Trauma Memory Characteristics and Neurocognitive Performance in Trauma Exposed Youth

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Abstract

For a substantial minority of young people, exposure to a traumatic event may subsequently result in the development of post-traumatic stress disorder (PTSD). Cognitive models of PTSD propose that trauma memory characteristics including disorganisation, greater sensory content, and temporal disruption, are relevant to the aetiology of the disorder. Research pertaining to trauma memory characteristics in youth populations had produced mixed findings. Research suggests that PTSD in youth may be accompanied by difficulties in neurocognitive functioning, which could plausibly affect memory function. Neurocognitive functioning has predominantly been investigated in multiply traumatised youth populations and understanding in relation to single-event trauma is limited.

This portfolio presents a systematic review and meta-analysis investigating strength of the relationship between trauma memory characteristics, as measured by a standardised trauma memory questionnaire, and post-traumatic stress symptoms (PTSS) in youth. Following this, an empirical paper presents analysis of pre-existing pre- and post-treatment data on self-report and narrative trauma memory, and neurocognitive functioning, from a study investigating single-event trauma in youth.

The meta-analysis demonstrated a large estimated effect size for the relationship between trauma memory characteristics and PTSS in youth. The empirical study indicated that pre-treatment trauma memories were more sensory-laden, temporally disrupted, and difficult to verbally access, but not disorganised. Post-treatment results demonstrated decreased self-reported sensory content alongside increased verbal accessibility and narrative coherence. Clearer results were observed for self-report data than narrative data. Neurocognitive functioning was found to be preserved in trauma exposed youth.

The results suggest that trauma memory characteristics are relevant to the aetiology of PTSD in youth and that these are more likely to be underpinned by cognitive factors than neurocognitive factors. Further research clarifying the interaction between trauma memory characteristics and other core cognitive factors in youth PTSD could further advance understanding of the disorder and refinement of psychological treatments.

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Chapter One: Introduction to the thesis portfolio

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A traumatic event is defined as one in which an individual is exposed to actual - or threatened - death, serious injury, or sexual violence (American Psychiatric Association [APA], 2013). The experience of such events is common for children and young people, with a recent study estimating that approximately a third of young people had been exposed to a traumatic event by the age of 18. Whilst many young people experience natural recovery, without psychological intervention, in the months following a traumatic event, a significant minority may subsequently develop post-traumatic stress disorder (PTSD). PTSD is characterised by intrusion or ‘re-experiencing’ symptoms, cognitive and behavioural avoidance of reminders of the trauma, negative alterations in cognition and mood, and increased reactivity and hyperarousal (APA, 2013). Prevalence estimates for PTSD in children and young people suggest that between 10 and 25% of young people meet diagnostic criteria for the disorder, which may have deleterious consequences during an important period of biopsychosocial development (Watson, 2019). Therefore, it is important to ensure that effective, evidence-based psychological interventions are available for young people with PTSD.

Seminal work by multiple cognitive behavioural theorists aimed to identify the key processes underpinning the onset and maintenance of PTSD (Brewin et al., 1996, 2010; Ehlers & Clark, 2000; Foa et al., 1989). The Ehlers & Clark (2000) cognitive model of PTSD has become one of the most widely cited models and hypothesises that there are three core cognitive processes which maintain post-traumatic stress symptoms (PTSS) by perpetuating an ongoing, current sense of threat. Firstly, negative appraisals of the traumatic event and one’s response to the event, (e.g. *Nowhere is safe; I’ll never get over this*; Ehlers & Clark, 2000) create a sense of serious current threat. Secondly, high levels of arousal disrupt encoding of the trauma memory at the time of the event, resulting in a memory which is ‘separate’ from other autobiographical memories and thus has limited semantic, contextual or temporal information (Ehlers & Clark, 2000). Stimuli representing reminders of the traumatic event subsequently trigger involuntary recall of the memory in the form of 're-experiencing' symptoms (Brewin et al., 2010; Ehlers & Clark, 2000). These involuntarily recalled, flashback-style memories are dominated by sensory impressions and a sense that one is experiencing the traumatic event again in the here and now (Brewin, 2015), further compounding a sense of ongoing threat. Thirdly, in an attempt to control these symptoms and the associated sense of threat, an individual may engage in maladaptive coping strategies such as cognitive avoidance or thought suppression. These strategies are conceptualised as maladaptive due to their inadvertent exacerbation of symptoms, both directly, through rebound effects, and indirectly, by preventing the opportunity to adaptively process the trauma memory and update negative appraisals (Clohessy & Ehlers, 1999; Ehlers & Clark, 2000). Although the cognitive model of PTSD was developed primarily in relation to adult populations, accumulating evidence indicates that the core processes outlined by the model are also relevant to youth populations (Bryant et al., 2007; Dalgleish et al., 2005; Meiser-Stedman, Dalgleish, et al., 2007; Salmond et al., 2011; Stallard & Smith, 2007).

Further elaborating on the role of trauma memory in PTSD, the revised dual representation theory proposes the existence of two distinct types of memory representations (Brewin et al., 1996; 2010). Firstly, contextually bound memory representations, termed C-reps, refer to memories which are represented within their associated autobiographical context, in a form that can be voluntarily retrieved. Secondly, sensation-based memory representations, termed S-reps, refer to low-level memories dominated by sensory and affective qualities. It is hypothesised that flashbacks in PTSD arise due to the formation of an S-rep relating to the trauma event, without the typical association to a corresponding C-rep to provide 'top down' control and contextualisation, thus explaining the intrusive nature and sense of ‘nowness’ associated with trauma memories (Brewin et al., 2010). Flashbacks are conceptualised an adaptive process during which information may be further elaborated and processed once the threat of danger has passed. However, failure to attend to this information due to cognitive avoidance perpetuates the lack of integration between these memory representations and thus precludes the ability to place traumatic images with their wider autobiographical context and reduce the sense of current threat associated with these memories (Brewin et al., 2010).

However, some authors have disagreed with theorists proposing that unique, specific memory mechanisms are implicated in PTSD, the so-termed ‘special mechanism’ view, and have argued instead for the ‘basic mechanism’ view. This alternative view proposes that PTSS can be understood through ‘basic’ psychological mechanisms related to memory and emotion (Rubin et al., 2008). Authors propose that the level of PTSS an individual experiences is related to the degree to which the traumatic memory is central to their life story and identity. Increased ‘centrality’ of the trauma memory leads to greater ‘general availability’ of the memory and thus more frequent intrusive recall. Authors suggest that heightened emotional impact is typical to all involuntary memories, due to the ‘uncontrolled’ style of retrieval providing limited opportunity to employ emotional regulation. Therefore, ‘flashback’ style memories are understood with reference to mechanisms which are proposed to be broadly applicable to all involuntary memories, rather than being seen to possess unique features specific to PTSD (Rubin et al., 2008). Authors of the ‘basic mechanism’ view acknowledge that this perspective is borne out of an attempt to understand autobiographical memory from a broader academic perspective, whereas the ‘special mechanisms’ view is derived from clinical research and offers an account of PTSD symptoms which is more directly relevant to the development of psychological treatments for the disorder. These alternative views have historically been pitched as diametrically opposing one another (Brewin, 2016; Rubin et al., 2016), however it may be the case that elements of both theories provide utility in understanding trauma memory. Therefore, the main intention of the work presented within this portfolio is not to provide evidence for one theoretical position over another, but rather consider the potential utility of both perspectives to further our understanding of trauma memory in youth.

Trauma focused cognitive behavioural therapy (TF-CBT), is the recommended first-line treatment for PTSD in youth (National Institute for Health and Care Excellence, 2018), and targets the cognitive processes outlined in the cognitive model of PTSD, aligned with the ‘special mechanisms’ view. A recent network meta-analysis has indicated the efficacy of TF-CBT in youth populations (Mavranezouli et al., 2020). A key element of TF-CBT is trauma narrative work, which involves detailed recollection of the traumatic event. It is hypothesised that this facilitates symptom reduction through multiple mechanisms of action. The deliberate recollection of the event can facilitate the elaboration and integration of the trauma memory, such that it becomes successfully embedded within its wider autobiographical context and is thus less subject to involuntary retrieval (Brewin et al., 2010; Ehlers & Clark, 2000). Additionally, narrative work can operate as a form of exposure which subsequently reduces the level of negative affect associated with the trauma memory and can also offer opportunity to integrate updated, corrective information to counter the ‘current’ sense of threat (Foa & Kozak, 1986; Foa & McLean, 2016; Knutsen & Jensen, 2019). Narrative work also offers the opportunity to identify and challenge negative appraisals related to the trauma memory and trauma symptoms (Ehlers & Clark, 2000; Kleim et al., 2012; Meiser-Stedman et al., 2017).

