. It was found that although individuals could sometimes lack explicit awareness of the first intrusion in the respective study, the unaware intrusions shared the same characteristics as aware intrusions in terms of modality, meaningfulness, and accessibility. Moreover, when experiencing multiple different intrusions, the ones that were particularly meaningful and visual to an individual were more prone to meta-awareness. When the same intrusions occurred on multiple occasions, the intrusions were more noticeable to participants (i.e., they were aware of the intrusions) with higher levels of dissociative characteristics (e.g., derealisation). These studies expanded upon Ehlers and Clark's model by presenting evidence that intrusions involving less imagery and vividness were less likely to be

spontaneously identified by participants. Furthermore, the findings supported other aspects of Ehlers and Clark's cognitive model of PTSD in that (1) all intrusions created a sense of threat regardless of meta-awareness, (2) intrusions were perceived as highly accessible even when individuals lack meta-awareness of them, and (3) appraisals were relevant to the occurrence of intrusions given aware intrusions appeared to be more meaningful to participants than unaware intrusions.

Another theory that guided Study 1 and Study 2 was Winkielman and Schooler's (2011) theory of Conscious and Meta-consciousness in Social Cognition. Winkielman and Schooler suggested that vague and quick mental content tends not to enter meta-awareness, unless this content somehow gains the attention from individuals. Although meta-awareness is facilitated by the strength and robustness of an experience, without explicitly checking one's mental content or orienting one's thinking toward the thought itself, meta-awareness failure is still likely to occur even when one's mental content is clear and strong. Such explanation can be used to understand the findings of Study 1 which show more commonalities between aware and unaware intrusions than not. However, considering the results of Study 2, Winkielman and Schooler's theory might only provide an explanation for the first trauma-related intrusions that come into mind in a circumscribed period. Study 2 results suggested that when experiencing more than one intrusion, vivid and meaningful trauma-related mental images are prone to meta-awareness. Perhaps due to significant distress and negative emotions associated with the trauma content, this mental content might not necessarily require individuals to explicitly attend to it for meta-awareness to be triggered. The strength of the intrusions experience itself might be enough for the occurrence of meta-awareness, without individuals consciously checking their mental content by asking themselves "just now, what was I thinking?". Since Winkielman and Schooler's theory was developed to understand non-trauma-related thoughts, future studies could investigate such explanation by comparing whether trauma-related and non-trauma-related mental images trigger meta-awareness differently. For example, a type of mind-wandering that involves future planning might require individuals to

explicitly ask, “just now, what was I thinking” to trigger meta-awareness, whereas trauma-related intrusions with clear mental images might trigger meta-awareness without the need of asking such question. Furthermore, future studies might examine whether the first intrusion and multiple intrusions enter meta-awareness differently to help refine current theories of meta-awareness of trauma-related intrusions.

The findings from Study 1 and 2 have clinical implications. Specifically, findings that intrusions with lower levels of vividness, meaningfulness, and imagery were more prone to meta-awareness failure. This implies there is a higher risk of underreporting intrusion frequency for those who tended to experience intrusions in a more verbal or abstract way (e.g., think about how one’s life had been impacted by trauma, or a smell associated with prior trauma) (Brewin & Burgess, 2014; Murray et al., 2002). Clinicians should consider intrusion modalities when estimating the accuracy of self-reported intrusion frequency. Moreover, both aware and unaware intrusions were highly associated with negative outcomes (e.g., distress, sense of threat, derealisation etc.). While the former relationship (aware intrusions and distress) is well-established, it is important that clinicians understand unaware intrusions are also accompanied by high levels of negative emotion. Another important message is that being aware of the occurrence of intrusions not only enables more accurate reporting of intrusion frequency, but it also affords individuals a greater opportunity to engage in potentially healthy or adaptive strategies, which might allow them to counteract the negative influences of intrusions (e.g., cognitive restructuring, mindfulness).

The second aim of the project was to understand factors underlying the PTSD and meta-awareness failure relationship. As aforementioned, intrusions and maladaptive strategies used to control such intrusions contribute to each other, and hence form a vicious circle (Ehlers & Clark, 2000). Two common maladaptive cognitive strategies used by individuals to control intrusions and the associated distress are thought suppression and rumination (Ehlers & Clark, 2000). As a form of cognitive avoidance, thought suppression increases intrusion frequency, known as with rebound effect (Wegner, 1994). Rumination enhances problematic appraisal of trauma and worsens one’s

mood (Kubota et al., 2015). Therefore, in Study 3, these two maladaptive cognitive processes were selected as potential moderators of the PTSD–meta-awareness relationship. Alexithymia was also selected as a variable of interest, given its strong association with PTSD as well as the possibility to impede one's ability to identify and describe emotions and feelings (Zlotnick et al., 2001). Moreover, Study 3 also widened the nature of the intrusions examined by expanding upon the definition of trauma, thus including non-criterion-A type trauma-exposed individuals to increase the generalisability of findings around meta-awareness and trauma-related intrusions. Results showed that meta-awareness failure could occur to negative-event-exposed individuals, regardless of whether the event represented a criterion A type trauma. Although alexithymia and trait rumination were not identified as moderators, individuals with PTSD who engaged in high levels of thought suppression and/or trauma-specific rumination were more likely to be meta-aware of their intrusions.

The findings of Study 3 and the replicated findings in Study 4 provided some theoretical implications in relation to PTSD and meta-awareness of intrusions. Being the first studies to investigate the relationship among alexithymia, PTSD, and meta-awareness, these studies did not find support for the hypothesised role of alexithymia in the PTSD–meta-awareness/meta-awareness failure relationships. Although alexithymia has been shown to be highly correlated with PTSD and is argued to hinder emotional processing (see Emotional Processing Theory, Foa & Kozak, 1986, and the influence of role alexithymia, Frewen et al., 2008; McCaslin et al., 2006; Putica et al., 2021), the link between one's inability to recognise emotion states and explicit awareness of trauma-related intrusions appeared to be absent for my samples. As meta-awareness is considered a self-regulation and self-monitoring ability (Dunne et al., 2019; Schooler, 2002), it is surprising that alexithymia did not influence the proposed relationship. It would have been expected that alexithymia would prevent individuals from recognising mood changes with intrusions, thus, failing to trigger meta-awareness by making individuals answer, "just now, what was I thinking?" because

the individuals would not identify that an intrusion just occurred as a negative mood (e.g., distress or sense of threat etc.). To my knowledge, the current work was the first to investigate the relationship between alexithymia and meta-awareness. Therefore, drawing on evidence outside of the trauma field might help explain some of the null findings. For example, research on imagination suggested that there is no difference in picturing emotional imagery between females that were high versus low in alexithymia (Bausch et al., 2011). Moreover, Bausch and colleagues also reported that both groups rated the levels of vividness and arousal similarly when imagining past and future emotional events. Another fMRI research in mental imagery has reported differences between a high-alexithymic group and a low-alexithymic group when engaging in happy imagery, but not in a sad imagery condition (Mantani et al., 2005). Although the studies mentioned above did not measure meta-awareness, they shed light on the null findings that alexithymic individuals might experience (sad) mental images the same way as non-alexithymic individuals. Given that intrusions predominantly occur as negative mental images, perhaps alexithymia (difficulty in identifying emotions) does not play a role in meta-awareness. However, empirical evidence is needed to examine the differences in meta-awareness of intrusions between non-alexithymic and alexithymic individuals.

The moderating role of certain cognitive processes in the PTSD – meta-awareness relationship has further implications. An interesting perspective from the mind-wandering research field might help explain the moderation pattern in relation to rumination. It has been proposed that meta-awareness can impact the duration of mind-wandering periods. With individuals being conscious that their thoughts are task-unrelated, they are likely to control the duration of mind-wander (Wong et al., 2023). Perhaps rumination was found to moderate the PTSD–meta-awareness relationship (that higher level of rumination was associated with a stronger effect between PTSD and meta-awareness) because the process of ruminating trauma-related intrusions tends to be deliberate and repetitive (Holmes & Bourne, 2008; Michael et al., 2007). Therefore, individuals

who ruminate in relation to intrusions were probably conscious of such a process. In relation to thought suppression, it has been theorised and empirically supported that those who suppress intrusions experience rebound effects and also become hypersensitive to the suppressed thoughts when they come into mind (Wegner et al., 1987, 1990, 1994; Wenzlaff & Wegner, 2000). The moderation results of my study build on a previous study which reported that those formally diagnosed with PTSD had significantly lower levels of meta-awareness failure compared to the non-clinical group (Nixon et al., 2019). My study provided a possible explanation for the results found by Nixon et al. Because individuals with higher PTSD severity tended to engage in high levels of maladaptive strategies (i.e., thought suppression and trauma-specific ruminations), thus they might experience intrusions with higher levels of meta-awareness. In line with the cognitive PTSD model (Ehlers & Clark, 2000), the reciprocal loop between maladaptive strategies and intrusions might partly be a result of increased hypersensitivity to intrusions due to higher levels of meta-awareness. In other words, individuals might report more intrusions due to thought suppression and rumination encouraging meta-awareness of intrusions. The increased intrusions frequency could also further enhance the maladaptive cognitive process.

The focus of my research and methodology used to assess the meta-awareness of intrusions builds on past work and provides future directions of the field. Supporting previous studies, this work demonstrated that intrusion frequency was positively correlated with thought suppression and rumination (Amstadter & Vernon, 2006; Birrer et al., 2007; Birrer & Michael, 2011; Bomyea & Lang, 2016; Shipherd & Beck, 1999, 2005). Adding to this literature, the findings of moderation suggest that maladaptive cognitive processes enhance the effect of PTSD on meta-awareness. Given that prior studies only employed the self-caught method to examine the relationship between intrusion frequency and thought suppression/rumination in trauma-exposed samples, the findings offer further explanation for past results. That is, meta-awareness might be the reason that previous research found individuals reported more intrusions after engaged maladaptive cognitive processes.

Nevertheless, it should be noted that Study 4 did not replicate the moderating effect of trauma-specific rumination on the PTSD–meta-awareness relationship. Therefore, the role of trauma-specific rumination requires further empirical evidence. Perhaps the mixed findings between Study 3 and 4 were due to methodological differences. It could also be because Study 4 recruited a higher percentage of non-criterion-A type trauma-exposed individuals compared to the Study 3 sample. Therefore, future studies are recommended to recruit criterion-A-type trauma-exposed individuals to confirm the effect of trauma-specific rumination between PTSD and meta-awareness. Another future direction to understand the role of trauma-specific rumination in the PTSD–meta-awareness relationship is to understand whether different types of rumination might influence meta-awareness differently. Such recommendation is from a mind-wandering study that reported that only a specific type of rumination (i.e., brooding) was relevant to meta-awareness failure (Nayda & Takarangi, 2021). Finally, the designs of Study 3 and 4 did not allow for a more nuanced understanding of the exact dynamic between the variables. It requires further investigations into the exact timing of inter-relationships between intrusions frequency, meta-awareness, trauma-specific ruminations, and thought suppression. As most of my results, including moderation findings, were largely correlational, future research might benefit from either experimental research that manipulates different variables or Ecological Momentary Assessment (EMA; Shiffman et al., 2008; Stone & Shiffman, 1994). The latter research tracks closely in a time-based fashion to explore how people respond to aware intrusions, and would shed more detailed light on whether different types of different maladaptive cognitive processes lead to more or less awareness and how this interacts with PTSD severity.

The moderation results also lead to clinical implications. First, the evidence supported that intrusions tend to occur with immediate meta-awareness for those who have severe PTSD symptoms and engage in maladaptive cognitive strategies. The moderation pattern might be a result of increased intrusions frequency and hypersensitivity to intrusion occurrences. Therefore, when the clients self-report a high frequency of intrusions, clinicians should examine whether clients with

PTSD engage in thought suppression and/or rumination. Second, it is worth mentioning that the moderation pattern is opposite to prior expectations. It was initially hypothesised that the maladaptive cognitive process would strengthen the relationship between PTSD and meta-awareness failure. Such contradiction highlights an important question – whether meta-awareness is beneficial in PTSD. Literature suggests that meta-awareness is healthier as meta-awareness failure correlated with poor task performance and depression severity (e.g., Deng et al., 2014; Nayda & Takarangi, 2021; Smallwood et al., 2007, 2008; Takarangi et al., 2014, 2017). Similarly, it was argued that meta-awareness failure might not be beneficial in PTSD as the high-PTSD group (relative to the low-PTSD group) were more at risk of underreporting accurate intrusion frequency (Nixon et al., 2021). Perhaps there are different ways or pathways to being meta-aware of intrusions. For example, one pathway might be that individuals are meta-aware of intrusions because they are hypersensitive to intrusions as a result of maladaptive cognitive processes. Such pathway suggests a more heightened sense of threat and fear of trauma and associated symptoms. Another possible pathway is that individuals are meta-aware of intrusions because they are trained to be focused on the present so can easily catch that one's attention has drifted away due to intrusions (i.e., mindful meta-awareness, Dunne et al., 2019). Such pathway suggests a healthier form of meta-awareness as individuals practise being mindful of one's presence and mental content. It is likely that my moderation results are more representative of the first pathway of meta-awareness given the established literature on the negative effects of maladaptive cognitive processes in PTSD (see Ehlers & Clark, 2000; Purdon, 1999; Szabo et al., 2017). Future studies are suggested to investigate the second proposed type or pathway of meta-awareness (e.g., manipulations of mindfulness) as well as studies that examine whether the proposed types of meta-awareness have harmful/beneficial effects on PTSD.