However, research investigating cognitive processes in PTSD is dominated to an extent by literature pertaining to adult populations and it is important to clarify the relevance of cognitive theory to youth populations to ensure that treatments are based on appropriate theory. The study of trauma memory characteristics in youth populations has produced mixed findings (Kenardy et al., 2007; McGuire et al., 2021; McKinnon et al., 2017; O'Kearney et al., 2007; Salmond et al., 2011), which may be due to methodological heterogeneity between studies (Crespo & Fernandez-Lansac, 2016). Therefore, this thesis portfolio aimed to investigate the role of trauma memory characteristics, using multiple methodologies, to further understand the role of this cognitive factor in the aetiology of youth PTSD. Chapter 2 presents a meta-analysis examining the strength of the relationship between relevant trauma memory characteristics, as measured by the Trauma Memory Quality Questionnaire (TMQQ; Meiser-Stedman, Smith, et al., 2007) and PTSS. Chapter 3 is an empirical research project, utilising pre-existing data collected as part of the Acute Stress Programme for Children and Teenagers (ASPECTS) study. The ASPECTS study investigated single-event trauma in children and young people utilising a screening study, prospective longitudinal study, case control study, and randomised controlled trial (RCT). The primary aim was to investigate the efficacy and mechanisms of action of cognitive behavioural therapy (CBT) as an early intervention for PTSD in youth. Secondary aims of the study included experimental investigation of cognitive processes associated with PTSD in youth. Outcomes from the RCT and the prospective longitudinal study have previously been published (Meiser-Stedman et al., 2017, 2019), which included data pertaining to trauma memory characteristics measured by the TMQQ. A measure of trauma event centrality, a trauma narrative task and a neurocognitive battery were also completed by participants during the original study and are relevant to the understanding of trauma memory in youth but had not yet been analysed or published. Therefore, the aim of the empirical paper was to analyse and interpret this data, alongside TMQQ data, to provide a novel contribution to the field. The final chapter summarises and integrates the finding of the meta-analysis and empirical paper and presents a critical appraisal of the work as a whole. The clinical and theoretical implications of the work presented within this portfolio are also discussed, alongside directions for future research.

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Chapter Two: Systematic Review and Meta-Analysis

Prepared for submission to Journal of Traumatic Stress

Author Guidelines available in Appendix A.

The Relationship Between Trauma Memory Characteristics and Post-Traumatic Stress Symptoms in Youth: A Systematic Review and Meta-Analysis.

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Abstract

Cognitive models of PTSD propose that specific trauma memory characteristics are implicated in the aetiology of the disorder. It is important to provide empirical support for cognitive models in youth, to ensure that psychological interventions are based on appropriate theory. The current meta-analysis aimed to provide a quantitative investigation of the strength of the relationship between trauma memory characteristics, as measured by the Trauma Memory Quality Questionnaire (TMQQ), and post-traumatic stress symptoms (PTSS) in children and adolescents. The review was prospectively registered with PROSPERO. PsycINFO, MEDLINE, CINAHL, PTSDPubs and ProQuest Dissertations and Theses Global were searched for relevant literature. Eleven studies meeting the inclusion criteria, comprising 1270 participants, were included in a random effects meta-analysis. A large effect size was observed for the relationship between trauma memory characteristics and PTSS (r=.51, 95% CI = .44-.58). This large effect size was maintained in subgroup analysis of the prospective relationship between trauma memory characteristics and later PTSS (r=.51, 95% CI= .42-.59). A slightly larger effect size was observed in subgroup analysis of the cross-sectional relationship between trauma memory characteristics and concurrent PTSS (r=.62, 95% CI= .53-.70). The robustness of these results was supported by sensitivity analyses pertaining to study quality, alteration of the TMQQ, chronic trauma exposure, LMIC populations, and PTSS measure used. These findings provide empirical support for the role of trauma memory characteristics in PTSS, congruent with cognitive models, suggesting this theoretical framework is appropriate for youth populations. Limitations and recommendations for future research are elaborated in the discussion.

Keywords: trauma memory, post-traumatic stress, children, adolescents, meta-analysis

Introduction

Exposure to traumatic events is common in children and adolescents (Lewis et al., 2019). Many young people naturally return to pre-trauma levels of psychological functioning in the subsequent months following the event and do not experience symptoms meeting the criteria for psychiatric diagnoses (Hiller et al., 2016). However, a proportion of individuals may subsequently experience post-traumatic stress symptoms (PTSS), characterised by re-experiencing distressing memories, hyperarousal, and avoidance of reminders of the trauma (Lewis et al., 2019; Sara & Lappin, 2017). High levels of PTSS within one month following a traumatic event is indicative of acute stress disorder (ASD), whereas ongoing experience of PTSS over one month following the event is indicative of post-traumatic stress disorder (PTSD; American Psychiatric Association, 2013). A substantial degree of natural recovery is still possible for children meeting the diagnostic criteria for ASD and not all children with ASD subsequently develop PTSD (Kassam-Adams & Winston, 2004). It is important to understand the psychological factors involved in the development and maintenance of post-traumatic stress (PTS) to guide the development of effective interventions for this population.

Cognitive models of PTSD propose that negative appraisals, cognitive avoidance, and disrupted autobiographical memory are key cognitive processes in the development and maintenance of the disorder (Brewin et al., 1996; Ehlers & Clark, 2000). It is proposed that high levels of peritraumatic threat and data-driven processing, in which sensory and perceptual characteristics are prioritised over the meaning of the event, disrupt memory consolidation (Ehlers & Clark, 2000). This results in memories that are separate, fragmented, poorly elaborated into their autobiographical context, and thus subject to involuntary recall in the form of re-experiencing symptoms (Brewin et al., 2010; Ehlers & Clark, 2000). It is hypothesised that negative appraisals and avoidance subsequently hinder one's ability to adaptively process the fragmented trauma memory, thus maintaining distressing re-experiencing symptoms (Brewin et al., 1996; Steil & Ehlers, 2000).

Trauma-focused cognitive behavioural therapy (TF-CBT) aims to target the key processes involved in the maintenance of PTSD, as proposed by cognitive models. An important element of TF-CBT is trauma narrative work, in which a detailed narrative of the traumatic event is constructed. This may be facilitated by techniques such as prolonged exposure or imaginal reliving of the trauma event. It is proposed that this facilitates the elaboration of fragmented memories into their wider autobiographical memory base, thus reducing re-experiencing symptoms (Ehlers & Clark, 2000). There is evidence that TF-CBT protocols adapted for youth populations are effective in reducing PTSS (Mavranezouli et al., 2020). However, it is important to provide empirical support for cognitive theory in youth populations so that relevant mechanisms of action can be identified or confirmed, and psychological interventions can be distilled into their key elements to further improve the efficacy and efficiency of interventions.

Meta-analyses provide the most robust empirical evidence for cognitive factors relevant to PTSD in youth. Although research in youth populations has been less extensive than that pertaining to adults (LoSavio et al., 2017), meta-analyses have indicated that peritraumatic threat, data driven processing, negative appraisals and cognitive avoidance are associated with PTSD in youth (Memarzia et al., 2021; Mitchell et al., 2017; Trickey et al., 2012). Cognitive factors such as negative appraisals, cognitive avoidance, and even intrusive memories, have been associated with a range of mental health difficulties, including depression and anxiety (Patel et al., 2007; Reynolds & Brewin, 1999). However, the disruption of encoding processes during a traumatic event and a specific type of intrusive memory termed a 'flashback', featuring strong sensory qualities and a sense of 'nowness', is argued to be specific to PTSD (Brewin, 2015; Bryant et al., 2011). Given that these trauma memory characteristics may represent a unique, defining feature of PTS, it is particularly important to empirically explore this in youth populations.

The analysis of trauma narratives and the administration of self-report questionnaires are the predominant methods used to investigate trauma memory characteristics. Narrative methodology involves written or verbal recollection of the traumatic event, which is subsequently coded for relevant memory characteristics specified by cognitive theory including: fragmentation, disorganisation, temporal disruption, and sensory features. Research utilising this methodology in youth has produced relatively mixed, inconclusive results (Kenardy et al., 2007; McGuire et al., 2021; McKinnon et al., 2017; O'Kearney et al., 2007; Salmond et al., 2011). Self-report methodology involves the completion of standardised questionnaires pertaining to trauma memories characteristics, such as the Trauma Memory Quality Questionnaire (TMQQ; Meiser-Stedman et al., 2007). The TMQQ was developed to facilitate research into trauma memory in children and adolescents. The items were developed based on memory characteristics proposed to be relevant to trauma memories by cognitive theory and the dual representation theory (Brewin et al., 1996; Ehlers & Clark, 2000). The items were designed to specifically capture the qualities and characteristics of trauma memories rather than the frequency or the way in which these memories were elicited. A non-clinical school sample and a clinical sample of youth emergency department attendees were utilised in the initial development of the TMQQ. The initial 14 items were condensed to 11 items which demonstrated satisfactory internal consistency. Items in the questionnaire refer to the visual quality, non-visual sensory quality, temporal context, and verbal accessibility of trauma memories memories (see Appendix B). The original development of the questionnaire demonstrated that participants with ASD and PTSD scored higher on the TMQQ than youth without a diagnosis, indicating criterion validity of the measure. Higher scores on the TMQQ reflect greater visual and sensory content in trauma memories, a sense of ‘nowness’, and difficulty verbally accessing trauma memories. The measure has also been shown to correlate with validated measures of PTSS, demonstrating construct validity (Meiser-Stedman et al., 2007).

Research combining narrative and self-report methods has found that self-reported trauma memory characteristics may be a stronger predictor of PTSS than narrative characteristics (McKinnon et al., 2017). Furthermore, self-reported trauma memory characteristics have been shown to be cross-sectionally associated with PTSS in the acute period (McGuire et al., 2021; McKinnon et al., 2017), in addition to predicting later development of PTSD (McGuire et al., 2021; Meiser-Stedman et al., 2009; Meiser-Stedman et al., 2019). Whilst it can be argued that narrative recollection may provide a more objective rating of trauma memory characteristics compared to self-report questionnaires, young people may limit what they choose to disclose in their narratives, particularly given the established role of cognitive avoidance in PTS (Ehlers & Clark, 2000; McGuire et al., 2021). Additionally, heterogeneity between methodologies used to code and rate narratives across studies has made it challenging to conduct quantitative synthesis of findings in this area, and currently only narrative syntheses are available (Crespo & Fernandez-Lansac, 2016; Richard & Perrott, 2006). The majority of studies included in these reviews feature adult samples and, as yet, no systematic reviews exist pertaining to trauma memory characteristics solely in youth.