Study 4 employed an experimental design to fulfil the final aim of the thesis – to understand the possibility that individuals could be guided to improve/decrease meta-awareness of intrusions.

The null findings revealed a lack of strong evidence that thought suppression caused changes in meta-awareness of intrusions. Again, the null findings should be interpreted with caution given Study 4 failed to manipulate thought suppression successfully. An additional area for my PhD to investigate was the role of mindfulness. As detailed in the previous chapter, in Study 4, I aimed to test the proposed moderating role of mindfulness, with the expectation that higher levels of mindfulness would buffer the experience of high levels of meta-awareness failure among those with PTSD symptoms. Meta-awareness is conceptualised as a form of self-regulation in relation to one's attention to mental content (i.e., internal resources) (Dunne et al., 2019; Schooler, 2002). While meta-awareness is understood to be an element of mindfulness (Holas & Jankowski, 2013), definitions of mindfulness also emphasise nonjudgmental attention and awareness in the present moment (i.e., both internal and external environments; Brown & Ryan, 2003; Kabat-Zinn, 1994), which is an opposite concept to meta-awareness failure. Similarly, thought suppression reflects cognitive avoidance, which can be driven by the unwantedness of trauma-related intrusions (Ehlers & Clark, 2000; Wenzlaff & Wegner, 2000). Whereas mindfulness was characterized by acceptance and openness of attitude towards experiences (Brown & Ryan, 2003; Martin, 1997). Therefore, mindfulness was expected as a moderator between thought suppression and meta-awareness.

Being the first study investigating the relationships among mindfulness, trait thought suppression, and changes in meta-awareness, mindfulness was not found to have an effect on the proposed relationships. Nevertheless, trait mindfulness was found to be negatively correlated with probe-caught intrusion, self-caught intrusion, and trait thought suppression. These relationships were consistent with the mind-wandering literature and the trauma literature (Garland & Roberts-Lewis, 2013; Mrazek et al., 2012; Turkelson & Mano, 2022). These results altogether suggested that the poor measurement of constructs or the unrepresentativeness of the sample cannot fully explain the null findings. While taking into account the impact of the failed thought suppression manipulation on meta-awareness, these correlations suggest there is still a potential effect or at least

a relationship between mindfulness and meta-awareness. To further study this relationship and to explore the proposed moderation model in Study 4, future studies may consider using mindfulness training or intervention, rather than using a self-report measure for mindfulness Since mindfulness is considered a useful tool in meta-cognitive therapy (Hussain, 2015), it remains plausible that mindfulness can protect individuals from being overly sensitive (i.e., a high meta-awareness) to intrusions due to thought suppression. Future research directions for this mechanism and the related clinical.

Drawing from the literature relating to meta-awareness can help us better understand the clinical implications of mindfulness for PTSD management. Although tentative, good meta-awareness might be required in the recovery from PTSD. Without the meta-awareness of one's train of thought, interventions that require observation of one's cognition (e.g., common in trauma-focused cognitive-behavioural therapies such as Cognitive Processing Therapy or CPT; Resick et al., 2017) might not be as effective. As discussed earlier, meta-awareness of intrusions might reflect individuals being hyper-alert due to fear of intrusions or in contrast, reflect being nonjudgmental and observant of intrusions occurrence (i.e., mindful meta-awareness). As discussed earlier, meta-awareness of intrusions might reflect individuals being hyper-alert due to fear of intrusions or in contrast, individuals being nonjudgmental and observant of their intrusion occurrence (i.e., mindful meta-awareness). Partially supporting the latter notion, previous research has shown that mindfulness might protect individuals from high levels of intrusion frequency from thought suppression. For example, Aliche et al. (2021) found that mindfulness was negatively associated with PTSD severity via lowered experiential avoidance. Another study showed that specific aspects of mindfulness (i.e., *acting with awareness, non-judging of inner experience, and non-reactivity to inner experience*) were negatively correlated with intrusions severity (Martin et al., 2018, p. 1571). Although these studies did not investigate meta-awareness per se, they illustrate that mindfulness (which requires meta-awareness) might be beneficial for the management of PTSD.

The beneficial role of mindfulness in improving PTSD can also be supported by the mind-wandering research on meta-awareness of mental content. For instance, an experimental study found that a mindfulness technique both increased meta-awareness of mind-wandering, and decreased mind-wandering that was associated with threat (Ruimi et al., 2020). Research in a sample with depressive symptoms also reported that a mindfulness intervention effectively increased meta-awareness of emotions and suicidal mental contents (Hargus et al., 2010). Since depression and PTSD comorbidity was shown to be highly prevalent (with a comorbidity rate of around 50%; Angelakis & Nixon, 2015), and because both disorders can result in considerably frequent intrusions (Patel et al., 2007; Mark et al., 2018), future PTSD research might benefit from drawing on the empirical research of other clinical disorders. Moreover, given the increasing evidence of mindfulness facilitating improvement in PTSD (Boyd et al., 2018), future studies could explore the possibility that manipulating mindfulness might change hypersensitivity (meta-awareness) to intrusions. Understanding such underlying mechanism might potentially benefit PTSD treatment outcomes.

In addition to the specific limitations outlined for each study in the relevant chapter, there were limitations or caveats that can be applied to the overall thesis more broadly. First of all, the variability in methods used for measuring meta-awareness and meta-awareness failure could have contributed to some inconsistent findings. I used the probe-caught only method for Study 1 (as a categorical measure) and Study 3 (as a continuous measure), and used the probe-caught method (i.e., the combination of self-caught and probe-caught) for Study 2 and 4. Although introducing such variability was inevitable for the design constraints for the specific time (e.g., online studies during COVID-19 lockdowns) and certainly added to the methodological heterogeneity of the research, it might have limited the potential to make a more systematic, quantitative cross-study comparison on the research findings.

The methodological concerns relating to each method that is used in the thesis need to be acknowledged. First, the self-caught method is considered to be the most accurate method to measure meta-awareness, as it implies individuals are explicitly aware of their attention drifting away from their current task without external reminders (i.e., probes) (Chu et al., 2023). This ties in with the potential criticism of Study 1 and 3 that the aware intrusions measured by probes can represent the moment participants become (meta-)aware of the intrusions. That is, the awareness of intrusions could have been introduced by receiving the probe and processing one's mental content. As suggested by Krosnick and Presser (2010), respondents go through four steps to reply to a question: (1) comprehend the question, (2) search inner resource (e.g., memory) to find a possible response, (3) select the answer that best corresponds to the question, and (4) provide an answer based on the selected information. These steps, especially Step 2 and 3, are highly likely to trigger meta-awareness, thus the meta-awareness indexed might have been interfered by the probe-caught only method. Second, consistent with the majority of mind-wandering research, Study 3 used a 6-point scale to index meta-awareness, however, such measure does not provide a middle point to index one's "neutral alternatives" (Weinstein, 2018). It has been argued that having a middle point offers respondents an option to reflect they are truly unsure about the answer, hence, increasing scale reliability and validity (O'Muircheartaigh et al., 2001). Finally, in the probe-caught method, although the self-report option reflects meta-awareness, it also represents the frequency of intrusion and the ability to report intrusions (Chu et al., 2023). Altogether, the comparison between aware and unaware intrusions is nuanced by the methodological differences, which needs to be considered especially in understanding inconsistent results. That said, there is evidence suggesting that methodological differences alone might not fully explain inconsistent results, given that replicability was achieved in some of my studies that used slightly different meta-awareness assessment methods. Although the most valid and reliable method to index meta-awareness is yet to be found, it is mostly agreed that probe-caught mental contents are distinct from self-caught ones

(Christoff et al., 2009; Smallwood & Schooler, 2015). Hence, future studies were encouraged to use consistent probe-caught methods to examine meta-awareness of intrusions.

Next, because not all participants experienced the criterion A type trauma across studies, it has implications regarding the generalisability of findings about the meta-awareness of intrusions for PTSD populations. Criterion A type trauma has been retained by some diagnostic (e.g., DSM-5) as a required type of trauma for PTSD to be diagnosed, given that otherwise the definition of trauma would become too broad, thus, reducing the validity of the diagnosis (Spitzer et al., 2007). Although I deliberately recruited non-criterion A type trauma to explore meta-awareness more broadly, trauma type seemed to impact meta-awareness levels (see discussion in Chapter 5). For example, the criterion A type trauma groups, regardless of experimental condition, reported a higher percentage of unaware intrusions in Study 4. Literature has also documented that criterion-A-type trauma-exposed individuals (including those diagnosed with PTSD) tend to report at least 10% of their intrusions as unaware intrusions (Nixon et al., 2019). Therefore, it is plausible that non-criterion-A type trauma (e.g., verbal bully from peers) results in less frequent intrusions than criterion-A-type trauma (e.g., childhood sexual assault), thus impacting the meta-awareness of intrusions. Perhaps future studies that include only criterion-A-type trauma-exposed individuals could further discover the role of meta-awareness in trauma-related intrusions, which might provide more clinical recommendations for managing PTSD. Recruiting clinical samples also increases the generalisability of my studies.

Third, with the meta-awareness task used in this thesis, I could only understand how meta-awareness of intrusions (or lack of) was operating when trauma-exposed individuals were reading text. There are three main types of meta-awareness tasks (Chu et al., 2023), those: (1) adapted from continuous performance tests (CPTs) for sustained attention (e.g., SART; Sustained Attention to Response Task, Robertson et al., 1997), (2) adapted from breathing and mindfulness meditation (e.g., Mrazek et al., 2012), and (3) adapted from daily life tasks such as reading (e.g., Takarangi et

al., 2014). Although all the meta-awareness tasks in the current studies were designed to mimic everyday reading tasks to observe meta-awareness of intrusions in real-life situations, the scientific articles provided had a strong possibility to 'bore' the participants, leading to more induced intrusions. However, the validity of the task could be influenced by participants' interest in the provided articles (e.g., students with science backgrounds might find the articles interesting and more engaging, hence, less likely to think about trauma). Future studies could use other types of tasks to index meta-awareness to explore interactions between meta-awareness and other variables. For example, using continuing performance tests to index meta-awareness might lead to a better understanding of the meta-awareness of intrusions during attentional control in the PTSD population. Likewise, using breathing and mindfulness meditation to index meta-awareness might provide a more coherent view of the interaction between mindfulness and meta-awareness in the PTSD population. Finally, future studies could use different tasks to further explore the effect of meta-awareness of trauma-related intrusions in different contexts.

Conclusion

In conclusion, this thesis represents a significant examination of the phenomenology and the processes underlying the meta-awareness of trauma-related intrusions. It employed multiple methods for assessing meta-awareness, and found that certain characteristics and cognitive processes may be particularly relevant to meta-awareness. Although replications are needed, the findings provide a future research avenue for improving self-reporting methods used in PTSD assessment and treatment. It is hoped that this thesis has provided a solid grounding for future research to investigate this phenomenon, in ways that could help manage intrusive experiences and improve PTSD treatment.

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APPENDICES

APPENDIX A – META-AWARENESS TASK INSTRUCTIONS AND ARTICLES (STUDY 1 – 4)

Appendix A1: Meta-awareness task instructions for Study 1 and 3[8]

Please read carefully the following instructions.

In this task, you will read ten articles. There will be one article per page. Click the 'next' page to advance to the next article. From time to time while the reading task, you will see a screen asking your mental contents (in other words, describe your thoughts the moment just before the blue screen popped up). You will be asked to respond by selecting the statement that best corresponds to your mental contents. These instructions will appear onscreen, so you do not have to memories them, but the options will be:

1. I was thinking about my trauma
2. I was thinking about the reading task
3. I was thinking about something else
4. I was not thinking about anything

If option 2, 3 or 4 is selected, you will continue doing the reading tasks and will receive further probes while reading. Each time you receive a probe, you will advance to the next article automatically. Don't worry if you haven't finished reading an article, the study is not a test of reading speed. Please just read at your normal reading speed.

If you select option 1, the next screen will ask you to describe how aware you were that you were thinking about the trauma-related thought/memory that occurred JUST BEFORE the probe appeared. You will also be asked about the form of the memory (e.g., was it a thought, or images associated with sense of being back in the trauma etc.). Please press the number key next to the statement that best corresponds to your thoughts just before the probe appeared on the screen. These instructions will appear onscreen at the time, so you do not have to memorize them now, but the options will be:

1. Yes, I was fully aware of my trauma-related memory/thought. It felt like a flashback (i.e., to some degree I had a sense of reliving it again or I was 'back' there).
2. Yes, I was fully aware of my trauma-related memory/thought. It was a memory/thought but I didn't have a sense or feeling of reliving the event again.
3. No, I was NOT aware of my trauma-related memory/thought until the probe. It felt like a flashback (i.e., to some degree I had a sense of reliving it again or I was 'back' there).
4. No, I was NOT aware of my trauma-related memory/thought until the probe. Although it was a memory/thought, I didn't have a sense or feeling of reliving the event again.

After you selected an option above, you will need to rate your awareness level on a 6-point scale. After that, there will be a questionnaire which asks about how you experienced of that specific trauma-related memory/thought occurred in the moment just before the screen appeared. You will

[8] Study 1 and 3 instructions were identical except for Study 3 added the highlighted sentence.

also be asked some questions about how you generally experience that specific trauma-related memory/thought in your day-to-day life.
Please click the 'next' button to begin the reading task.