The current review aims to address the gap in the literature regarding trauma memory characteristics in youth. The administration of standardized self-report questionnaires of trauma memory characteristics, such as the TMQQ, offers reduced heterogeneity between studies compared to narrative methodology and thus the opportunity to quantitatively synthesise literature exploring the relationship between trauma memory characteristics and PTSS. This will be the first systematic review and meta-analysis of the relationship between trauma memory characteristics, as measured by the TMQQ, and PTSS in youth populations. In line with cognitive theory, we expect to find a strong relationship between scores on TMQQ and PTSS, whereby higher TMQQ scores are associated with higher levels of PTSS. The review aims to explore this relationship both within the acute (ASD) and post-acute (PTSD) phase following trauma exposure. This can help to establish whether trauma memory characteristics are an important factor in the initial development of PTSS, i.e. a strong relationship is observed in the acute phase, and whether trauma memory characteristics remain an important factor in the subsequence maintenance of PTSS, i.e. a strong relationship also observed in the post-acute phase

Methods

Search Strategy

This review was prospectively registered with PROSPERO (3rd February 2021, CRD42021221552). A systematic search for relevant publications was conducted in the following psychological and medical literature databases: PsycINFO, MEDLINE, CINAHL and PTSDPubs. The ProQuest Dissertations and Theses Global database was also searched to identify unpublished literature. A citation search for the TMQQ was conducted to identify any further relevant literature. Reference lists from included studies were hand searched to identify any further relevant studies. The search dated from 2007 (when the TMQQ was first published) until March 2021. Search terms were developed and refined by conducting an initial brief search for studies citing the original TMQQ paper. The search terms were: trauma* or PTSD or "post traumatic stress" or "post-traumatic stress" or “posttraumatic stress” or "acute stress" AND TMQQ or "trauma memory" or "memory quality" AND child* or adolescen* or youth or "young pe*" or pupil or student. For the main databases, full-text searches were conducted for all search terms due to the specificity of the terms used. Due to the volume of available studies within the ProQuest Dissertations and Theses Global database, a title search was used for the first line of search terms, followed by a full-text search for the remaining search terms to ensure relevancy of identified literature.

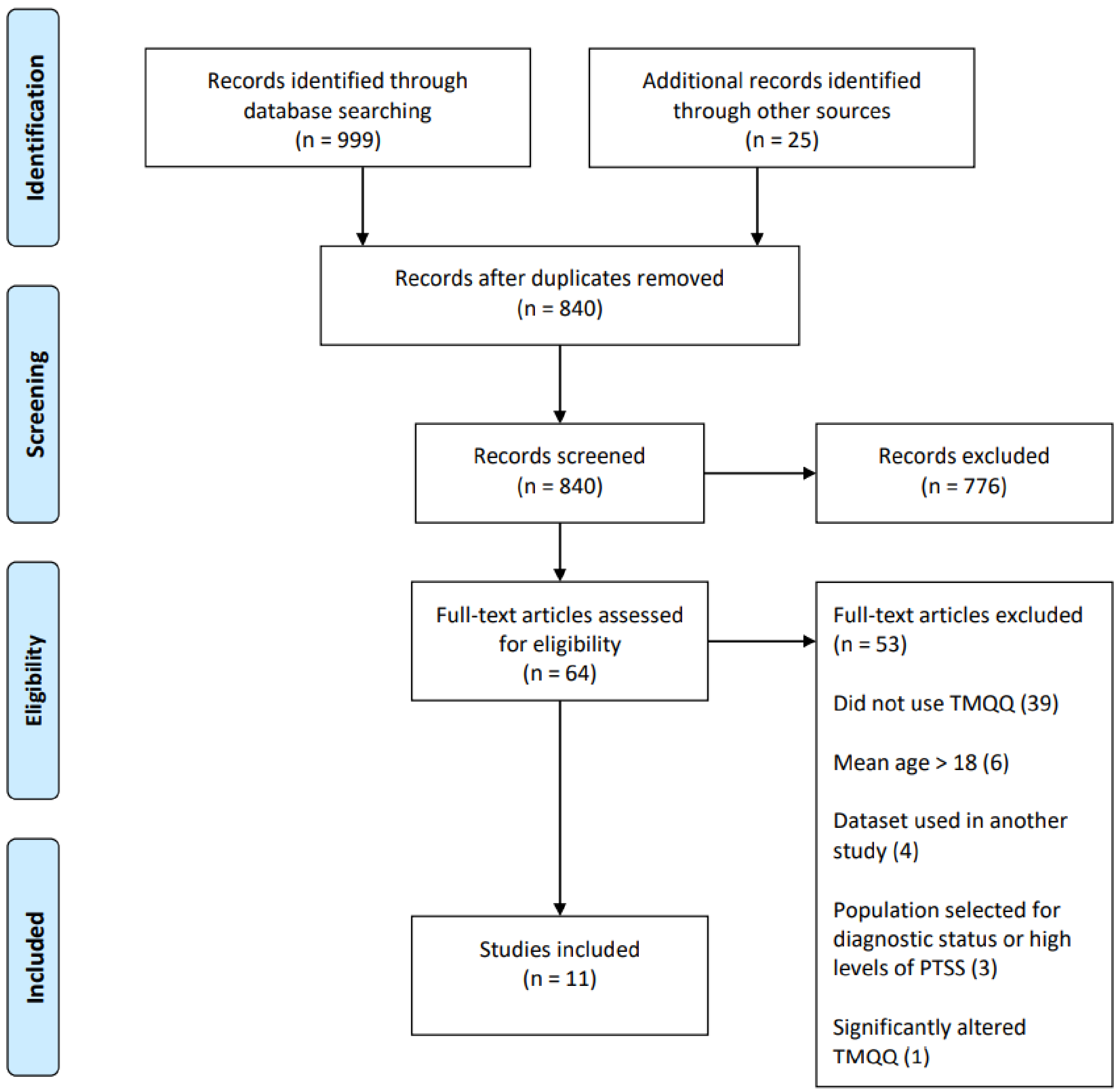
The following inclusion criteria were applied: exposure to a traumatic event meeting the *Diagnostic and Statistical Manual of Mental Disorders* Criterion A definition (5th ed.; DSM–5; American Psychiatric Association, 2013), use of the TMQQ, use of a validated measure of PTSS, and mean participant age <18. To determine that the Criterion A definition was met, if this was not already stated explicitly within the paper, the description of the nature of the traumatic event and the level of direct exposure that participants had to these events were considered. In the event that participants were exposed to a range of different index trauma events, all of the events were required to meet the Criterion A definition, otherwise the study was excluded. The following exclusion criteria were applied: studies not published in English, book chapters, qualitative studies, single case studies, dataset used in a previous study (in these instances, the study with the largest sample size was used), and substantial alterations to the TMQQ such that it could not be meaningfully compared to the original. Treatment trial or samples only including youth selected for high levels of PTSS or with a diagnosis of PTSD were also excluded as these had the potential to skew the data. Clinical trials were included only if baseline data (preceding the intervention) was available and participants were not selected solely based on diagnostic status. Studies were not excluded based on geographical location.

Screening Method

The study selection, inclusion and exclusion processes are outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher et al., 2009) flow diagram (see Figure 1). Titles and abstracts were screened by JR. Relevant full text studies were reviewed for eligibility against inclusion and exclusion criteria by JR and this process was subsequently repeated by GR. Where disagreements occurred, this was discussed further between JR and GR until consensus was reached.

Figure 1

PRISMA Flow Diagram



Data Extraction

Pearson's correlation coefficient, *r*, was used as the estimate of effect size and extracted for analysis. Where this was not explicitly reported, means and standard deviations of the TMQQ and PTSS measure were used to calculate Cohen's *d*, which was subsequently converted to Pearson's *r* (Aaron et al., 1998). If the data was reported in such a way that it was not possible to calculate Pearson's *r*, for example if the data was split into subgroups, authors were contacted to obtain the required effect size. All included studies reported Cronbach's alpha for the TMQQ which was also extracted and pooled using a random effects meta-analysis, to assess overall internal consistency of the measure.

As the intensity of PTSS within the acute period (two to four weeks post-trauma) is liable to change over time, it was initially intended that the main analysis would focus on studies pertaining to the post-acute period in which PTSD can be diagnosed and symptoms are typically more stable (over one-month post-trauma). Secondary analysis was planned for the acute period. However, a relatively small number of relevant studies exploring the post-acute period were identified and the majority of studies reported data pertaining to the acute phase. Some prospective longitudinal studies reported data for both the acute and post-acute phase. It was decided therefore that the main analysis would include data from both the acute and post-acute phase to maximise the number of studies which could be included. Rules were devised such that effect sizes of the relationship between TMQQ scores and post-acute PTSS was prioritized for inclusion. Data was extracted and labelled according to the following rules:

- Rule A – Prospective data; TMQQ administered over one-month post-trauma and the strength of its association with later PTSS.

- Rule B – Acute prospective data; TMQQ administered within one-month post-trauma and the strength of its association with later PTSS.
- Rule C – Cross-sectional data; TMQQ administered over one-month post-trauma and the strength of its association with concurrent PTSS.
- Rule D – Acute cross-sectional data; TMQQ administered within one-month post-trauma. and the strength of its association with concurrent PTSS.

Only one effect size per study was used in the main analysis and the selection of the effect size from each study was prioritised hierarchically, i.e. effect sizes meeting specifications for rule A superseded effect sizes meeting specifications for rule B and so forth. The main analysis included data pertaining to all four rules. Descriptive data was also extracted, including demographic information for participants. Data extraction was conducted initially by JR and repeated for all studies by GR. Where disagreement occurred, or for data which could not be readily extracted and required further calculation; these were double-checked in discussion with RMS.