Appendix A2: Meta-awareness task instructions for Study 2 and 4[9]

IN THE next phase of the study you will be doing a task on the computer. Please listen carefully to the following instructions.

In this task you will read one article. Text from the article is presented one paragraph at a time. Once you have read a paragraph, to advance to the next paragraph, press the space bar. The article is followed by a reading comprehension test. The test is multiple choice – answers are labeled 1 to 4 – use the number keys to respond to the questions.

During this task, I would like you to press the 'x' key any time that you notice that you are experiencing an intrusive memory or thought about your trauma (i.e., the negative event that you mentioned in the questionnaire earlier). In other words, if you catch yourself thinking about the trauma, press the 'x' key, then do your best to focus back on the reading task until you catch yourself having slipped back to thinking about the event again. Each 'x' key press should be for a separate occasion of thinking about the trauma.

In addition, from time to time you will see a blue screen asking if you were just thinking about the trauma (in other words, thinking about the trauma the moment just before the blue screen popped up). You will be asked to use the number keys 1-5 to respond. Please press the number key next to the statement that best corresponds to your thoughts just before the blue screen appeared. These instructions will appear onscreen, so you do not have to memorise them, but I will tell you now what the options will be:
If you were thinking about the trauma when the blue screen appeared but already reported this memory/thought with the x key, please select option1. If you were thinking about the trauma when the blue screen appeared and were aware of it, please select option 2. If you were thinking about the trauma when the blue screen appeared and but were NOT aware of it until you saw the screen, please select option 3. If you were focusing on the reading task when the blue screen appeared, please select option 4. If you were thinking about something else at that moment, please select option 5.
When we finish the computer task, I'd like to get a bit of an idea of the kinds of thoughts/memories you might have had about the trauma/negative event, but I don't want to interrupt you during the computer task. So, during the computer task I want you to write a single word down on this piece of paper which will remind you about what the thoughts/memory was about. This means whenever you find yourself thinking about the trauma and/or respond to probes as "having thoughts in your head but were not aware of the thoughts", you will write a key word that will help you answer questions about it later. For example, if your negative event was an assault, you might write down 'sneer' because the memory that came into your mind was of the person's face and their expression. If you have thoughts or memories about different parts of the trauma (or even different traumas), try to use a different word so you can separate them later on. If the thoughts/memories are exactly the same, please write down the same word on this piece of paper.
Because I've just given you a lot of information, I'll quickly sum it up. While you are reading, press the space bar to advance to the next paragraph. When you find yourself thinking about the negative event, press the 'x' key and write a cue word on the left side of the noting sheet. When you see the blue screen, use the number keys to respond. If you respond option 3 to the blue screen – that is, you were thinking about the trauma BUT WERE NOT AWARE OF IT until the blue screen appeared - please write down a cue word on the right side of the noting sheet. When doing the reading comprehension test, use number keys to respond too.

Post-intervention task intrusions for Study 4

[9] Study 2 and 4 (pre-intervention) instructions were identical except for Study 4 excluded the highlighted sentences.

IN THE next phase of the study you will be doing a same task on the computer again but with a different set of articles. Just in case you don't remember the instructions, I'll give you a quick reminder, please listen carefully to the following instructions.

When you are reading, press the space to advance to the next paragraph. When you find yourself thinking about the negative event, press the 'x' key. When you see the blue screen, use the number keys to respond. When doing the reading comprehension test, use number keys to respond too. Would you like to see a quick demo again?
Any questions? Okay, please press the spacebar to begin.

Appendix A3: Meta-awareness task articles

ARTICLE 1 (used in Study 1 – 4):

By the early twentieth century it was known that atoms were made of parts- Thomson's discovery of the electron had established that- but it wasn't known how many parts there were or how they fitted together or what shape they took. Some physicists thought that atoms might be cube-shaped, because cubes can be packed together so neatly without any wasted space. The more general view, however, was that an atom was more like a currant bun or a plum pudding: a dense, solid object that carried a positive charge but that was studded with negatively charged electrons, like the currants in a currant bun.

In 1910, Rutherford (assisted by his student Hans Geiger, who would later invent the radiation detector that bears his name) fired ionized helium atoms, or alpha particles, at a sheet of gold foil. To Rutherford's astonishment, some of the particles bounced back. It was at if, he said, he had fired a 15-inch shell at a sheet of paper and it rebounded into his lap. This was just not supposed to happen. After considerable reflection he realized there could be only one possible explanation: the particles that bounced back were striking something small and dense at the heart of the atom, while the other particles sailed through unimpeded. An atom, Rutherford realized, was mostly empty space, with a very dense nucleus at the centre. This was most gratifying discovery, but it presented one immediate problem. By all the laws of conventional physics, atoms shouldn't therefor exist.

Let us pause for a moment and consider the structure of the atom as we know it now. Every atom is made from three kinds of elementary particles: protons, which have a positive electrical charge; electrons, which have a negative electrical charge; and neutrons, which have no charge. Protons and neutrons are packed into the nucleus, while electrons spin around outside. The number of protons is what gives an atom its chemical identity. An atom with one proton is an atom of hydrogen, one with two protons is helium, with three protons lithium, and so on up the scale. Each time you ass a proton you get a new element. (Because the electrons, you will sometimes see it written that it is the number of electrons that defines an element; it comes to the same thing. The way it was explained to me is that protons give an atom its identity, electrons its personality.

Neutrons don't influence an atom's identity, but they do add to its mass. The number of neutrons is generally about the same as the number of protons, but they can vary up and down slightly. Add or subtract a neutron or two and you get an isotope. The terms you hear in reference to dating techniques in archaeology refer to isotopes – carbon-14, for instance, which is an atom of carbon with six protons and eight neutrons (the fourteen being the sum of the two).

Neutrons and protons occupy the atom's nucleus. The nucleus of an atom is tiny- only one-millionth of a billionth of the full volume of the atom- but fantastically dense, since it contains virtually all of the atom's mass. As Cropper has put it, if an atom were expanded to the size of the cathedral, the nucleus would only be about the size of a fly- but a fly many thousands of times heavier that the cathedral. It was the spaciousness – this resounding, unexpected roominess – that has Rutherford scratching his head in 1910.

It is still a fairly astounding notion to consider that atoms are mostly empty space, and that the solidity we experience all around us is an illusion. When two objects come together in the real world- billiard balls are most often used for illustration- they don't actually strike each other. Rather, as Timothy Ferris explains, "the negative charged fields if the two balls repel each other...Were it not for their electrical charges they could, like galaxies, pass right through each other unscathed." When you sit in a chair, you are not actually sitting there, but levitating above it at a height of one angstrom (a hundred millionth of a centimetre), you electrons and its electrons implacably opposed to any closer intimacy.

The picture of an atom that nearly everybody has in mind is of an electron or two flying around a nucleus, like planets orbiting a sun. This image was created in 1904, based on little more

than clever guesswork, by a Japanese physicist named Hantaro Nagaoka. It is completely wrong, but durable just the same. As Isaac Asimov like to note, it inspired generations of science-fiction writers to create stories of worlds-within-worlds, in which atoms become tiny inhabited solar systems or out solar system turns out to be merely a mote in some much larger scheme. Even now CERN, the European Organization for Nuclear Research, uses Nagaoka's image as a logo on its website. In fact, as physicists were soon to realise, electrons are not like orbiting planets at all, but mote like the blades of a spinning fan, managing to fill every bit of space in their orbits simultaneously (but with the crucial difference that the blades of a fan only seem to be everywhere at on, electrons are).

Needless to say, very little of this was understood in 1910 or for many years afterwards. Rutherford's finding presented some large and immediate problems, not least that no electron should be able to orbit a nucleus without crashing. Conventional electrodynamic theory demanded that a flying electron should run out of energy very quickly – in only an instant or so – and spiral into the nucleus, with disastrous consequences for both. There was also problem of how protons, with their positive charges, could bundle together inside the nucleus without blowing themselves and the rest of the atom apart. Clearly, whatever was going on down there in the world of the very small was not governed by the laws that applied in the macro world where our expectations reside.

ARTICLE 2 (used in Study 1 – 4):

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 meaningfully apply at the cellular scale), and not an atom's width of space is unused. There is activity every where 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 is that it is all happening on a tiny scale: a mere 0.1 volts traveling distances measured in nanometres. However, scale that up and it would translate as a jolt of twenty million volts per meter, 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 a 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 must 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 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 20,000 different types of protein, and of these about 2,000 types will each be represented by at least 50,000 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 liters of blood an hour, over 8,000 liters every day, 3 millions liters 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 delivered, after processing, to the mitochondria, where they are converted into a molecule called adenosine triphosphate, or ATP.

You 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.

ARTICLE 3 (used in Study 1 – 4):

Mendeleyev (also sometimes spelled Mendeleev or Mendeléef) was born in 1834 at

Tobolsk, in the far west of Siberia, into a well-educated, reasonably prosperous and very large family—so large, in fact, that history has lost track of exactly how many Mendeleyev's there were: some sources say there were fourteen children, some say seventeen. All agree, at any rate, that Dmitri was the youngest. Luck was not always with the Mendeleyev's. When Dmitri was small his father, the headmaster of a local school, went blind and his mother had to go out to work. Clearly an extraordinary woman, she eventually became the manager of a successful glass factory. All went well until 1848, when the factory burned down and the family was reduced to penury. Determined to get her youngest child an education, the indomitable Mrs. Mendeleyev hitchhiked with young Dmitri four thousand miles to St. Petersburg—that's equivalent to travelling from

London to Equatorial Guinea—and deposited him at the Institute of Pedagogy. Worn out by her efforts, she died soon after.

Mendeleyev dutifully completed his studies and eventually landed a position at the local university. There he was a competent but not terribly outstanding chemist, known more for his wild hair and beard, which he had trimmed just once a year, than for his gifts in the laboratory.

However, in 1869, at the age of thirty-five, he began to toy with a way to arrange the elements. At the time, elements were normally grouped in two ways—either by atomic weight (using Avogadro's Principle) or by common properties (whether they were metals or gases, for instance). Mendeleyev's breakthrough was to see that the two could be combined in a single table.

As is often the way in science, the principle had actually been anticipated three years previously by an amateur chemist in England named John Newlands. He suggested that when elements were arranged by weight they appeared to repeat certain properties—in a sense to harmonize—at every eighth place along the scale. Slightly unwisely, for this was an idea whose time had not quite yet come, Newlands called it the Law of Octaves and likened the arrangement to the octaves on a piano keyboard. Perhaps there was something in Newlands' manner of presentation, but the idea was considered fundamentally preposterous and widely mocked. At gatherings, droller members of the audience would sometimes ask him if he could get his elements to play them a little tune. Discouraged, Newlands gave up pushing the idea and soon dropped out of sight altogether.

Mendeleyev used a slightly different approach, placing his elements into groups of seven, but employed fundamentally the same premise. Suddenly the idea seemed brilliant and wondrously perceptive. Because the properties repeated themselves periodically, the invention became known as the Periodic Table.

Mendeleyev was said to have been inspired by the card game known as solitaire in North America and patience elsewhere, wherein cards are arranged by suit horizontally and by number vertically. Using a broadly similar concept, he arranged the elements in horizontal rows called periods and vertical columns called groups. This instantly showed one set of relationships when read up and down and another when read from side to side. Specifically, the vertical columns put together chemicals that have similar properties. Thus copper sits on top of silver and silver sits on top of gold because of their chemical affinities as metals, while helium, neon and argon are in a column made up of gases. (The actual, formal determinant in

the ordering is something called their electron valences, and if you want to understand them you will have to enrol in evening classes.) The horizontal rows, meanwhile, arrange the chemicals in ascending order by the number of protons in their nuclei—what is known as their atomic number.

The structure of atoms and the significance of protons will come in a following chapter; for the moment, all that is necessary is to appreciate the organizing principle: hydrogen has just one proton and so it has an atomic number of 1 and comes first on the chart; uranium has 92 protons and so it comes near the end and has an atomic number of 92. In this sense, as Philip Ball has pointed out, chemistry really is just a matter of counting. (Atomic number, incidentally, is not to be confused with atomic weight, which is the number of protons plus the number of neutrons in a given element.)

There was still a great deal that wasn't known or understood. Hydrogen is the most common element in the universe, and yet no-one would guess as much for another thirty years. Helium, the second most abundant element, had only been found the year before—its existence hadn't even been suspected before that—and then not on the Earth, but in the Sun, where it was found with a spectroscope during a solar eclipse, which is why it honours the Greek sun god Helios. It wouldn't be isolated until 1895. Even so, thanks to Mendeleyev's invention, chemistry was now on a firm footing.

For most of us, the Periodic Table is a thing of beauty in the abstract, but for chemists it established an immediate orderliness and clarity that can hardly be overstated. "Without a doubt,

the Periodic Table of the Chemical Elements is the most elegant organizational chart ever devised," wrote Robert E. Krebs in The History and Use of Our Earth's Chemical Elements—and you can find similar sentiments in virtually every history of chemistry in print.

Today we have "120 or so" known elements—92 naturally occurring ones plus a couple of dozen that have been created in labs. The actual number is slightly contentious because the heavy, synthesized elements exist for only millionths of seconds and chemists sometimes argue over whether they have really been detected or not. In Mendeleyev's day just sixty-three elements were known, but part of his cleverness was to realize that the elements as then known didn't make a complete picture, that many pieces were missing. His table predicted, with pleasing accuracy, where new elements would slot in when they were found.

No-one knows, incidentally, how high the number of elements might go, though anything beyond 168 as an atomic weight is considered "purely speculative"; but what is certain is that anything that is found will fit neatly into Mendeleyev's great scheme.

ARTICLE 4 (used in Study 1, 3, 4):

We will produce electricity in our cities and villages using solar cells, which we set up everywhere and integrate into everything. Solar panels on walls and roofs, solar cells integrated into roof tiles, windows, bridges, roads, benches and lighting, or solar-cell paint on our walls, window frames and doors.

In 2025, the surplus solar panel electricity of a neighbourhood, city or village is fed into the electricity grid. Given the moderate penetration of solar panels, the surplus electricity can always be used elsewhere. But in the future, when every house is equipped with solar panels, there will be a huge surplus of summer electricity production everywhere: in every neighbourhood and city, in every village and also in the countryside. Of course, at first we'll use batteries to store the electricity for use at night. Those batteries will absorb part of the surplus, but far from all of it. We store solar-panel electricity in batteries for day-night storage, and convert it into hydrogen for summer-winter storage.

This summer electricity will therefore have to be absorbed somewhere in the system. One obvious option is to convert it into hydrogen, which is after all much easier to store than electricity. We can do this with electrolysers, but where should we set them up? Do we decentralise them, placing them in the neighbourhood, next to the large parking garage, as described above? Or do we take a more regional or centralised approach? In the first case, that is, a decentralised location in the neighbourhood, the electricity network does not need to be adapted, reinforced or even made two-way. We solve the overproduction problem in a decentralised manner, and actually use the hydrogen network – i.e., the adapted natural gas network – for the transport of the surplus solar power; of course, only after as much of the hydrogen as possible has first been used to fill up our vehicles. In any case, a good economic system analysis will provide an answer to whether a decentralised or centralised location of the electrolyser is most sensible. Regardless, it is clear that a decentralised solution is clearly a robust solution.

In 2025, when energy supply is not yet fully sustainable, there are two different possible heating systems for areas where a heat network is an option. The first possibility is a large-scale heat network, which distributes the heat at a temperature of 70 to 90 degrees Celsius. Such city heating systems have existed in several cities for a few decades. As a heat source they use the residual heat of fossil power plants or of waste incineration plants, but this is not renewable energy. These large-scale heat distribution systems can also be fed by a geothermal source, which means that the heat is of course renewable.

With a heat pump and solar power, we can produce heat at 40 to 60 degrees Celsius in the summer, store it in the subsurface and then use it in the winter. The second possibility involves an ATES (aquifer thermal energy storage) system. The system stores summer heat in the subsurface in a well at a temperature of 15 to 20 degrees Celsius, while in the winter the cold is stored in a second well at a temperature of 5 to 10 degrees Celsius. In the summer we can now directly cool buildings

or homes from the cold well. But in the winter we can't directly heat buildings or houses from the warm well because it is not hot enough. To achieve a desired temperature of about 30 to 40 degrees Celsius in the winter, the building or house needs to have a heat pump to raise the temperature of the water pumped up from the well. In the winter the pump consumes electricity. But in a sustainable energy system, with solar panels on every roof, we now in fact produce far too little electricity in the winter. Moreover, the connected load of all those heat pumps means that the electricity grid's capacity in the area certainly needs to be doubled.

This is why, in a fully sustainable energy system, it is of interest to study whether we can actually produce this heat in the summer using a large central heat pump, instead of doing it in the winter. We can then store this heat, at a temperature of 40 to 60 degrees Celsius, in a subsurface aquifer in the summer. In the winter we can then pump it up from the aquifer into the heat network, which directly heats the building or home. We can also easily cool the buildings in the summer by storing the cold in the winter in a cold well in the subsurface. Now we have three sources in the subsurface: a cold well at 5 to 10 degrees Celsius, a hot well at 40 to 60 degrees Celsius, and a balancing well at 15 to 35 degrees Celsius. This means that heat pumps would not be needed in the homes and buildings, no electricity would be consumed during shortage periods in the winter and, above all, there would be no need to reinforce the electricity grid.

In 2025, drinking water is usually produced on a large scale by pumping water from the ground or from surface water. The water is then treated to produce potable water which is transported and distributed through a network to consumers. Coastal countries with insufficient surface water and groundwater resources, pump their water from the sea. The seawater is evaporated in large energy and water installations to produce freshwater that is distributed through a water network. In addition, many hotels and large buildings in these countries have reverse osmosis installations to make their own drinking water. In 20257 in city areas, rainwater largely falls on our roofs and is then discharged into the sewer system, or finds another course to reach surface water. This is a shame, because rainwater represents a significant source of clean water. We'd therefore like to harvest rainwater with our solar-panelled roofs or at our solar panel farms. We could then store the water in a subsurface aquifer, and recover it when we need it. We can use it directly to water our plants, but we can also, through reverse osmosis, make demiwater from it and, then, using electricity, make hydrogen. We could also make drinking water from the demiwater by adding minerals and salts to it. Houses in many parts of the world receive enough solar radiation and rain to meet their own electricity and drinking water needs. The sun provides most places in the world with sufficient energy. At the same time, enough rain falls to meet our own energy needs for heating, cooling and electricity, but also for drinking water.

ARTICLE 5 (used in Study 1, 3, 4):

What is density? Density is simply the amount of "stuff" in a given space. Scientists measure density by dividing the mass of something by its volume (d = m/v). This is a story about how the concept of density was first "discovered."

It is the story of a Greek mathematician named Archimedes who lived around 250 B.C. The King of Syracuse, where Archimedes lived, thought that he was being cheated by the metal craftsman who made his golden crown. The King called Archimedes to him and gave him the task of finding out whether the craftsman had replaced some of the gold in the King's crown with silver. Silver was worth less money than gold, and it also was an insult to the King to be wearing a crown that was not pure gold.

The King gave Archimedes some rules. Archimedes could not damage the crown in any way. He could not melt down the crown to see if it was made of other metals. He could not scratch the crown to see if there was silver underneath the golden outside. Archimedes thought about the problem while taking a bath. As he entered the bathing pool, he noticed that water spilled over the sides of the pool. He realized that the amount of water that spilled was equal in volume to the space

that his body occupied. This fact suddenly provided him with a method for finding out if the King's crown was made of pure gold.

Archimedes knew that silver is not as "heavy" as gold. (Actually, silver has less density than gold.). Because an amount of silver occupies more space than an equivalent amount of gold, Archimedes placed the craftsman's crown and a pure gold crown of the same mass in two tubs of water. He found that more water spilled over the sides of the tub when the craftsman's crown was submerged. It turned out that the craftsman had been cheating the King! Legend has it that Archimedes was so excited about his discovery that he ran naked through the streets of Syracuse shouting "Eureka! Eureka!" which is the Greek word for "I have found it!"

When Archimedes stepped into his bathing pool, not only did he realize that water spilled over the edges, but he also noticed something that we all notice when we go swimming - he felt lighter. The ability of an object to float when it is placed in a liquid is called buoyancy, and it is related to density. If an object is less dense than the liquid in which it is placed, it will float on the liquid. If it is denser than the liquid, it will sink.

For example, wood floats on water because it is less dense. Steel sinks because it is denser than water. How can large steel ships float? Large ships have a tremendous amount of space in them that is filled with air. The cabins, halls, and dining room are all filled with air. While steel is denser than water, air is less dense. Metal ships can float because their total density is less than that of the water that they float on. When the Titanic struck an iceberg, water rushed in and replaced the air in the ship's hull. As a result, the total density of the ship changed and caused the ship to sink.

Archimedes had a problem to solve. He came up with a hypothesis based upon his observations, and he found a way to test his hypothesis. Archimedes used the scientific method to solve the King's problem. Archimedes also used what he knew and applied it to his problem. This is the basis for all science. You can be a scientist like Archimedes, too!

ARTICLE 5 (used in Study 1, 3, 4):

Uranium compounds have been used as colorants since Roman time. Uranium was discovered as a chemical element in a pitchblende specimen by Martin Heinrich Klaproth, who published the results of his work in 1789. Pitchblende is an impure uranium oxide, consisting partly of the most reduced oxide uraninite (UO2) and partly of U3O8. Earlier mineralogists had considered this mineral to be a complex oxide of iron and tungsten or of iron and zinc, but Klaproth showed by dissolving it partially in strong acid that the solutions yielded precipitates that were different from those of known elements. Therefore he concluded that it contained a new element; he named it after the planet Uranus, which had been discovered in 1781 by William Herschel, who named it after the ancient Greek deity of the Heavens.

The name ‘Uranus’ was first proposed by Johann Elert Bode in conformity with the other planetary names from classical mythology, but this name for the planet did not come into common use until 1850. However, uranium was accepted as the name for the chemical element.

The pure oxide UO2 isolated by Klaproth by reduction was believed to be the elemental form until 1841, when Euge`ne-Melchior Pe´ligot (1841) showed that Klaproth’s ‘partially metallic’ substance was in reality the oxide UO2. Pe´ligot succeeded in preparing metallic uranium by reducing the tetrachloride with potassium. Pe´ligot may thus properly be considered the founder of modern uranium chemistry; he was the first to use the word ‘uranyl’ to designate the yellow salts of uranium.

In the elaboration of the periodic table, Mendeleev assigned in 1872 an atomic weight of 240 and a highest valence of six to uranium, rather than the value of 120 that was then commonly used based on the assumption that uranium was trivalent. Mendeleev’s reason was that he could not place an element with atomic weight 120 in group III of the periodic table; thus he conferred upon uranium the distinction of having the highest atomic weight in the periodic table. An atomic weight of nearly 240 was firmly established by Zimmerman (1882) by determining the mass ratios of several oxides and sodium uranyl acetate. The valence and atomic weight were confirmed by

determination of the vapor density of UCl4 and later of UF6 and the atomic number 92 was established (Hahn, 1925) from nuclear decay systematics.

The principal use of uranium during the first century after its discovery (and for the previous two millenia) was as a colorant for ceramics and glasses. The obscurity surrounding the element was permanently dissipated by the discovery of Henri Becquerel (1896) that uranium emits penetrating rays. In connection with investigations of the fluorescence and phosphorescence of uranium salts that had been undertaken by generations of Becquerels, H. Becquerel placed photographic plates that were covered with black paper near any salt or other material containing uranium. Whether the material was phosphorescent or not, he found that the emulsion was blackened by emanations that passed through the paper. He compared this phenomenon to that of X-rays, which had been announced only a few weeks earlier by Roentgen. Later Becquerel showed that the penetrating rays could discharge an electroscope. Shortly thereafter, Marie Curie developed quantitative techniques for measuring the radioactivity of uranium. She and others also found thorium to be radioactive and discovered by chemical separations that there were other elements present at trace levels in the uranium ore. Working with her husband Pierre, she discovered and named polonium and radium and described this property of these heavy elements as ‘radioactivity’.

Because the Curies recognized that ores of uranium and thorium are much more radioactive than purified compounds of these elements, they and other radiochemists separated other radioelements and identified their chemical and nuclear transformations. The luminescent and medical properties of radium created a market for uranium ores and the processed radium that far exceeded the use of uranium as a colorant for glasses.

By 1911, the atomic weight of uranium had been refined to 238.5. The natural isotope 235U was discovered in 1935 by mass spectrometry. The artificial isotope 239U, which is the precursor of 239Np and 239Pu, was postulated and identified by Hahn and coworkers as a 23 min half-life intermediate to transuranium elements that were not identified until the famous studies of Seaborg and coworkers 3 years later.

Despite these important discoveries, the crucial importance of uranium was not established until Hahn and Strassman discovered nuclear fission in late 1938. Since then, the chemistry, materials science, and nuclear properties of uranium have occupied a central position in the field of nuclear energy. Most schemes so far proposed for the release of nuclear energy involve the naturally occurring fissionable 235U, fertile 238U, or the artificial fissionable 233U in one way or another, so that the chemistry and technology of uranium have become of great scientific and technical importance. For these reasons many reviews dealing with uranium chemistry, technology, and metallurgy have been published. The main volume on uranium of the Gmelin Handbook of Inorganic Chemistry and a chapter by Mellor (1932) are the earliest comprehensive reviews of uranium chemistry prior to the discovery of fission. The Manhattan Project work was summarized in a number of volumes of the National Nuclear Energy Series. These volumes deal with the chemistry of uranium and its compounds, 233U, metallurgy, and technology of uranium, respectively. The most recent monograph on the chemistry of uranium is that by Cordfunke (1969). The most comprehensive treatment of all phases of uranium chemistry is the multi-volume uranium supplement to the Gmelin Handbook of Inorganic Chemistry.

ARTICLE 7 (used in Study 1, 3):

Today, your sun has achieved relative stability, but its eleven and one-half year sunspot cycles betray that it was a variable star in its youth. In the early days of your sun the continued contraction and consequent gradual increase of temperature initiated tremendous convulsions on its surface. These titanic heaves required three and one-half days to complete a cycle of varying brightness. This variable state, this periodic pulsation, rendered your sun highly responsive to certain outside influences which were to be shortly encountered.

Thus was the stage of local space set for the unique origin of Monmatia, that being the name of your sun's planetary family, the solar system to which your world belongs. Less than one per cent of the planetary systems of Orvonton have had a similar origin.

4,500,000,000 years ago the enormous Angona system began its approach to the neighborhood of this solitary sun. The center of this great system was a dark giant of space, solid, highly charged, and possessing tremendous gravity pull.