Subgroup and Sensitivity Analyses

Subgroup analyses were conducted to examine whether results differed between data collected in the acute and post-acute phase, and between data collected cross-sectionally and prospectively. Only one effect size per study was used for each subgroup analysis. Effect sizes were hierarchically selected according to the following rules for each subgroup analysis (see Appendix C): Prospective analysis - rules A and B; Acute analysis - rules B and D; Cross-sectional analysis - rules C and D; and Acute cross-sectional analysis - rule D.

Given the relatively small number of studies included, there was insufficient statistical power to conduct moderator analyses. Instead, sensitivity analyses were conducted to explore whether the exclusion of certain study characteristics generated different results. The following sensitivity analyses were undertaken: exclusion of low quality studies, exclusion of altered TMQQ, exclusion of Low- and Middle-Income Country (LMIC) populations, exclusion of non-single event trauma, analysis of studies using the same PTSS measure: Child PTSD Symptom Scale (CPSS; Foa et al., 2001) and Children's Revised Impact of Event scale (CRIES-13; Perrin et al., 2005).

Quality Assessment and Risk of Bias

A quality assessment tool was developed for the current review based on the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (National Heart Lung and Blood Institute, 2014). The tool was shortened from the original 14 items to 6, with only the most relevant items selected to ensure efficiency of the quality rating process (see Appendix D). For example, questions regarding the validity of measures were not necessary as this was already specified in the inclusion criteria. The tool assessed: appropriateness of recruitment and sampling, analysis of nonresponse bias, sample size justification, and drop-out rates in prospective studies.

Studies were rated 'high risk' or 'low risk' for each question. Prospective studies were scored out of 6 and cross-sectional studies scored out of 5. Prospective studies were rated high quality if they scored 'low risk' on 5 or 6 items (4 or 5 for cross-sectional studies); medium quality if they scored 'low risk' on 3 or 4 items (2 or 3 for cross-sectional studies); and low quality if they scored 'low risk' on 0, 1 or 2 items (0 or 1 for cross-sectional studies). The quality rating process was initially conducted by JR and repeated by JT. Where disagreements occurred this was discussed between JT and JR and full consensus was reached for all studies.

Data Synthesis

Random effects meta-analyses were conducted using the 'metafor' (version 3.0-2; Viechtbauer, 2010) package in R (version 4.1.2). Extracted *r* values underwent Fisher Z-transformation during analyses and were subsequently back-transformed to Pearson's *r* correlation coefficients for reporting and interpretation. Pearson's *r* was interpreted as a small (0.1), medium (0.3) or large (>0.5) effect (Cohen, 1988). Heterogeneity of effect sizes was estimated using Q and I^2 statistics. Heterogeneity was classified as small (25%), medium (50%), or large (75%; Higgins et al., 2003). A leave-one-out analysis was conducted for the main analysis to identify any studies which potentially presented as outliers.

Publication Bias

To estimate risk of publication bias, funnel plots were generated and Duval and Tweedie's trim and fill method (Duval & Tweedie, 2000) was used to indicate whether the study sample may be missing studies with smaller effect sizes. Egger's regression test of funnel plot asymmetry (Egger et al., 1997) was also used to establish whether there was statistically significant asymmetry indicative of publication bias.

Results

Study Characteristics

A total of 11 studies were included, providing 17 effect sizes. A summary of study characteristics is presented in Table 1[1]. Most studies assessed single event trauma including acute medical illness or injury (k=8) and a natural disaster (k=1). Two studies assessed more

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[1] It is noted that RMS is an author on many of the included studies and co-authored the TMQQ, which could be argued to present a conflict of interest. However, given the systematic methodology clearly outlined and followed when conducting this review, this should provide assurance that the review has been conducted with integrity.

chronic forms of trauma including maltreatment and war exposure. All studies were rated against the quality assessment tool. Three were high quality, six were medium quality and two were low quality. See Figure 2 for a breakdown of the proportion of studies rated as low or high risk of bias across the six questions of the quality rating tool. Four studies featured a cross-sectional design and seven featured a prospective longitudinal design. Table 1 specifies the PTSS measure used in each study.

Figure 2

Proportion of Studies Rated as Low or High Risk of Bias Across Each Quality Rating Question

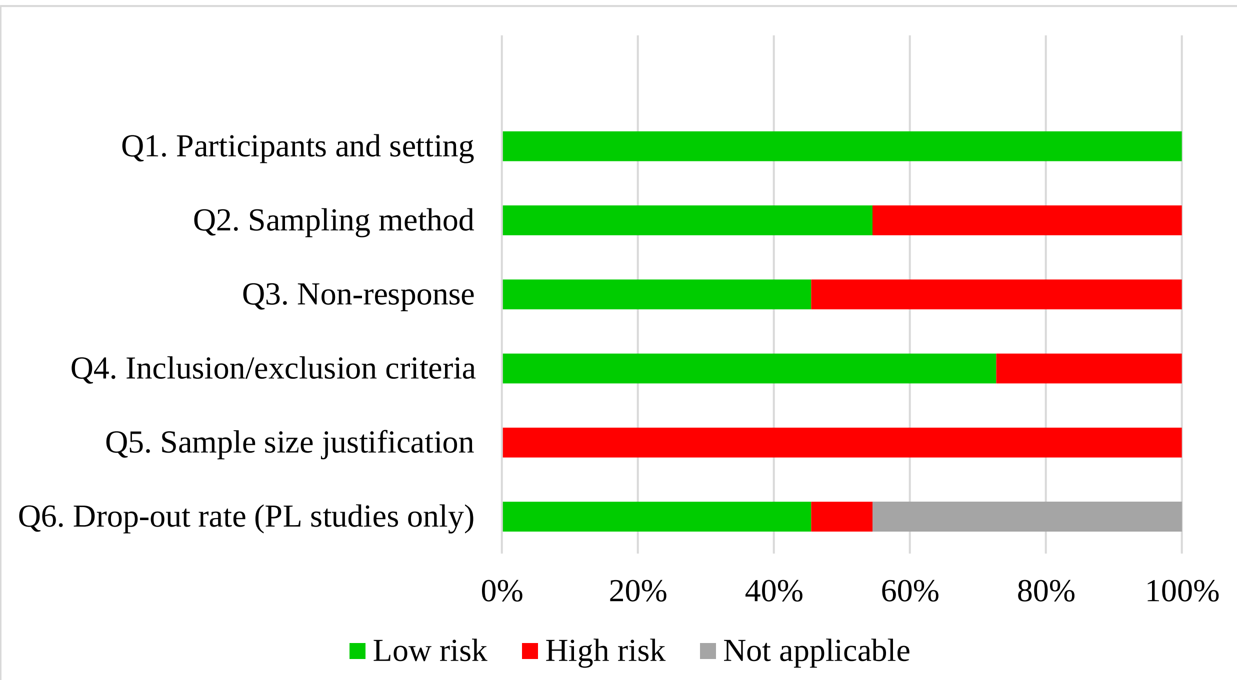


Table 1

Study Characteristics

Article	Trauma type	N	Age range	Mean age	% female	Country	Study Design	Time since trauma. BL, FU	PTSS measure. BL, FU	Interview or self-report	Repeat TMQQ at FU	Quality rating
Bray et al., 2018	Med ill/inj	25	7-17	12.26[2]	33.9[2]	Aus.	PL	1 wk, 2mnths	ASC-Kids, CPSS	Self-report	Yes	Medium
Dow et al., 2019	Med ill/inj	70	6-17	11	44	Aus.	CS	3 wks	CRIES-13	Self-report	-	High
Hiller et al., 2019	Med ill/inj	132	6-13	9.9	37.9	UK	PL	2-6 wks, 7 mnths	PTSD-RI	Self-report	No	High
Hiller et al., 2021	Maltreatment (abuse/neglect)	120	10-18	13.5	55	UK	PL	12 mnths[4]	CATS	Self-report	No	Medium
McKinnon et al., 2008	Med ill/inj	75	7-16	11	31	Aus.	CS	1-4 wks	ASC-Kids	Self-report	-	Medium
McKinnon et al., 2017	Med ill/inj	67	7-16	11.8	37	Aus.	PL	4 wks, 8-12 wks	CASQ, CPSS	Self-report	No	Medium
Meiser-Stedman et al., 2007[1]	Med ill/inj	226	11-16	14	36.8	UK	PL	2-4 wks, 3 mnths	RIES-C	Self-report	No	Low
Meiser-Stedman et al., 2019	Med ill/inj	83	8-17	14.1	42.5	UK	PL	2-4wks, 2 mnths	CPSS	Self-report	No	High
Mordeno et al., 2018	Natural disaster	225	9-17	14.2	55.1	Philip.	CS	<1 mnth	ASDI	Interview	-	Medium
Peltonen et al., 2017	War exposure	197	10-12	11.4	49.4	Pal./Isr.	PL[3]	11mnths	CRIES-13	Self-report	-	Low
Salmond et al., 2011	Med ill/inj	50	8-17	13.5	60	UK	CS	2-4 wks	CPSS	Self-report	-	Medium

Note: Aus. = Australia; ASC-Kids=Acute Stress Checklist for Children; ASDI=Acute Stress Disorder Interview; BL=Baseline; CASQ: Child Acute Stress Questionnaire; CATS=Child and Adolescent Trauma Screen; CPSS= Child PTSD Symptom Scale; CRIES-13=Children's Revised Impact of Event Scale; CS=cross sectional; FU=follow up; Med ill/inj=Medical illness/injury; Philip. = Phillippines; Pal./Irs. = Palestine/Israel; PTSD-RI=Post Traumatic Stress Disorder Reaction Index; PL=prospective longitudinal; Med ill/inj=Medical illness/injury; RIES-C=Children's Revised Impact of Events Scale; UK = United Kingdom

[1] Only sample 2 was used, sample 1 not exposed to Criterion A trauma. [2] Demographic data split into two subgroups (high/low PTSS), mean of subgroup values reported. [3]PL, however TMQQ only administered 11 months post-trauma. [4]Not possible to determine time since trauma at BL due to chronic nature of trauma (maltreatment), FU at 12 months.