As Angona more closely approached the sun, at moments of maximum expansion during solar pulsations, streams of gaseous material were shot out into space as gigantic solar tongues. At first these flaming gas tongues would invariably fall back into the sun, but as Angona drew nearer and nearer, the gravity pull of the gigantic visitor became so great that these tongues of gas would break off at certain points, the roots falling back into the sun while the outer sections would become detached to form independent bodies of matter, solar meteorites, which immediately started to revolve about the sun in elliptical orbits of their own.

As the Angona system drew nearer, the solar extrusions grew larger and larger; more and more matter was drawn from the sun to become independent circulating bodies in surrounding space. This situation developed for about five hundred thousand years until Angona made its closest approach to the sun; whereupon the sun, in conjunction with one of its periodic internal convulsions, experienced a partial disruption; from opposite sides and simultaneously, enormous volumes of matter were disgorged. From the Angona side there was drawn out a vast column of solar gases, rather pointed at both ends and markedly bulging at the center, which became permanently detached from the immediate gravity control of the sun.

This great column of solar gases which was thus separated from the sun subsequently evolved into the twelve planets of the solar system. The repercussional ejection of gas from the opposite side of the sun in tidal sympathy with the extrusion of this gigantic solar system ancestor, has since condensed into the meteors and space dust of the solar system, although much, very much, of this matter was subsequently recaptured by solar gravity as the Angona system receded into remote space.

Although Angona succeeded in drawing away the ancestral material of the solar system planets and the enormous volume of matter now circulating about the sun as asteroids and meteors, it did not secure for itself any of this solar matter. The visiting system did not come quite close enough to actually steal any of the sun's substance, but it did swing sufficiently close to draw off into the intervening space all of the material comprising the present-day solar system.

The five inner and five outer planets soon formed in miniature from the cooling and condensing nucleuses in the less massive and tapering ends of the gigantic gravity bulge which Angona had succeeded in detaching from the sun, while Saturn and Jupiter were formed from the more massive and bulging central portions. The powerful gravity pull of Jupiter and Saturn early captured most of the material stolen from Angona as the retrograde motion of certain of their satellites bears witness.

Jupiter and Saturn, being derived from the very center of the enormous column of superheated solar gases, contained so much highly heated sun material that they shone with a brilliant light and emitted enormous volumes of heat; they were in reality secondary suns for a short period after their formation as separate space bodies. These two largest of the solar system planets have remained largely gaseous to this day, not even yet having cooled off to the point of complete condensation or solidification.

The gas-contraction nucleuses of the other ten planets soon reached the stage of solidification and so began to draw to themselves increasing quantities of the meteoric matter circulating in near-by space. The worlds of the solar system thus had a double origin: nucleuses of gas condensation later on augmented by the capture of enormous quantities of meteors. Indeed they still continue to capture meteors, but in greatly lessened numbers.

The planets do not swing around the sun in the equatorial plane of their solar mother, which they would do if they had been thrown off by solar revolution. Rather, they travel in the plane of the Angona solar extrusion, which existed at a considerable angle to the plane of the sun's equator.

While Angona was unable to capture any of the solar mass, your sun did add to its metamorphosing planetary family some of the circulating space material of the visiting system. Due to the intense gravity field of Angona, its tributary planetary family pursued orbits of considerable distance from the dark giant; and shortly after the extrusion of the solar system ancestral mass and while Angona was yet in the vicinity of the sun, three of the major planets of the Angona system swung so near to the massive solar system ancestor that its gravitational pull, augmented by that of the sun, was sufficient to overbalance the gravity grasp of Angona and to permanently detach these three tributaries of the celestial wanderer.

All of the solar system material derived from the sun was originally endowed with a homogeneous direction of orbital swing, and had it not been for the intrusion of these three foreign space bodies, all solar system material would still maintain the same direction of orbital movement. As it was, the impact of the three Angona tributaries injected new and foreign directional forces into the emerging solar system with the resultant appearance of retrograde motion. Retrograde motion in any astronomic system is always accidental and always appears as a result of the collisional impact of foreign space bodies. Such collisions may not always produce retrograde motion, but no retrograde ever appears except in a system containing masses which have diverse origins.

ARTICLE 8 (used in Study 1, 3):

Truly revolutionary nanotech products, materials and applications, such as nanorobotics, are years in the future (some say only a few years; some say many years). What qualifies as "nanotechnology" today is basic research and development that is happening in laboratories all over the world.

"Nanotech" products that are on the market today are mostly gradually improved products (using evolutionary nanotechnology) where some form of nano-enabled material (such as carbon nanotubes, nanocomposite structures or nanoparticles of a particular substance) or nanotech process (e.g. nanopatterning or quantum dots for medical imaging) is used in the manufacturing process.

In their ongoing quest to improve existing products by creating smaller components and better performance materials, all at a lower cost, the number of companies that will manufacture "nanoproducts" (by this definition) will grow very fast and soon make up the majority of all companies across many industries. Evolutionary nanotechnology should therefore be viewed as a process that gradually will affect most companies and industries. So what exactly is nanotechnology? One of the problems facing this technology is the confusion about how to define nanotechnology. Most revolve around the study and control of phenomena and materials at length scales below 100 nm and quite often they make a comparison with a human hair, which is about 80,000 nm wide.

Some definitions include a reference to molecular nanotechnology systems and devices and 'purists' argue that any definition needs to include a reference to "functional systems". The inaugural issue of Nature Nanotechnology asked 13 researchers from different areas what nanotechnology means to them and the responses, from enthusiastic to sceptical, reflect a variety of perspectives. It seems that a size limitation to the 1-100 nm range, the area where size-dependant quantum effects come to bear, would exclude numerous materials and devices, especially in the pharmaceutical area, and some experts caution against a rigid definition based on a sub-100 nm size. Another important criteria for the definition is the requirement that the nano-structure is man-made, i.e. a synthetically produced nanoparticle or nanomaterial. Otherwise you would have to include every naturally formed biomolecule and material particle, in effect redefining much of chemistry and molecular biology as 'nanotech. The most important requirement for the nanotechnology definition is that the nano-structure has special properties that are exclusively due

to its nanoscale proportions. This definition is based on the number of dimensions of a material, which are outside the nanoscale (<100 nm) range.

Accordingly, in zero-dimensional (0D) nanomaterials all the dimensions are measured within the nanoscale (no dimensions are larger than 100 nm); in two-dimensional nanomaterials (2D), two dimensions are outside the nanoscale; and in three-dimensional nanomaterials (3D) are materials that are not confined to the nanoscale in any dimension. This class can contain bulk powders, dispersions of nanoparticles, bundles of nanowires, and nanotubes as well as multi-nanolayers.

In some senses, nanoscience and nanotechnologies are not new. Chemists have been making polymers, which are large molecules made up of nanoscale subunits, for many decades and nanotechnologies have been used to create the tiny features on computer chips for the past 20 years. However, advances in the tools that now allow atoms and molecules to be examined and probed with great precision have enabled the expansion and development of nanoscience and nanotechnologies.

The bulk properties of materials often change dramatically with nano ingredients. Composites made from particles of nano-size ceramics or metals smaller than 100 nanometers can suddenly become much stronger than predicted by existing materials-science models. For example, metals with a so-called grain size of around 10 nanometers are as much as seven times harder and tougher than their ordinary counterparts with grain sizes in the hundreds of nanometers. The causes of these drastic changes stem from the weird world of quantum physics. The bulk properties of any material are merely the average of all the quantum forces affecting all the atoms. As you make things smaller and smaller, you eventually reach a point where the averaging no longer works. The properties of materials can be different at the nanoscale for two main reasons: First, nanomaterials have a relatively larger surface area when compared to the same mass of material produced in a larger form. This can make materials more chemically reactive (in some cases materials that are inert in their larger form are reactive when produced in their nanoscale form), and affect their strength or electrical properties. Second, quantum effects can begin to dominate the behavior of matter at the nanoscale – particularly at the lower end – affecting the optical, electrical and magnetic behavior of materials. Materials can be produced that are nanoscale in one dimension (for example, nanowires, nanorods and nanotubes), in two dimensions (plate-like shapes like nanocoatings, nanolayers, and graphene) or in all three dimensions (for example, nanoparticles).

ARTICLE 9 (used in Study 1, 3):

Microorganisms are minute organisms of microscopic dimensions, too small to be seen by the eye alone. Bacteria, for example, are so small that approximately a million individual bacterial cells would fit in the space of the period at the end of this sentience. To be viewed, microorganisms must be magnified by an optical or electron microscope. The bacterium Thiomargarita namibienus, however, is visible to the unaided eye. The bacterium is about three millions times bigger than the average bacterium.

The most common types of microorganisms are viruses, bacteria, blue-green bacteria, some algae, some fungi, yeasts, and protozoans. Viruses, bacteria, and blue-green bacteria are all prokaryotes, meaning that they do not have an organized cell nucleus separated from the protoplasm by a membranelike envelope. Viruses are the simplest of the prokaryotic life forms. They are little more than simple genetic material, either DNA (deoxyribonucleic acid) or RNA (ribonucleic acid), plus associated proteins of the viral shell (called a capsid) that together comprise an infectious agent of cells. Viruses are not capable of independent reproduction. They reproduce by penetrating a host cell and diverting much of its metabolic and reproductive physiology to the reproduction of copies of the virus.

The largest kingdom of prokaryotes is the Monera. In this group, the genetic material is organized as a single strand of DNA, neither meiosis or mitosis occur, and reproduction is by asexual cellular division. Bacteria (a major division of the Monera) are characterized by rigid or

semi-rigid cell walls, propagation by binary division of the cell, and a lack of mitosis. Bluegreen bacteria or cyanobacteria (also in the Monera) use chlorophyll dispersed within the cytoplasm as the primary light-capturing pigment for their photosynthesis.

Many microorganisms are eukaryotic organisms, having their nuclear material organized within a nucleus bound by an envelope. Eukaryotes also have paired chromosomes of DNA, which can be seen microscopically during mitosis and meiosis. They also have a number of other discrete cellular organelles. Protists are a major kingdom of eukaryotes that includes microscopic protozoans, some fungi, and some algae. Protists have flagellated spores, and mitochondria and plastids are often, but not always, present. Protozoans are single-celled microorganisms that reproduce by binary fission and are often motile, usually using cilia or flagellate for propulsion; some protozoans are colonial.

Fungi are heterotrophic organisms with chitinous cell walls, and they lack flagella. Some fungi are unicellular microorganisms, but others are larger and have threadlike hyphae that form a more complex mycelium, which take the form of mushrooms in the most highly developed species. Yeasts are a group of single-celled fungi that reproduce by budding or by cellular fission. Algae are photosynthetic, non-vascular organisms, many of which are unicellular, or are found in colonies of several cells; these kinds of algae are microscopic.

Microorganisms comprise a wide range of diverse but unrelated groups of tiny organisms, characterized only by their size. As a group, microorganisms are extremely important ecologically as primary producers, and as agents of decay of dead organisms and recycling of the nutrients contained in their biomass. Some species of microorganisms are also important as parasites and as other disease-causing agents in humans and other organisms.

A microscope magnifies and resolves the image of an object that otherwise would be invisible to the naked eye, or whose detail could not be resolved using the unaided eye. These objects include such items as human skin, the eye of a fly, cells of a living organism, microorganisms such as bacteria, protozoa and viruses, individual molecules, and atoms.

Some of the above objects are large enough to be visible using the magnifying power of a light microscope. Examples include skin cells, parts of insects, and bacteria. Bacteria appear just as tiny objects. They are so small that they approach the detection limits of the light microscope. In order to make out details of microorganisms such as bacteria, and to be able to visualize viruses, much higher magnification is required.

All light moves as a wave. The wavelength of visible light is too large to resolve bacterial detail to any degree. Viruses are invisible. An analogy would be to place a small pebble in the path of an oncoming wave at an ocean side beach. The wave will pass right over the pebble, as if the pebble were not there. However, if the same pebble is placed in a stream, where the waves are much smaller in size, the pebble can disrupt the wave’s path.

The smaller wave in microscopy (the study and use of microscopes) is achieved by the use of electrons instead of visible light. The wavelength of an electron beam is extremely small. Thus, objects like bacteria and viruses can be visualized. Indeed, versions of microscopes that rely on electrical repulsion between surfaces can now visualize molecules, including the constituents of deoxyribonucleic acid (DNA).

ARTICLE 10 (used in Study 1, 3):

Mathematics tends to play a significant role in a modern-day physicist's professional life. This is a theme deftly brought out byWigner in a celebrated essay on the unreasonable effectiveness of mathematics in the natural sciences-particularly, its effectiveness in physics. It is pointed out that “... mathematical concepts turn up in entirely unexpected connections. Moreover, they often permit an unexpectedly close and accurate description of the phenomena in these connections”

Despite the seemingly restrictive subtitle of this book, Concrete Mathematics: A Foundation for Computer Science, is first and foremost a most approachable book on mathematics: mathematics pure and simple, mathematics theoretical and applied, mathematics combinatorial and

algorithmic, mathematics discrete and continuous. It is also the kind of book on mathematics many physicists will enjoy reading and be rewarded by the experience.