Main Analysis

The main analysis included one effect size from all 11 studies. The analysis captured both cross-sectional and prospective data in the acute and post-acute phase. The overall sample size for the main analysis was 1270.

As shown in Table 2, a large estimated effect size of r =.52 (95% CI=.44-.58) was observed for the relationship between self-reported trauma memory characteristics, as measured by TMQQ, and PTSS (see Figure 3). Estimates of heterogeneity showed that there was significant, medium variance across the studies (Q = 24.61, df =10, p = .006, I^2 = 61.1%). Leave-one-out analysis indicated that removing McKinnon et al., (2008) maintained a large estimated effect size of r=.49 (95% CI=.44-.55) and reduced estimates of heterogeneity to non-significant, small variance (Q = 11.11, df = 9, p=.27, I^2 = 31.85%), suggesting this effect size was an outlier and accounted for a large proportion of the observed variance (see Appendix E). A random effects meta-analysis of Cronbach's alpha values produced a pooled estimate of a=.76, indicating satisfactory internal consistency for the TMQQ (Cohen, 1960).

The trim and fill funnel plot identified three studies as potentially missing, however the predicted missing studies showed *larger* effect sizes compared to the majority included in the analysis, therefore suggesting that inclusion of these studies would generate a larger overall estimated effect size rather than smaller (see Appendix F). Regression test of funnel plot asymmetry indicated no significant asymmetry indicative of publication bias (p=.74).

Table 2

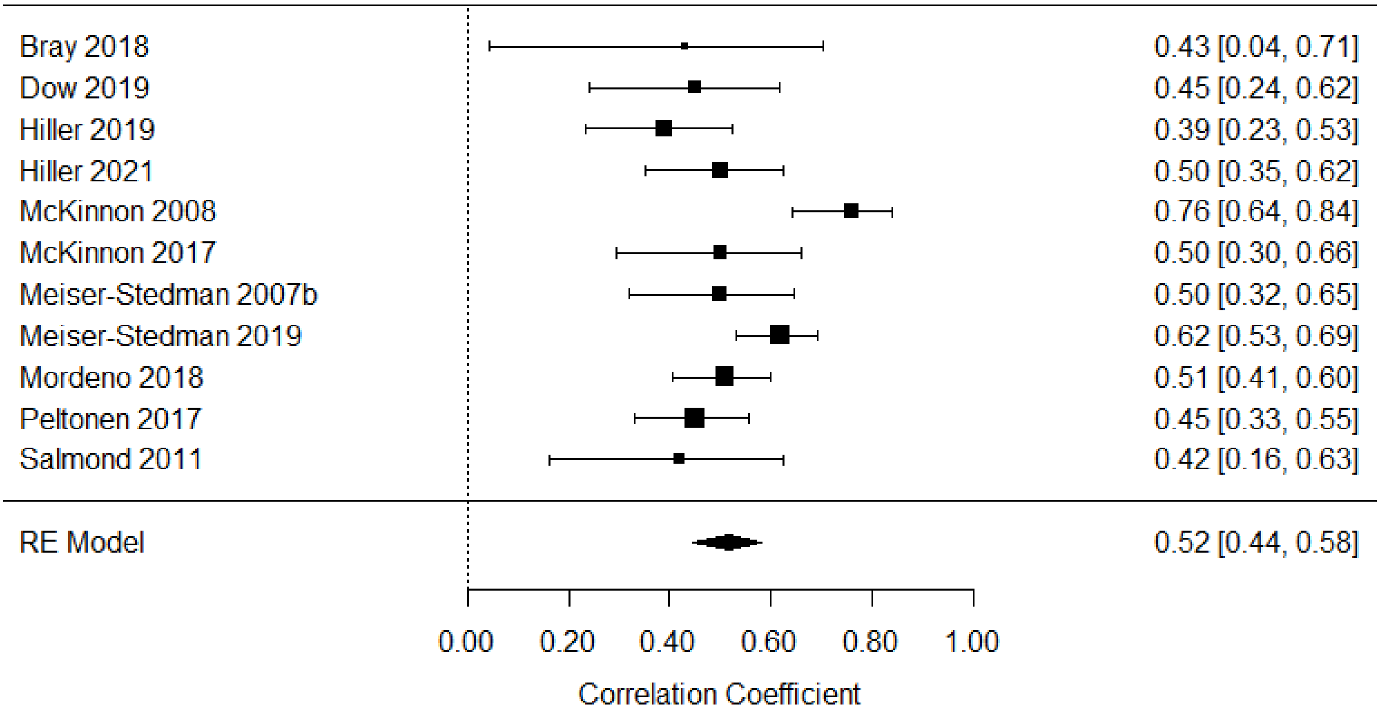
Results From Main, Subgroup and Sensitivity Analyses

Analysis	k	N	r	LL	UL	Z	Q	I^2 (%)
Main analysis	11	1270	.52	.44	.58	11.84**	24.61*	61.1
Subgroup analyses								
Prospective	5	628	.51	.42	.59	9.36**	8.57	52
Acute prospective	9	953	.52	.43	.61	9.23**	23.71*	68.4
Cross-sectional	11	1270	.62	.53	.70	10.51**	52.79**	81.5
Acute cross-sectional	9	953	.63	.52	.72	8.85**	41.60**	82.9
Sensitivity analyses								
Excl. altered TMQQ	8	793	.54	.44	.62	8.98**	20.05*	66.1
Excl. LMIC populations	9	848	.53	.43	.61	9.42**	22.44*	64.8
Excl. low quality	9	990	.53	.44	.61	9.79**	22.53*	66.9
Excl. non-single event trauma	9	953	.53	.44	.61	9.66**	22.45*	66.4
CRIES-13 only	3	350	.46	.37	.54	9.23**	.26	0.0
CPSS only	4	368	.53	.41	.64	7.43**	4.59	40.4

Note: ** significant at p<.001 *significant at p<.01

Figure 3

Forest Plot Illustrating Effect Sizes (r) Extracted From Each Study and the Estimated Overall Effect Size of the Relationship Between Trauma Memory Characteristics and PTSS



Subgroup analyses

As shown in Table 2, subgroup analysis of acute data and post-acute prospective data yielded similar results to the main analysis and to each other. Estimates of heterogeneity indicated medium-large, significant variance across studies included in the acute analysis (Q = 23.71, df =8, *p*= .002, I^2 = 68.4%), whereas non-significant variance was observed across studies included in the post-acute prospective analysis (Q = 8.57, df =4, *p*= .07, I^2 = 52%).

Subgroup analyses of cross-sectional and acute cross-sectional data yielded similar results to each other, with a large estimated effect size of r=.62 (95% CI= .53-.70) and r=.63 (95% CI= .52-.72), respectively. These estimated effect sizes were higher than those observed in the main, acute, and prospective analyses. Estimates of heterogeneity indicated significant (*p*= <.001), large variance (I^2 = >80%) across studies in both cross-sectional and acute cross-sectional analyses.

Sensitivity analyses

As shown in Table 2, a large estimated effect size was observed for all exclusionary sensitivity analyses. The estimated effect sizes for each exclusionary sensitivity analysis were similar to each other and to the observed effect size for the main analysis, with all analyses indicating a positive relationship between self-reported trauma memory characteristics and PTSS. For all sensitivity analyses, estimates of heterogeneity indicated significant (*p*=<.01), medium-large variance (I^2 = 64.8%-66.9%) across the studies. Sensitivity analyses grouped by PTSS measures revealed an overall medium-large estimated effect size of r=.46 (95% CI= .37-.54) for studies using the CRIES-13, and a large estimated effect size of r=.53 (95%CI .41-.64) for studies using the CPSS. The estimated effect size for CRIES-13 sensitivity analysis was slightly lower than observed in other analyses. Estimates of heterogeneity indicated non-significant variance across studies using the CRIES-13 (Q = .26, df =2, p = .88, I^2 = 0%), and non-significant, small-medium variance across the studies using the CPSS (Q =

4.59, df =3, p = .20, I^2 = 40.4%). Total sample sizes for subgroup and sensitivity analyses can be seen in Table 2.

Discussion

The current review aimed to meta-analyse the strength of the relationship between trauma memory characteristics, as measured by the TMQQ, and PTSS in youth populations. The main analysis indicated a large estimated effect size for the relationship between self-reported memory characteristics and PTSS. In line with our hypothesis, this demonstrated that higher scores on the TMQQ, indicating a preponderance of visual and sensory content, a sense of ‘nowness’ and difficulties verbally accessing trauma memories, were associated with higher levels of PTSS. Observed results for the cross-sectional analyses differed slightly from the main analysis but were similar to each other. This may be due to both cross-sectional analyses including acute cross-sectional data, i.e. TMQQ administered in the acute phase associated with concurrent PTSS. Effect sizes pertaining to post-acute administration of the TMQQ and concurrent PTSS could only be extracted from three studies for the overall cross-sectional analysis. Therefore, the estimated effect size observed in this analysis is likely skewed by acute cross-sectional data. As previously highlighted, a reduction in PTSS may be expected over time as natural recovery occurs. Within the short time frame of the acute phase, opportunity for natural recovery is more limited and it can logically be proposed that young people may be more likely to perceive their symptoms as more intense during this period. This is relevant to both self-reported trauma memory characteristics and PTSS, as almost all PTSS measures also relied on self-report. The concurrent administration of two self-report measures within the acute phase may therefore have inflated the estimated effect size of the relationship between trauma memory characteristics and PTSS. Although the observed results of the cross-sectional analyses differed slightly, they indicated a stronger relationship rather than a weaker one, which can instil confidence in the large, estimated effect size seen in the main analysis. The acute analysis showed similar results to the main analysis, likely due to the inclusion of both prospective and cross-sectional data within the analysis. Similar results were also observed in the post-acute prospective analysis, suggesting that the strength of the relationship between trauma memory characteristics and PTSS is maintained past the acute phase, between several months up to a year after trauma exposure. Even the smallest observed estimated effect size within all analyses (r=.46) indicated a medium-large effect. Additionally, recent research has suggested that current standardised interpretation of effect sizes may be too conservative and proposes that an effect size *r* of .30 in fact indicates a large effect (Funder & Ozer, 2019). Taking these suggestions into account, all results observed in the current analyses would represent large effect sizes.

Taken together, the results indicate a strong relationship between trauma memory characteristics, captured by the TMQQ, and both concurrent and future PTSS. To place the results observed here in context, they are substantially larger than the small estimated effect size (r=-.12) of the relationship between social support and PTSD (Allen et al., 2021), similar to the large estimated effect size (r=.63) of the relationship between negative appraisals and PTSS (Mitchell et al., 2017), but smaller than the large estimated effect size (r=.70) of the relationship between cognitive avoidance and PTSS (Trickey et al., 2012). However, it is noted that the latter result is based only on a very small number of studies available at the time the review was conducted. Together, these meta-analytic results provide support for the cognitive model of PTSD which highlights trauma memory characteristics, negative appraisals, and cognitive avoidance as core cognitive processes relevant to the aetiology of PTSD, suggesting these may present the most relevant targets for psychological interventions. The current study indicates that trauma memory characteristics are prospectively associated with both acute and post-acute PTSS, which may provide some tentative evidence that these memory characteristics could be relevant to both the development and maintenance of PTSS. However, whilst the results provide a clear indication that trauma memory characteristics are implicated in the phenomenology of PTS, it is not possible draw definitive conclusions on whether these memory characteristics are necessarily causative of PTSS.

Given the self-report nature of the TMQQ, some authors have highlighted that the measure may tap into ‘meta-memory’ processes, and suggested that negative *perceptions* of trauma memory characteristics may be more important in the aetiology of PTSD than specific memory characteristics themselves (Bray et al., 2018; McGuire et al., 2021; McKinnon et al., 2017). This is logical given the strong empirical support for the role of negative appraisals in PTS (Gómez de La Cuesta et al., 2019; Mitchell et al., 2017) and the assertion that PTSS are underpinned by multiple, interacting cognitive factors, as outlined in cognitive models, rather than cognitive factors operating in isolation. It is plausible that *perceived* greater intensity of sensory content, a sense of ‘nowness’, and difficulty verbally accessing the trauma memory, could be appraised as more threatening. The relationship between self-reported trauma memory characteristics and PTSS observed in the current meta-analysis could therefore potentially represent a relationship between *perceptions* of trauma memory and PTSS, whereby *perceived* greater intensity of certain trauma memory characteristics is related to higher levels of PTSS. Understanding this further has relevance for subsequent clinical recommendations, as narrative exposure elements of TF-CBT could incorporate a more explicit focus on addressing appraisals of trauma memory characteristics in addition to overarching negative appraisals linked to the traumatic experience. Research exploring mechanisms of action of TF-CBT indicated that improvements in negative appraisals and trauma memory characteristics correlated with symptom reduction (Kangaslampi & Peltonen, 2019). However, other research found that changes in negative appraisals during treatment mediated symptom reduction, whereas changes in trauma memory characteristics did not

(Meiser-Stedman et al., 2017). Therefore, it would be beneficial for future research to explore changes in both trauma memory characteristics and negative appraisals during psychological interventions, and investigate their respective mediatory effects. Future research could also consider using network analysis to explore relationships between multiple cognitive factors and specific symptom clusters, such as re-experiencing symptoms, simultaneously. This would help clarify in greater detail the relationships between cognitive factors themselves as well as relationships between cognitive factors and symptom clusters. This would be beneficial in exploring cognitive theory in more detail and identifying relevant mechanisms of action for psychological interventions.

Some limitations of the current review merit consideration. Firstly, the limited number of studies included in the main analysis meant that it was not possible to conduct moderator analyses to statistically explore the potential influence of individual study characteristics. However, the results observed in the sensitivity analyses suggest it was unlikely that individual study characteristics influenced the results of the main analysis. Secondly, the majority of the extracted effect sizes pertained to the relationship between trauma memory characteristics and PTSS within the acute phase, due to limited prospective data. Understanding of relevant cognitive factors in the post-acute phase is important given that psychological interventions are not recommended until symptoms have stabilised and a diagnosis of PTSD can be made, i.e. in the post-acute phase (National Institute for Health and Care Excellence, 2018). Additionally, most of the prospective studies included in this review explored trauma memory and PTSS within two to three post-trauma, and research has shown that organic reduction in PTSS may continue to up to six months post-trauma (Hiller et al., 2016). Therefore, it could be beneficial for future research to employ prospective designs to replicate the preliminary results here indicating that the relationship between trauma memory characteristics and PTSS remains strong in the post-acute phase, and to investigate whether the strength of this relationship is maintained over a longer period of time. It is also important to note that re-experiencing symptoms are a diagnostic criterion for PTSD and that it is possible that the focus of the TMQQ may overlap with this, thus inflating the observed association between the TMQQ and measures of PTSS. However, during the development of the TMQQ, the authors highlight that the measure does not simply act as a proxy for re-experiencing symptoms but rather captures specific information about the *characteristics* of trauma memories, therefore it is unlikely that this is the sole reason for the large effect size observed. A broader limitation within the field of trauma memory in youth populations is a paucity of studies in non-western populations and the overrepresentation of single-event trauma, specifically acute medical illness or injury. This limits the overall generalisability of the results and it is therefore important for future research to investigate trauma memory characteristics in a wider variety of single-event traumas, chronic trauma exposure, and LMIC populations.

In conclusion, the current review indicates a strong relationship between trauma memory characteristics and PTSS in youth, suggesting that this represents an important cognitive factor in the phenomenology of PTS. This provides support for cognitive models of PTSD, however it would be beneficial to clarify the cognitive processes captured by the TMQQ before definitive recommendations for psychological interventions are made.

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Chapter Three: Empirical Paper

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Trauma Memory Characteristics and Neurocognitive Performance in Youth Exposed to Single-Event Trauma

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Abstract

Cognitive models of PTSD highlight characteristics of trauma memories, such as fragmentation and disorganisation, as key mechanisms in the aetiology of the disorder. Studies investigating trauma memory in youth have provided inconsistent findings. Research has highlighted that PTSD in youth may also be accompanied by difficulties in neurocognitive functioning, which may detrimentally impact one's ability to recall the trauma memory and engage in psychological intervention. The present study sought to investigate both trauma memory characteristics and neurocognitive functioning in youth aged 8-17 years (N= 69) who had experienced a single-event trauma, and a group of non-trauma exposed controls (N= 36). An experimental battery consisting of self-report measures of trauma memory, a narrative memory task and a battery of neurocognitive tests was completed two months post-trauma. Participants with a diagnosis of PTSD subsequently participated in a randomised controlled trial (RCT) of cognitive therapy for PTSD. All trial participants repeated the experimental battery upon completion of the RCT. Pre-treatment results indicated that trauma memories in youth with PTSD were more sensory-laden, temporally disrupted and difficult to verbally access. Post-treatment results suggested a reduction in self-reported sensory characteristics and temporal disruption and improved self-reported verbal accessibility and coherence of the trauma narrative. Greater differences were observed for self-reported memory characteristics compared to narrative characteristics both pre- and post-treatment. No between group differences in neurocognitive function were observed pre- or post-treatment, suggesting this was unlikely to affect narrative recall or treatment. Recommendations for future research and clinical practice are elaborated in the discussion.

Keywords: trauma memory, neurocognition, child, adolescent

Introduction

Exposure to traumatic experiences in childhood and adolescence can result in distressing psychological sequalae in the form of post-traumatic stress disorder (PTSD; American Psychiatric Association, 2013). It is important to understand the processes underpinning the development and maintenance of PTSD in this population to facilitate effective psychological interventions.

Cognitive models of PTSD highlight characteristics of trauma memories, such as fragmentation and disorganisation, as key mechanisms in the development and maintenance of the disorder (Brewin et al., 1996; Ehlers & Clark, 2000). It is proposed that high levels of peritraumatic threat and ‘data-driven’ processing, i.e. processing sensory and perceptual characteristics of the event, as opposed to the meaning of the event (Halligan et al., 2003; McKinnon et al., 2008), impairs the encoding process. This results in memories of the traumatic event that are not fully elaborated into their autobiographical context. These memories are instead fragmented, disorganised, sensory-laden, temporally disrupted and easily triggered by related environmental cues (Brewin et al., 2010; Sündermann et al., 2013), thus giving rise to intrusive reliving symptoms and poorer post-trauma adjustment (Ehlers & Clark, 2000).