Concrete Mathematics is an enlightening, serious college-level textbook treating several topics in detail, by way of lucid, well-structured exposition, providing further guidance in the form of extensive exercises (complete with answers) and an occasional research problem. The two senior coauthors (Graham and Knuth) are mathematicians of international renown and respected scholars widely known to the general public and the computer science community through their earlier popular works. The unmistakable presence of the clearly recognizable talent and refreshing light touch of the junior co-author (Patashnik) is also keenly felt throughout this work

This book is the outgrowth of a course taught annually at Stanford since 1970 under the same title, "Concrete Mathematics." In organization it is an expanded, annotated version of the Mathematical Preliminaries Section 1.2 in the monumental, (continuing) multi-volume computer science classic The Art of Computer Programming, Donald E. Knuth, Addison-Wesley, 1973. The book is divided into nine chapters, many of which may be read independently as individual expository articles.

As the reader quickly catches on, an essential component of concrete mathematics lies in the interplay between the discrete and the continuous and in the cross fertilization between combinatorics and algorithmics. This book achieves its highest, most enduring level of success dealing with these topics. There are masterful discussions of the use of summations and manipulations of indices and a delightful excursion into "special numbers" of combinatoric significance. To facilitate the discussions, Iverson's notation for the ceiling and floor functions has been adopted (do you know how to express in closed form the nth term of the ascending infinite sequence 1, 2, 2, 3, 3, 3, 4, ... in which the integer m occurs m times in succession?), as has number theorist Bachmann's notation on asymptotic analysis ("big Dh" and "little Dh", etc.), both now considered standard notation in the analysis of algorithms and appearing with increasing frequency in physics journals.

It is common knowledge that physicists love and indeed thrive on analogies. In these days while the analogy between the discrete (summation) and continuous (integral) "polynomial sums and derivatives" is no longer taught in the schools as part of the regular curriculum, this book bucks the trend and gently reminds the readers of these fascinating interrelationships; it offers a fresh perspective on some of these long neglected results in the calculus of finite differences, which one rarely encounters outside their customary applications in numerical analysis and which faded in time with the advent of the infinitesimal calculus.

There are in this book interesting discussions on elementary number theory, combinatorial identities (binomial coefficients, Stirling numbers of the first and second kind, recast in an innovative and visually suggestive notation to highlight their combinatorial significance and origin), hypergeometric functions (also in a generalized notation), Euler numbers, Bernoulli numbers (dealing with the sum of the powers of integers), harmonic numbers, Fibonacci numbers, recurrence, continuant polynomials and infinite continued fractions, generating functions, asymptotic analysis, etc., to mention just a few of the many topics covered.

To all solid state physicists and materials scientists whose work involves molecular-beam epitaxy and "Fibonacci (super) lattices" (and models of other "quasicrystals" such as Penrose tilings) the reviewer heartily recommends taking a closer look at Section 6.6 on the Fibonacci numbers. In about eleven pages, many elementary results on these numbers are succinctly and elegantly laid out, including the beautifully symmetric Cassini identity between any three successive Fibonacci numbers. It should be noted, however, that this symmetry is destroyed if any indexing choice other than having ° as the zeroth term and 1 as the first term in the Fibonacci sequence is made for the boundary conditions on the Fibonacci recurrence. I hope all Fibonacci superlattice researchers will find it possible to adopt this convention in their analysis and, in so doing, reconcile the essential physics of these man-made quasi-onedimensional systems with the symmetry inherent in the mathematics.

Another strength of Concrete Mathematics is a plethora of well-placed problems to further stimulate the reader, extending his or her knowledge and problem solving skills. The viewpoint taken is that the essence of concrete mathematics resides in the solution of useful problems. Since all three authors have taught the materials of the book a number of times since 1970, the complete set of solutions to these challenging problems is a gem in clarity and illumination, which should be of tremendous help to the serious reader. (As a printed marginal note in the book wryly warned, “I would advise the casual student to stay away from this course”).

There is a chapter on discrete probability, which is presented with an eye for the beginning computer science major. It gives definitions for the mean and variance, discusses the binomial distribution, gives one example of a finite-state automaton, and then analyzes some aspects of hashing techniques in computer science. Presented on a level seemingly less exalted and more mundane than the others, this chapter handles some topics more explicitly belonging to computer science. In summary, Concrete Mathematics is a delightful, highly readable and informative book on mathematics, skillfully and expertly presented in an accessible manner.

APPENDIX B – MEASURES, QUESTIONNAIRES, AND MATERIALS

(STUDY 1 – 4)

Appendix B1: Online Intrusions Characteristics Questionnaire (Study 1 and 3)

PART 1:

Please briefly describe the intrusive memory/thought that occurred when the probe appeared: _____
_____

Please answer the following questions for the memory/thought you were having <u>the moment when probe appeared</u>

1. **I deliberately tried to bring the trauma-related memory/thought to mind**

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

2. **I intended to bring the trauma-related memory/thought to mind**

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

3. **When the trauma-related memory/thought came to mind, they felt intrusive**

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

4. **The trauma-related memory/thought came to mind spontaneously**

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

5. **The trauma-related memory/thought came to mind effortlessly**

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

6. **It was easy to bring the trauma-related memory/thought to mind**

1	2	3	4	5	6	7

Not at all accurate						Completely accurate

7. I tried hard to bring the trauma-related memory/thought to mind

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

8. On average, how distressing were the trauma-related memory/thought?

1	2	3	4	5	6	7
Not at all distressing						Extremely Distressing

9. To what extent were the trauma-related memory/thought unwanted?

1	2	3	4	5	6	7
Not at all unwanted						Completely unwanted

10. To what extent were the trauma-related memory/thought threatening?

1	2	3	4	5	6	7
Not at all threatening						Completely threatening

11. On average, how vivid were the trauma-related memory/thought?

1	2	3	4	5	6	7
Not at all vivid						Extremely vivid

12. How intense were the emotions you felt when the trauma-related memory/thought came to mind?

1	2	3	4	5	6	7
Not at all intense						Extremely intense

13. While having the trauma-related memory/thought, were the emotions you felt negative or positive?

1	2	3	4	5	6	7
Extremely negative						Extremely positive

14. To what extent did you feel like you were reliving the traumatic moment when this memory/thought occurred?

1	2	3	4	5	6	7
Not at all reliving						Extremely reliving

15. To what extent did you 'see' yourself in any image you experienced or observe yourself as if from a distance when this thought/memory occurred?

1	2	3	4	5	6	7
Not at all						Extremely

16. To what extent did you feel like you were disconnected with your environment when this thought/memory occurred? (feeling like it isn't real or feels as if in a dream)

1	2	3	4	5	6	7
Not at all disconnected						Extremely disconnected

17. To what extent did this thought/memory seem like snapshot of the overall traumatic experience. That is, disjointed from the other parts of the experience, or seemed like just random snippet of the experience?

1	2	3	4	5	6	7
Not at all like a snapshot						Extremely like a snapshot

18. When this thought/memory occurred at the probe, was it in the form of a thought, picture/single image, or moving images/like a video?

1) As verbal thought only
2) As a picture/single image (no movement)
3) As moving images only
4) Both single image and movement/video replay
5) Thoughts, single images/pictures, and movement/video replay
6) Other: _____

19. Did you smell, taste, feel, hear anything when this thought/memory occurred?

1) Smelled
2) Tasted
3) Felt (physical sensation, <u>not</u> emotion)
4) Heard
5) Other: _____

PART 2: The following questions are about how you experience in **<u>daily life</u>** this trauma-related memory/thought.

1. **Please briefly describe the *meaning* of this memory/thought to you (e.g., an important life lesson, a major event that created my current personality etc.): _____.**

2. **To what extent was the trauma-related memory/thought meaningful <u>to you</u>?**

1	2	3	4	5	6	7
Not at all meaningful						Extremely meaningful

3. **To what extent was the trauma-related memory/thought meaningful <u>to your life</u>?**

1	2	3	4	5	6	7
Not at all meaningful						Extremely meaningful

4. **How difficult is it to deliberately recall this memory in your day-to-day life?**

1	2	3	4	5	6	7
Not at all difficult						Extremely difficult

5. **How likely would you think of this specific memory/thought if someone asked you to describe your negative experience/trauma?**

1	2	3	4	5	6	7
Not at all likely						Extremely likely

6. **How many times does <u>this</u> memory/thought occur in a typical week? __**

7. **How many times a typical week do you have <u>any</u> thoughts/memories about the negative event/trauma.__**

Appendix B2: Face-to-face Intrusions Characteristics Questionnaire (Study 2)

ICQ for the general experience of aware intrusions:

Rate the following statements as to how well they describe, on average, your experience of the memories/thoughts coming to mind in a way that led you to press the 'x' key. That is, answers the questions below about the thoughts/memories **you noticed yourself** had come into your mind. The questions are about your thoughts/memories at the time they occurred during the reading task (not what you think now).

☐ I never had this type of memories during the task (please see the experimenter)

1. I deliberately tried to bring the trauma-related memories/thoughts to mind

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

2. I intended to bring the trauma-related memories/thoughts to mind

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

3. When the trauma-related memories/thoughts came to mind, they felt intrusive

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

4. The trauma-related memories/thoughts came to mind spontaneously

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

5. The trauma-related memories/thoughts came to mind effortlessly

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

6. It was easy to bring the trauma-related memories/thoughts to mind

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

7. I tried hard to bring the trauma-related memories/thoughts to mind

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

8. On average, how distressing were the trauma-related memories/thoughts?

1	2	3	4	5	6	7
Not at all distressing						Extremely Distressing

9. On average, how vivid were the trauma-related memories/thoughts?

1	2	3	4	5	6	7
Not at all vivid						Extremely vivid

10. To what extent were the trauma-related memories/thoughts unwanted?

1	2	3	4	5	6	7
Not at all unwanted						Completely unwanted

11. How intense were the emotions you felt when the trauma-related memories/thoughts came to mind?

1	2	3	4	5	6	7
Not at all intense						Extremely intense

12. While having the trauma-related memories/thoughts, were the emotions you felt negative or positive?

1	2	3	4	5	6	7
Extremely negative						Extremely positive

ICQ for the general experience of unaware intrusions:

Rate the following statements as to how well they describe, on average, your experience of the memories/thoughts coming to mind in a way that led you to respond 'option 3' to probes. That is, answer the questions below about the thoughts/memories **you were not initially aware** had come into your mind. The questions are about your thoughts/memories at the time they occurred during the reading task (not what you think now).

☐ I never had this type of memories during the task (please see the experimenter)

1. I deliberately tried to bring the trauma-related memories/thoughts to mind

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

2. I intended to bring the trauma-related memories/thoughts to mind

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

3. When the trauma-related memories/thoughts came to mind, they felt intrusive

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

4. The trauma-related memories/thoughts came to mind spontaneously

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

5. The trauma-related memories/thoughts came to mind effortlessly

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

6. It was easy to bring the trauma-related memories/thoughts to mind

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

7. I tried hard to bring the trauma-related memories/thoughts to mind

1	2	3	4	5	6	7

Not at all accurate						Completely accurate

8. On average, how distressing were the trauma-related memories/thoughts?

1	2	3	4	5	6	7
Not at all distressing						Extremely Distressing

9. On average, how vivid were the trauma-related memories/thoughts?

1	2	3	4	5	6	7
Not at all vivid						Extremely vivid

10. To what extent were the trauma-related memories/thoughts unwanted?

1	2	3	4	5	6	7
Not at all unwanted						Completely unwanted

11. How intense were the emotions you felt when the trauma-related memories/thoughts came to mind?

1	2	3	4	5	6	7
Not at all intense						Extremely intense

12. While having the trauma-related memories/thoughts, were the emotions you felt negative or positive?

1	2	3	4	5	6	7
Extremely negative						Extremely positive

Appendix B3: Life Event Checklist and Posttraumatic Stress Disorder Checklist (PCL-5)

Listed below are a number of difficult or stressful things that sometimes happen to people. For each event check one or more of the boxes to the right to indicate that: (a) it happened to you personally; (b) you witnessed it happen to someone else; (c) you learned about it happening to a close family member or close friend; (d) you were exposed to it as part of your job (for example, paramedic, police, military, or other first responder); (e) you're not sure if it fits; or (f) it doesn't apply to you.

Be sure to consider your *entire life* (growing up as well as adulthood) as you go through the list of events.

Questions	Happened to me	Witnessed it	Learned about it	Part of my job	Not sure	Doesn't apply
1. Transportation accident (for example, an industrial, farm, car, plane, train or boating accident)						
2. Fire or Explosion						
3. Natural disaster (for example, tornado, hurricane, flood, or major earthquake)						
4. Serious accident at work, home, or during recreational activity						
5. Exposure to toxic substance (e.g., dangerous chemicals, radiation)						
6. Physical assault (for example, being physically attacked, hit, slapped, kicked, beaten up)						
7. Assault with a weapon (e.g., being shot, stabbed, threatened with a knife, gun, bomb)						
8. Sexual assault (for example, rape or attempted rape, made to perform any type of sexual act through force or threat of harm)						
9. Other unwanted or uncomfortable sexual experience						

10. Military combat or exposure to a war zone (in the military or as a civilian)						
11. Captivity (for example, being kidnapped, abducted, held hostage, prison inmate, prisoner of war)						
12. Severe human suffering)						
13. Life-threatening illness or injury						
14. Sudden violent death (for example, homicide, suicide)						
15. Sudden accidental death						
16. Serious injury, harm, or death you caused to someone else						
17. Any other traumatic event (please specify: _ _____						

Amended from LEC-5 (Weathers, F.W., Blake, D.D., Schnurr, P.P., Kaloupek, D.G., Marx, B.P., & Keane, T.M. (2013) *The Life Events Checklist for DSM-5 (LEC-5).*

A. If you checked anything for #20, briefly identify the event you were thinking of:
_____

B. If you have experienced more than one of the events listed on the previous page/above, think about the event you consider the *worst event,* which for this questionnaire means the event that currently bothers you the most. If you have experienced only one of the events on the previous page/above, use that one as the worst event. Please answer the following questions about the worst event *(check all options that apply)*:

1. Briefly describe the worst event *(for example, what happened, who was involved, etc.)*.
_____
_____
_____
_____

2. How long ago did it happen (in years)? _____ *(please estimate if you are not sure)*

3. How did you experience it?

____ *It happened to me directly*
____ *I witnessed it*
____ *I learned about it happening to a close family member or close friend*

____ I was repeatedly exposed to details about it as part of my job (for example, paramedic, police, military, or other first responder)
____ Other, please describe:

4. Was someone's life in danger?

____ Yes, my life
____Yes, someone else's life
____No

5. Was someone seriously injured or killed?

____ Yes, I was seriously injured
____ Yes, someone else was seriously injured or killed
____ No

6. Did it involve sexual violence? *____Yes ____No*

7. If the event involved the death of a close family member or close friend, was it due to some kind of accident or violence, or was it due to natural causes?

____ Accident or violence
____ Natural causes
____ Not applicable (The event did not involve the death of a close family member or close friend)

8. How many times altogether have you experienced a similar event as stressful or nearly as stressful as the worst event?

____ Just once
____ More than once (please specify or estimate the total # of times you have had this experience _____)

Part 3: Below is a list of problems that people sometimes have in response to a very stressful experience. Keeping your worst event in mind, please read each problem carefully and then circle one of the numbers to the right to indicate how much you have been bothered by that problem **in the past month**.

In the past month, how much were you bothered by:	**Not at all**	**A little bit**	**Moderately**	**Quite a bit**	**Extremely**
1. Repeated, disturbing, and unwanted memories of the stressful experience?	**0**	**1**	**2**	**3**	**4**
2. Repeated, disturbing dreams of the stressful experience?	**0**	**1**	**2**	**3**	**4**
3. Suddenly feeling or acting as if the stressful experience were actually happening again (as if you were actually back there reliving it)?	**0**	**1**	**2**	**3**	**4**
4. Feeling very upset when something reminded you of the stressful experience?	**0**	**1**	**2**	**3**	**4**
5. Having strong physical reactions when something reminded you of the stressful experience (for example, heart pounding, trouble breathing, sweating)?	**0**	**1**	**2**	**3**	**4**
6. Avoiding memories, thoughts, or feelings related to the stressful experience?	**0**	**1**	**2**	**3**	**4**
7. Avoiding external reminders of the stressful experience (for example, people, places, conversations, activities, objects, or situations)?	**0**	**1**	**2**	**3**	**4**
8. Trouble remembering important parts of the stressful experience?	**0**	**1**	**2**	**3**	**4**
9. Having strong negative beliefs about yourself, other people, or the world (for example, having thoughts such as: I am bad, there is something seriously wrong with me, no one can	**0**	**1**	**2**	**3**	**4**

be trusted, the world is completely dangerous)?					
10. Blaming yourself or someone else for the stressful experience or what happened after it?	**0**	**1**	**2**	**3**	**4**
11. Having strong negative feelings such as fear, horror, anger, guilt, or shame?	**0**	**1**	**2**	**3**	**4**
12. Loss of interest in activities that you used to enjoy?	**0**	**1**	**2**	**3**	**4**
13. Feeling distant or cut off from other people?	**0**	**1**	**2**	**3**	**4**
14. Trouble experiencing positive feelings (for example, being unable to feel happiness or have loving feelings for people close to you)?	**0**	**1**	**2**	**3**	**4**
15. Irritable behaviour, angry outbursts, or acting aggressively?	**0**	**1**	**2**	**3**	**4**
16. Taking too many risks or doing things that could cause you harm?	**0**	**1**	**2**	**3**	**4**
17. Being "super-alert" or watchful or on guard?	**0**	**1**	**2**	**3**	**4**
18. Feeling jumpy or easily startled?	**0**	**1**	**2**	**3**	**4**
19. Having difficulty concentrating?	**0**	**1**	**2**	**3**	**4**
20. Trouble falling or staying asleep?	**0**	**1**	**2**	**3**	**4**

Appendix B4: Depression Anxiety and Stress scale (DASS-21)

Please read each statement and circle a number 0, 1, 2, or 3 which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0. Did not apply to me at all
1. Applied to me to some degree, or some of the time
2. Applied to me to a considerable degree, or a good part of the time
3. Applied to me very much, or most of the time

1	I found it hard to wind down.	0	1	2	3
2	I was aware of dryness of my mouth.	0	1	2	3
3	I couldn't seem to experience any positive feelings at all.	0	1	2	3
4	I experienced breathing difficulty (e.g., excessively rapid breathing, Breathlessness in the absence of physical exertion).	0	1	2	3
5	I found it difficult to work up the initiative to do things.	0	1	2	3
6	I tended to over-react to situations.	0	1	2	3
7	I experienced trembling (e.g., in the hands).	0	1	2	3
8	I felt that I was using a lot of nervous energy.	0	1	2	3
9	I was worried about situations in which I might panic and make a fool of myself.	0	1	2	3
10	I felt that I had nothing to look forward to.	0	1	2	3
11	I found myself getting agitated.	0	1	2	3
12	I found it difficult to relax.	0	1	2	3
13	I felt down-hearted and blue.	0	1	2	3
14	I was intolerant of anything that kept me from getting on with what I was doing.	0	1	2	3
15	I felt I was close to panic.	0	1	2	3
16	I was unable to become enthusiastic about anything.	0	1	2	3
17	I felt I wasn't worth much as a person.	0	1	2	3
18	I felt that I was rather touchy.	0	1	2	3
19	I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat).	0	1	2	3
20	I felt scared without any good reason.	0	1	2	3
21	I felt that life was meaningless.	0	1	2	3

Appendix B5: White Bear Suppression Inventory (WBSI) (Study 1, 3, 4)

Please circle the number for each item that best describes how you generally deal with your thoughts SINCE THE TRAUMA, where 1 = 'strongly disagree' and 5 = 'strongly agree'. Please consider ALL types of thoughts, not just those related to the trauma.

	Strongly disagree				Strongly agree
1. There are things I prefer not to think about	1	2	3	4	5
2. Sometimes I wonder why I have the thoughts I do	1	2	3	4	5
3. I have thoughts that I cannot stop	1	2	3	4	5
4. There are images that come to mind that I cannot erase	1	2	3	4	5
5. My thoughts frequently return to one idea	1	2	3	4	5
6. I wish I could stop thinking of certain things	1	2	3	4	5
7. Sometimes my mind races so fast I wish I could stop it	1	2	3	4	5
8. I always try to put problems out of mind	1	2	3	4	5
9. There are thoughts that keep jumping into my head	1	2	3	4	5
10. Sometimes I stay busy just to keep thoughts from intruding on my mind	1	2	3	4	5
11. There are things that I try not to think about	1	2	3	4	5
12. Sometimes I really wish I could stop thinking	1	2	3	4	5

13. I often do things to distract myself from my thoughts	1	2	3	4	5
14. I often have thoughts that I try to avoid	1	2	3	4	5
15. There are many thoughts that I have that I don't tell anyone	1	2	3	4	5

Appendix B6: Cue Word Noting Sheet (Study 2)

Noticed memory/thought about your trauma (Pressed 'x' key)	**<u>Unnoticed</u> memory/thought about your trauma (Responded option '3' to blue screen)**

Appendix B7: Structured Intrusion Interview Checklist (Study 2)

Unless specified, the following interview questions ask you to describe your experience when this thought/memory occurred during the reading task:

Please elaborate your answer when respond to the following questions

Intrusive memories or thought

1. Did you see image or movement when this thought/memory occurred at that moment? (or it was just a verbal thought? If so, how is it trauma-related?)

Sensory experience and emotions

2. Did you smell, taste, feel, hear anything when this thought/memory occurred at that moment?
3. Did your emotions change when this thought/memory occurred at that moment? (e.g., becoming anxious, angry or sad)

Specific meaning of intrusions

1. What is the meaning of this thought/memory to you? (e.g., is it important or does it mean something to you that you've had this memory, and if so what/why')

Frequency and duration

2. How long did it feel like when this thought/memory occurred at that moment?
3. In your day-to-day life, how often does this thought/memory occur on a weekly basis?
4. In your day-to-day life, what do you normally do when this thought/memory come into mind?

Subjective thoughts about conscious intrusions

1. How did you notice this thought/memory during the task? (self-caught question only)

Avoidance

2. In your day-to-day life, do you try not to think about this memory/thought? If so, what do you do when this thought/memory pops in your head?

Please rate the following questions on a scale of 1-7, where 1 means not at all and 7 means extremely agree.

Appraisals of the intrusion episode

1. How unwanted is this thought/memory when you noticed it?
2. How distressing is this thought/memory when you noticed it?
3. How threatening is this thought/memory when you noticed it?

Accessibility of intrusions

1. How difficult is it to deliberately recall this thought/memory during this interview without noting down the cue words previously?
2. How difficult is it to recall this memory in your day-to-day life?
3. How likely would you think of this specific memory if someone asked you to describe your negative experience?

Characteristics of intrusions

4. How vivid was this thought/memory when it occurred at that moment?
5. How involuntary was this thought/memory?
6. To what extent did you feel like you were reliving the traumatic moment when this thought/memory occurred at that moment?
7. To what extent did you see yourself in the image or observe yourself from a distance when this thought/memory occurred at that moment?
8. To what extent did you feel like you disconnect with your environment when this thought/memory occurred at that moment? (feeling like it isn't real or feels as if in a dream)

9. To what extent did this thought/memory seem like snapshot of the overall traumatic experience. That is, disjointed from the other parts of the experience, or seemed like just random snippet of the experience?

Appendix B8: Positive and Negative Affect Scale – Negative affect subscale (PANAS-N) and Repetitive Thinking Questionnaire (RTQ) (Study 3)

Recall the last time you felt especially distressed or upset. Briefly describe this situation in terms of what happened and what you did.

Think about how you felt **at the time** of the situation. Rate how strongly you felt each of the following emotions.

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
1. Distressed	1	2	3	4	5
2. Upset	1	2	3	4	5
3. Guilty	1	2	3	4	5
4. Scared	1	2	3	4	5
5. Hostile	1	2	3	4	5
6. Irritable	1	2	3	4	5
7. Ashamed	1	2	3	4	5
8. Nervous	1	2	3	4	5
9. Jittery	1	2	3	4	5
10. Afraid	1	2	3	4	5

Now, please answer the following questions in relation to the situation you have just described. How true (1-5) are each of these statements with respect to your experience **after the situation**?

1 **2** **3** **4** **5**

Not true at all Somewhat true Very true

1. You had thoughts or images about the situation that occurred over and over again, that resulted in your feelings getting worse and worse.	1	2	3	4	5
2. There was nothing more I could do about the situation, so I didn't think about it anymore.	1	2	3	4	5
3. You listened to sad music	1	2	3	4	5
4. You had thoughts or images about turning the clock back to do something again, but do it better.	1	2	3	4	5
	Not true at all		Some-what true		Very true
5. You had thoughts or images about all your shortcomings, failings, faults, mistakes.	1	2	3	4	5

6. You went some place alone to think about your feelings.	1	2	3	4	5
7. Your thoughts overwhelmed you	1	2	3	4	5
8. You had thoughts or images like "*Why do I have problems other people don't have?"*	1	2	3	4	5
9. When you were under pressure, you thought a lot about the situation	1	2	3	4	5
10. You had thoughts or images about a past event that came into your head even when you did not wish to think about it again	1	2	3	4	5
11. You had thoughts or images that "*I won't be able to do my job/work because I feel so badly."*	1	2	3	4	5
12. You went away by yourself and thought about why you felt this way.	1	2	3	4	5
13. You had thoughts or images about the situation that resulted in you avoiding similar situations and that reinforced a decision to avoid similar situations.	1	2	3	4	5
14. I found it easy to dismiss distressing thoughts about the situation	1	2	3	4	5
15. You had thoughts or images like "*Why can't I get going*?"	1	2	3	4	5
16. You had thoughts or images of the situation that were difficult to forget.	1	2	3	4	5
17. I was always thinking about something.	1	2	3	4	5
18. I didn't tend to think about it (the situation)	1	2	3	4	5
19. Once I started thinking about the situation, I couldn't stop.	1	2	3	4	5
20. I didn't have enough time to do everything, so I didn't think about it	1	2	3	4	5
21. You had thoughts or images about how alone you felt.	1	2	3	4	5
22. You had a lot of thoughts or images of the situation after it was over.	1	2	3	4	5
23. I noticed that I had been thinking about the situation.	1	2	3	4	5
24. You had thoughts or images of the situation that you tried to resist thinking about.	1	2	3	4	5
25. You had thoughts or images about how angry you were with yourself.	1	2	3	4	5
26. I thought about the situation all the time.	1	2	3	4	5
27. I thought about the situation until it was all done	1	2	3	4	5
28. I knew I shouldn't have thought about the situation, but I couldn't help it	1	2	3	4	5
29. You had thoughts or images asking "*Why do I always react this way?*"	1	2	3	4	5
30. You had thoughts or images about the situation and wishing it had gone better.	1	2	3	4	5
31. The situation really made you think	1	2	3	4	5

Appendix B9: Repetitive Thinking Questionnaire – State version (RTQ-S) (Study 3, 4)

Please answer the following questions in relation to **the worst event you described on the previous page**. How true (1-5) are each of these statements with respect to your experience after your trauma happened to you?