However, support for this ‘special mechanisms’ view has not been unanimous. Some authors have argued instead for the ‘basic mechanisms’ view, proposing that reliving symptoms reflect greater availability and repeated rehearsal of trauma memories, due to these memories forming a central part of an individual’s life story (Rubin et al., 2008). It is important to clarify the processes underlying PTSS, as psychological therapies such trauma-focused cognitive behavioural therapy (TF-CBT) typically bases its key elements on the ‘special mechanisms’ view (Ehlers & Clark, 2000; Kangaslampi & Peltonen, 2019) and is the recommended first-line treatment for PTSD in youth (National Institute for Health and Care Excellence, 2018).

Different methodologies are available to investigate trauma memories, including self-report questionnaires such as the Trauma Memory Quality Questionnaire (TMQQ; Meiser-Stedman et al., 2007), or narrative recall of the traumatic event. It could be argued that narrative recall may offer a more detailed means of investigating the distinctive properties of trauma memory proposed by cognitive theory (Crespo & Fernandez-Lansac, 2016). However, this method is not without limitations, as anxiety during recall may activate cognitive avoidance, resulting in sparse narratives that do not reflect the true experience of the trauma (Gray & Lombardo, 2001). There is currently limited literature investigating trauma memory characteristics in youth populations, and that which is available has produced mixed findings. Some studies have observed an association between greater disorganisation of trauma narratives and higher levels of PTSS (Kenardy et al., 2007; Salmond et al., 2011), whilst others indicate greater coherence and less sensory properties of narratives in children experiencing higher levels of PTSS (O'Kearney et al., 2007). McKinnon et al., (2017) found that reduced cohesion and greater negative emotion was associated with acute PTSS, however these qualities were not predictive of later PTSS. This study also utilised self-report methodology and found scores on the TMQQ to be a greater predictor of PTSS than narrative characteristics. McGuire et al., (2021) similarly found that self-reported memory characteristics were associated with acute PTSS, whereas this association was not observed for narrative memory characteristics. This highlights the utility of combining both self-report and narrative methodology.

Cognitive theory proposes that elaboration of traumatic memories during TF-CBT reintegrates these memories into their autobiographical context, thus reducing distressing reliving symptoms. It would therefore be expected that post-treatment narratives might demonstrate greater organisation, coherence, temporal continuity and decreased sensory and emotional characteristics following TF-CBT. Whilst there is some limited evidence demonstrating increased organisation of trauma narratives post-treatment in adults (Foa et al., 1995; Van Minnen et al., 2002), there is disagreement in the literature as to whether this is related to changes in PTSS (Kangaslampi & Peltonen, 2020; Knutsen & Jensen, 2019) and there is a paucity of literature exploring this. Therefore, it is currently unclear whether the alteration of trauma memory characteristics through reintegration can be conclusively conceptualised as an important mechanism of action in TF-CBT.

In addition to the aforementioned cognitive processes, neurobiological conceptualisations of PTSD highlight a potential role for neurobiological factors in the development of PTSS. It is proposed that prolonged activation of the physiological stress response alters brain neurochemistry, with deleterious effects on the function of hippocampal and frontal lobe regions (Yehuda et al., 2015), contributing to re-experiencing symptoms and broader neurocognitive dysfunction. A meta-analysis of neurocognitive function in young people with PTSD has highlighted deficits in general intelligence, language and verbal skills, perceptual and visuospatial skills, and executive function (Malarbi et al., 2017). However, the majority of studies focused on enduring familial trauma, and low socioeconomic status (SES) has been identified as a separate risk factor for both familial trauma and poorer cognitive function (Hackman et al., 2015; Paxson & Waldfogel, 2002). Therefore, current conclusions regarding neurocognitive function in young people with PTSD are confounded by the influence of SES. Additionally, a large prospective study has indicated that poorer neurocognitive functioning may in fact precede PTSD and can be conceptualised as a risk factor for victimisation as opposed to an outcome (Danese et al., 2017). It can also logically be proposed that the hypothesised neurophysiological mechanisms would need to enact their effects over a period of time before significant downstream changes in neurocognitive function are observed, and may therefore be less relevant in single-event trauma. However, TF-CBT typically relies on detailed recollection of the trauma event and the capacity to integrate new learning (Kangaslampi & Peltonen, 2019) and it is plausible that neurocognitive difficulties may detrimentally affect this process (Nijdam et al., 2015). Therefore, investigation of neurocognitive functioning in young people exposed to non-chronic, single-event trauma is warranted to understand whether concerns regarding neurocognitive functioning are relevant to this population.

The current study will be the first to investigate trauma narratives, using self-report and narrative methodology, and neurocognitive function together in a youth sample exposed to single-event trauma. Firstly, the study aims to investigate trauma memories in trauma exposed (TE) youth, both with and without a diagnosis of PTSD. Secondly, the study aims to explore neurocognitive function in TE and non-TE youth using a standardised battery of neurocognitive tests. Finally, this study also proposes to conduct a preliminary exploration of post-treatment changes in trauma narratives and neurocognitive function in youth with PTSD. The following research questions are proposed:

1. Do trauma narratives in youth with PTSD significantly differ on trauma memory characteristics compared to TE youth without PTSD?
2. Are there significant differences in neurocognitive functioning in youth with PTSD compared to TE youth without PTSD and non-TE youth?
3. Are there significant changes in trauma memory characteristics and/or neurocognitive functioning following a form of TF-CBT; cognitive therapy for PTSD (CT-PTSD)?

Based on cognitive theory and the ‘special mechanisms’ view, we hypothesised that young people with PTSD would demonstrate higher levels of sensory and negative emotional content, disorganisation, incoherence, and temporal disruption in their trauma narratives. Drawing upon the ‘basic mechanisms’ view, we also hypothesised that the trauma memory would be more ‘central’ to identity and life story in youth with PTSD. Given the single-event nature of the trauma, we did not expect to see significant neurocognitive difficulties in youth with PTSD. Based on mechanisms of change suggested by cognitive models, we hypothesised that there would be increased organisation, coherence, temporal continuity and decreased sensory and emotional characteristics of trauma narratives in youth who received treatment. As we did not hypothesise significant differences in neurocognitive function at baseline, we did not expect to see significant differences post-treatment.

Method

Participants

One-hundred-and-five 8–17 year olds were recruited as parts of the Acute Stress Programme for Children and Teenagers (ASPECTS) study to facilitate a case-control study and randomised controlled trial (RCT). Trauma exposed participants were recruited from local emergency departments as part of an earlier screening and prospective longitudinal study. Details of recruitment and exclusion criteria of the screening study are available in Meiser-Stedman et al., (2019). Relevant to the current study, a group of 29 participants with PTSD (M_{age} = 13.6, 21 female) were recruited. Ten were recruited from the screening study and an additional 19 recruited from community mental health teams, family doctors, schools and adverts in health clinics. A control group of 40 TE participants that did not meet the diagnostic criteria for PTSD (M_{age} = 13.3, 21 female) were also recruited from the screening study. The TE control group offered the opportunity to establish whether observed results were attributable specifically to PTSD or to trauma exposure more generally. A control group of 36 participants (M_{age} = 13.9, 27 female) without trauma exposure was recruited through schools in the region covering a diverse catchment area and thus with matched socioeconomic background to the TE groups. See Table 6 for demographic characteristics and trauma type data.

Table 6

Participant Demographics

	PTSD	TE non-PTSD[1]	Non-TE
Age	13.65 (2.54)	13.27 (3.12)	13.91 (2.42)
Female sex	21 (72.4%)	21 (52.5%)	27 (75%)
Minority ethnicity	5 (17.24%)	3 (10)	4 (11.2%)
Household income >20K	17 (58.7%)	29 (72.5%)	25 (69.4%)
Trauma type			
RTA	15 (51.7%)	19 (47.5%)	-
Assault	7 (24.1%)	5 (12.5)	-
Accidental injury	3 (10.3%)	14 (35%)	-
Other	4 (13.8%)	-	-

Note: RTA = Road traffic accident, TE = Trauma exposed. Values presented as Mean (SD) or Frequency (%)
[1]Two participants were missing data for trauma type

Procedure

TE participants were assessed for PTSD two to six months post-trauma (*M* = 113.2 days, *SD* = 37.04). Participants completed questionnaires on PTSS and trauma-relevant psychological processes. All participants completed a narrative task and a battery of neurocognitive tests. For the narrative task, participants were instructed to give a verbal account of their trauma event and a recent negative event. Non-TE participants narrated a negative event only. The negative event provided a control narrative, to establish whether memory characteristics were generic to memories of negative valence or specific to trauma memories. The neurocognitive tests included measures of intelligence, memory, attention, and executive functioning.

Participants meeting the ICD-10 PTSD (World Health Organisation, 1992) criteria were invited to participate in a 10-week RCT of CT-PTSD (details reported in Meiser-

Stedman et al., 2017). Participants from both the intervention and wait-list (WL) arms of the RCT repeated the experimental battery post-intervention. Three participants did not complete any post intervention measures (2 from WL and 1 from CT-PTSD). Researchers conducting the post-intervention experimental battery were blind to participants' treatment condition. The study was approved by the UK National Research Ethics Service, Cambridgeshire 1 Research Ethics Committee (10/H0304/11) and registered with the ISRCTN Registry (ISRCTN38352118). Informed assent/consent from the child and their parent/carer was required for participation. See Appendix J for flow diagram detailing recruitment and procedure.