1 = not at all; 3 = somewhat true; 5 = very true

1. I had thoughts or images about the trauma that occurred over and over again, that resulted in your feelings getting worse and worse.	1	2	3	4	5
2. There was nothing more I could do about the trauma, so I didn't think about it anymore.	1	2	3	4	5
3. U listened to sad music	1	2	3	4	5
4. I had thoughts or images about turning the clock back to do something again, but do it better.	1	2	3	4	5
5. I had thoughts or images about all my shortcomings, failings, faults, mistakes.	1	2	3	4	5
6. I went some place alone to think about your feelings.	1	2	3	4	5
7. I thoughts overwhelmed me	1	2	3	4	5
8. I had thoughts or images like "*Why do I have problems other people don't have?"*	1	2	3	4	5
9. When I was under pressure, I thought a lot about the situation	1	2	3	4	5
10. I had thoughts or images about a past event that came into my head even when you did not wish to think about it again	1	2	3	4	5
11. I had thoughts or images that "*I won't be able to do my job/work because I feel so badly."*	1	2	3	4	5
12. I went away by myself and thought about why I felt this way.	1	2	3	4	5
13. I had thoughts or images about the situation that resulted in me avoiding similar situations and that reinforced a decision to avoid similar situations.	1	2	3	4	5
14. I found it easy to dismiss distressing thoughts about the trauma	1	2	3	4	5
15. I had thoughts or images like "*Why can't I get going*?"	1	2	3	4	5
16. I had thoughts or images of the trauma that were difficult to forget.	1	2	3	4	5
17. I was always thinking about something.	1	2	3	4	5
18. I didn't tend to think about it (the situation)	1	2	3	4	5
19. Once I started thinking about the trauma, I couldn't stop.	1	2	3	4	5
20. I didn't have enough time to do everything, so I didn't think about it	1	2	3	4	5
21. I had thoughts or images about how alone I felt.	1	2	3	4	5
22. I had a lot of thoughts or images of the trauma after it was over.	1	2	3	4	5

23. I noticed that I had been thinking about the trauma.	1	2	3	4	5
24. I had thoughts or images of the trauma that I tried to resist thinking about.	1	2	3	4	5
25. I had thoughts or images about how angry I was with myself.	1	2	3	4	5
26. I thought about the trauma all the time.	1	2	3	4	5
27. I thought about the trauma until it was all done	1	2	3	4	5
28. I knew I shouldn't have thought about the trauma, but I couldn't help it	1	2	3	4	5
29. I had thoughts or images asking "*Why do I always react this way?*"	1	2	3	4	5
30. I had thoughts or images about the trauma and wishing it had gone better.	1	2	3	4	5
31. The situation really made you think	1	2	3	4	5

Appendix B10: Toronto Alexithymia Scale (TAS-20) (Study 3, 4)

Using the scale provided as a guide, indicate how much you agree or disagree with each of the following statements. Give only one answer for each statement: (1) Strongly Disagree, (2) Moderately Disagree, (3) Neither Disagree nor Agree, (4) Moderately Agree, (5) Strongly Agree.

1. I am often confused about what emotion I am feeling	1	2	3	4	5
2. It is difficult for me to find the right words for my feelings	1	2	3	4	5
3. I have physical sensations that even doctors don't understand	1	2	3	4	5
4. I'm able to describe my feelings easily	1	2	3	4	5
5. I prefer to analyze problems rather than just describe them	1	2	3	4	5
6. When I am upset, I don't know if I am sad, frightened, or angry	1	2	3	4	5
7. I am often puzzled by sensations in my body	1	2	3	4	5
8. I prefer to just let things happen rather than to understand why they turned out that way	1	2	3	4	5
9. I have feelings that I can't quite identify	1	2	3	4	5
10. Being in touch with emotions is essential	1	2	3	4	5
11. I find it hard to describe how I feel about people	1	2	3	4	5
12. People tell me to describe my feelings more	1	2	3	4	5
13. I don't know what's going on inside me	1	2	3	4	5
14. I often don't know why I am angry	1	2	3	4	5
15. I prefer talking to people about their daily activities rather than their feelings	1	2	3	4	5
16. I prefer to watch "light" entertainment shows rather than psychological dramas	1	2	3	4	5
17. It is more difficult for me to reveal my innermost feelings, even to close friends	1	2	3	4	5
18. I can feel close to someone, even in moments of silence	1	2	3	4	5

19. I find examination of my feelings useful in solving personal problems	1	2	3	4	5
20. Looking for hidden meanings in movies or plays distracts from their enjoyment	1	2	3	4	5

Appendix B11: Post-intervention Questionnaire (Study 4)

Please read each statement and select a number on a 7-point-likert scale which indicates how much the statement applied to you when you were instructed to close your eyes. There are no right or wrong answers. Do not spend too much time on any statement.

1. **I tried hard to suppress any the negative-event-related memories/thoughts that came to mind**

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

2. **The negative-event-related memories/thoughts were hard to suppress**

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

3. **The negative-event-related memories/thoughts were distressing**

1	2	3	4	5	6	7
Not at all accurate						Completely accurate

4. **Please describe the most frequent intrusive memory during the 5-minute break:**

_____
_____
_____
_____
_____

Appendix B12: Mindfulness Attention and Awareness Scale (MAAS) (Study 4)

Below is a collection of statements about your everyday experience. Using the 1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every other item.

1	2	3	4	5	6
Almost always	Very frequently	Somewhat frequently	Somewhat infrequently	Very infrequently	Almost never

_____ 1. I could be experiencing some emotion and not be conscious of it until some time later.
_____ 2. I break or spill things because of carelessness, not paying attention, or thinking of something else.

_____ 3. I find it difficult to stay focused on what's happening in the present.
__ ___ 4. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.
_____ 5. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.
_____ 6. I forget a person's name almost as soon as I've been told it for the first time.
_____ 7. It seems I am "running on automatic," without much awareness of what I'm doing.

_____ 8. I rush through activities without being really attentive to them.
_____ 9. I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.
_____ 10. I do jobs or tasks automatically, without being aware of what I'm doing.
_____ 11. I find myself listening to someone with one ear, doing something else at the same time.
_____ 12. I drive places on 'automatic pilot' and then wonder why I went there.
_____ 13. I find myself preoccupied with the future or the past.
_____ 14. I find myself doing things without paying attention.
_____ 15. I snack without being aware that I'm eating.

APPENDIX C – SIGNIFICANT INTERACTION BETWEEN PTSD SEVERITY AND META-AWARENESS ON INTRUSION CHARACTERISTICS (STUDY 2)

Table C1

Mean, Standard Errors, Repeated Measures ANOVA for PSTD Severity and Meta-awareness Interaction on Tried Hard to Bring Back Trauma-related Intrusions

Meta-awareness	High-PTS *M* (*SE*)	Low-PTS *M* (*SE*)	*F*(1, 63)	partial η^2
Aware	1.53 (0.18)	1.68 (0.19)	4.88*	.072
Unaware	1.29 (0.16)	2.10 (0.17)		

Note. Ranges of variables (1 = not at all; 7 = extremely). PTS = Posttraumatic Stress Symptoms.

[a] Pairwise comparison significant ($p < .05$). *$p < .05$, **$p < .001$.

Table C2

Mean, Standard Errors, Repeated Measures ANOVA for PSTD Severity and Meta-awareness Interaction on Vividness

Meta-awareness	High-PTS *M* (*SE*)	Low-PTS *M* (*SE*)	*F*(1, 58)	partial η^2
Aware[a]	5.63 (0.23)	4.75 (0.25)	7.65*	.120
Unaware	4.66 (0.27)	4.74 (0.29)		

Note. Ranges of variables (1 = not at all; 7 = extremely). PTS = Posttraumatic Stress Symptoms.

[a] Pairwise comparison significant ($p < .05$). *$p < .05$, **$p < .001$.

APPENDIX D – SUPPLEMENTARY TABLE (STUDY 4)

Table D1

Means, Standard Deviations, Correlations Between Meta-awareness and Other Key Variables (N = 33)

Variables	*M* (*SD*)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. T1 self-caught intrusions	5.36 (6.35)	-															
2. T1 probe-caught aware intrusions (%)	5.15 (6.24)	.31*	-														
3. T1 probe-caught unaware intrusions (%)	9.96 (13.21)	.04	.32*	-													
4. Observed intrusion frequency	4.51 (4.00)	.37*	.16	.15	-												
5. Effort to suppress	4.42 (2.03)	.27	.26	.29	.33*	-											
6. Difficulty to suppress	3.51 (1.70)	.45*	.26	.21	.52**	.23	-										
7. Distress of intrusion	3.51 (1.93)	.26	.17	.31*	.36*	-.00	.71**	-									
8. T2 self-caught intrusions	4.78 (8.04)	.80**	.43**	.23	.31*	.37*	.42**	.29	-								

Variables	*M* (*SD*)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
9. T2 probe-caught aware intrusions (%)	4.24 (7.83)	.37*	.64**	.44**	.13	.29	.29	.15	.37*	-							
10. T2 probe-caught unaware intrusions (%)	8.16 (16.74)	-.05	.38**	.80**	.15	.22	.26	.25	.19	.39**	-						
11. PCL-5	32.29 (15.78)	.28	.31*	.36*	.19	.42**	.36*	.35*	.34*	.23	.33*	-					
12. DASS-D	13.96 (9.73)	.28	.24	.25	.31*	.19	.20	.28	.37*	.32*	.17	.29	-				
13. TAS-20	54.60 (9.25)	.28	.15	.34*	.15	.24	.15	.31*	.28	.28	.24	.29	.45**	-			
14. WBSI	50.56 (12.10)	.42**	.31*	.30*	.33*	.45**	.41**	.53**	.44**	.22	.25	.54**	.51**	.54**	-		
15. RTQS	75.27 (22.89)	.15	.30*	.36*	.25	.41**	.32*	.37*	.27	.16	.26	.72**	.45**	.17	.61**	-	
16. MAAS	3.40 (0.94)	-.24	-.34*	-.22	-.16	-.23	-.16	-.12	-.17	-.25	-.14	-.23	-.35**	-.31*	-.49**	-.27	-

Notes. T1 = Pre-intervention phase; T2 = Post-intervention phase; PCL-5 = Posttraumatic Stress Disorder; DASS-D = Depression Anxiety and Stress Disorder – Depression subscale; TAS-20 = Toronto Alexithymia Scale; RTQS = State Repetitive Thinking Questionnaire; WBSI = White Bear Suppression Inventory; MASS = Mindfulness Attention and Awareness Scale Questionnaire; *$p < .05$, **$p < .001$.

Table D2

Main Effects of Time and Group in Their Interaction on Meta-awareness

	Self-Caught Intrusions			Probe-caught intrusions														
				Continuous			Aware			Unaware			Non-trauma-related			Task-related		
Effect	*F*	*p*	η^2_p	*F*	*p*	η^2_p	*F*	*p*	η^2_p	*F*	*p*	η^2_p	*F*	*p*	η^2_p	*F*	*p*	η^2_p
Time	0.14	.716	.006	4.57	.044	.179	0.94	.344	.043	0.32	.578	.015	0.39	.540	.018	5.61	.028	.211
Group	2.28	.146	.098	1.46	.241	.065	1.10	.306	.050	1.91	.181	.084	0.59	.451	.027	3.72	.067	.151

Notes. η^2_p = partial eta squared; Degree of freedom = 1; error = 21.

Table D3

Significant Main Effects of Time in Time x Group Interaction on Probe-caught Continuous and Task-related Intrusions (%)

	Pre-intervention		Post-intervention	
Probe-caught intrusions	*M* (*SE*)	95% Confidence Intervals	*M* (SE)	95% Confidence Intervals
Continuous	11.28 (3.13)	[4.78, 17.79]	4.83 (1.75)	[1.18, 8.48]
Task-related	64.62 (5.22)	[53.75, 75.48]	72.66 (6.21)	[59.75, 85.57]

Notes. SE = standardised errors.

APPENDIX E –SIGNIFICANT THREE-WAY INTERACTION BETWEEN TIME, GROUP, AND TRAUMA ON UNAWARE INTRUSIONS AND TASK-RELATED THOUGHTS (STUDY 4)

Table E

Means, Standard Deviations and Pairwise Comparisons for Probe-caught Task-related Intrusions (%)

	Control				Thought Suppression			
Trauma type	Pre-intervention *M* (*SD*)	Post-intervention *M* (*SD*)	*p*	95% Confidence Intervals	Pre-intervention *M* (*SD*)	Post-intervention *M* (*SD*)	*p*	95% Confidence Intervals
	n = 11				*n* = 17			
Criterion A	65.91 (21.45)	77.55 (19.36)	.050	[-22.28, -0.05]	65.58 (26.32)	67.10 (30.35)	.744	[-10.88, 7.84]
	n = 12				*n* = 5			
Non-criterion A	66.30 (17.37)	68.18 (26.50)	.736	[-13.02, 9.27]	47.90 (35.97)	67.07 (38.23)	.030	[-36.43, -1.09]