Measures

Self-Report Questionnaires

The Trauma Memory Quality Questionnaire (TMQQ; Meiser-Stedman et al., 2007) was used to assess the sensory quality, temporal context, and verbal accessibility of trauma memories. The Children's Data Driven Processing Questionnaire (CDDPQ; McKinnon et al., 2008), adapted from the adult Data-Driven Processing Scale (Halligan et al., 2003), was used as a measure of peritraumatic data-driven processing. A youth-adapted version of the Centrality of Event Scale (CES; Berntsen & Rubin, 2006), named the Children's Centrality of Event Scale (CCES), was used to assess the extent to which the trauma memory formed a 'central' reference point for identity and attribution of meaning to other life experiences. The Child PTSD Symptom Scale (CPSS; Foa et al., 2001) was used to assess PTSS. The TMQQ, CDDPQ and CPSS were chosen due to their specificity for youth populations and favourable psychometric properties (Foa et al., 2001; McKinnon et al., 2008; Meiser-Stedman et al., 2007). All showed excellent internal consistency in the present study (α = >.90). The CCES was developed specifically for the current study, therefore less data is available on the psychometric properties of this adapted measure. However, the adult version of the scale shows good reliability (Berntsen & Rubin, 2006) and Cronbach's alpha for the current study indicated excellent internal consistency ($\alpha = .93$).

Narrative Task

Participants were asked to provide a verbal account of the trauma event and/or recent negative event (see Appendix K). Following protocols from previous studies (Foa et al., 1995; Halligan et al., 2003; McGuire et al., 2021; Salmond et al., 2011), narratives were transcribed and chunked into utterances. The content of each utterance was coded according to the following characteristics taken from the Foa et al., (1995) coding protocol: repetitions, disorganised thoughts, organised thoughts, sensations, and negative feelings. Repetitions and disorganised thoughts were converted into Z scores and added together, and the Z score of organised thoughts was subtracted from this to give an overall score pertaining to disorganisation (Halligan et al., 2003; Salmond et al., 2011). Sensations and negative feelings were converted into percentages of the total number of utterances to control for the length of each narrative (McGuire et al., 2021; Salmond et al., 2011). Each narrative was given a score between 1 and 10 to reflect overall incoherence of the narrative, with 1 indicating a highly coherent narrative and 10 indicating a highly incoherent narrative (Halligan et al., 2003). The Narrative Coherence Coding Scheme (Reese et al., 2011) proposes that narrative coherence can be further broken down into three dimensions: context, the extent to which the narrative was orientated into place and time; chronology, the extent to which the narrative was narrated in a sequential order; and theme, the extent to which the narrating 'hung together' in terms of a clear beginning, middle and end. Each narrative was given a score between zero and three on these dimensions. A score of zero reflected poor context, chronology and theme, whereas three indicated the narrative was well contextualised, followed a chronological order and followed a clear structure, i.e. theme. Coding of the narratives was completed by two blind raters and a third of the narratives were coded by both raters, to assess interrater reliability.

There was moderate agreement between raters for chronology (intraclass correlation coefficients [ICC] = 0.50) likely due to ceiling effects, and good agreement between raters for coherence, context and theme (ICC = 0.77-0.84).

Neurocognitive Battery

The Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) was used to provide an estimation of Full Scale Intelligence Quotient (FSIQ). The California Verbal Learning Test – Children's version (CVLT-C; Delis et al., 1991) was used to assess encoding, organisation and retrieval of verbal material. A parallel alternate form was developed by AMK for the purposes of retesting. The stories subtest from the Children's Memory Scale (CMS; Cohen, 1997) was used as a measure of immediate and delayed verbal memory for auditorily presented material. The digit span subtest of the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV; Wechsler, 2003) was used as a measure of verbal working memory. The Continuous Visual Memory Test (CVMT; Trahan & Larabee, 1983) was used as a measure of immediate and delayed visual memory. Sustained attention is necessary to encode information into short- and long-term memory stores (Awh et al., 2006), therefore a simple response time task (SRT) was included as a measure of sustained attention. Participants were asked to focus on a fixation point and respond as quickly as possible when a target stimulus appeared across 20 trials to determine mean reaction time. Two versions of the task were developed, both of approximately equal lengths but differing inter-stimulus intervals. The Computerised Multiple Elements Test (CMET; Hynes et al., 2015), a computerised game variation of the Six Elements Test of the Behavioural Assessment of the Dysexecutive Syndrome (Wilson et al., 2004), was used as a measure of executive functioning. The task measures attentional control, self-regulation, and planning and organisational skills. The CMET is the only test with limited evidence to support its reliability and validity in youth populations, however imaging research indicates the ability of the test to activate well-established executive networks and it is suggested that the computerised task may offer greater ecological validity compared to classic paradigms (Fuentes-Claramonte et al., 2021).

The order in which TE participants provided narratives, the version of SRT administered and the standard and alternate versions of the CVLT were counterbalanced between participants (see appendix L). Stories from the CMS stories subtest were counterbalanced by keeping a log and presenting stories alternately as participants entered the study. All self-report measures and tasks were repeated by trial participants post-intervention, except for the CDDPQ and WASI as these are not likely to change over time.

Analysis

All data was analysed cross-sectionally using between-group comparisons. Data was analysed using SPSS (Version 27.0) and R (Version 4.1.2). Measures of skewness and kurtosis, in addition to significant Shapiro-Wilk results, indicated that the data did not meet the assumptions for parametric analysis. The WRS2 package (v1.1-3; Mair & Wilcox, 2020) in R was used to apply robust statistical methods to the pre-intervention data, namely bootstrapping and trimmed means (see Appendix M). The bootstrapping function repeatedly resampled the study sample to provide an approximation of estimates that would be observed if the whole population was sampled. The number of resamples was 1000. The top and bottom 20% of scores were trimmed and the mean subsequently calculated from the remaining scores, as this has been shown to produce robust test statistics (Wilcox, 2017). Yuen's modified t-test for independent trimmed means (Yuen, 1974) was used to compare means between TE groups for self-report and trauma narrative data. A robust model, equivalent to a one-way ANOVA (Field & Wilcox, 2017) was used to compare trimmed means across both TE groups and the non-TE group for negative event narratives and neurocognitive data. Robust post-hoc tests were used to compare the difference between trimmed means and provide a *p* value for this difference ($\hat{\psi}$). The robust methods analyses produce an explanatory effect size, ξ (xi), interpreted as small = .01, medium =.03, or large =.5 (Field & Wilcox, 2017). Bootstrapping was not possible for some variables due to insufficient variation in the data. In such cases, non-parametric results and effect sizes are reported instead. As shown in Appendix N a similar profile of results was observed for non-parametric analyses.

Post-treatment data was missing for participants from both CT-PTSD and WL arms of the RCT. Multiple imputation was applied using the Mice package (v3.11.6; Van Buuren & Groothuis-Oudshoorn, 2011) in R. A one-way ANOVA, with baseline scores added as a covariate, was used to compare treatment outcomes between CT-PTSD and WL groups (see Appendix O). The analysis had limited power given the small sample size, therefore this was treated as a preliminary, exploratory analysis. Partial η^2 was reported and interpreted as small =.01, medium =.06, or large =.14 (Fritz et al., 2012).

Each narrative variable and neurocognitive test was compared separately between groups. Given the potentially inflated risk of type I errors, Holm-Bonferroni corrections were applied within groups of related results, i.e. self-report data, trauma and negative narrative data, and neurocognitive data (Holm, 1979). Descriptive statistics are reported for the original data without robust methods or multiple imputation applied. Reported *p* values and effect sizes pertain to results obtained using robust methods and multiply imputed data, unless otherwise stated.

Results

Self-Report and Narrative Memory Characteristics

As shown in Table 9, significant differences between TE PTSD and TE non-PTSD youth were observed for all self-report measures, supported by large effect sizes. TE PTSD youth scored significantly higher than TE non-PTSD youth on the TMQQ (p=<.001, ξ = .95) indicating greater sensory content, a sense of 'nowness' and difficulties verbally accessing trauma memories. Significantly higher scores on the CCES (p=<.001, ξ = .88) were also observed for PTSD youth compared to non-PTSD youth, indicating that the trauma memory was more 'central' to identity and life story in youth with PTSD. PTSD youth also scored significantly higher on the CDDPQ (p=<.001, ξ = .80) indicating increased data-driven processing at the time of the traumatic event compared to TE non-PTSD youth.

Analysis of trauma event narratives demonstrated that PTSD youth had a significantly higher percentage of sensory content in their narratives (p=.003, ξ = .50) compared to TE non-PTSD participants. PTSD participants also had significantly lower scores for chronology (p=.003, r=-.37) and theme (p=.002, r=-.38) in trauma narratives compared to TE non-PTSD participants, suggesting these narratives followed less of a chronological order and had less clear structure. There was a trending effect for incoherence (p=.04, ξ = .36), however this did not reach statistical significance at Holm-Bonferroni corrected alpha level (α =.01). There were no significant between group differences for any other trauma narrative characteristics.

Analysis of negative event narratives demonstrated significant between group differences in chronology, with post-hoc analysis indicating significantly poorer chronology in PTSD youth compared to non-TE youth (p=<.001), and significantly poorer chronology in TE non-PTSD youth compared to non-TE youth (p=<.001). There were no significant differences in chronology between PTSD and TE non-PTSD youth. There was a trending effect for incoherence (p=.04, ξ =.39), however this did not reach statistical significance at the Holm-Bonferroni corrected alpha level (α =.008). There were no significant between group differences for any other negative narrative characteristics.

Neurocognitive Function

As shown in Table 10, there were no significant between group differences for any neurocognitive tests, suggesting TE and non-TE youth demonstrated similar overall levels of neurocognitive functioning.

Table 9

Baseline Self-Report and Narrative Memory Characteristics

	Trauma-exposed, PTSD			Trauma-exposed, Non-PTSD			Non-trauma-exposed				
Variable	Mdn	IQR	N	Mdn	IQR	N	Mdn	IQR	N	Statistical test for group	Effect size (ξ)
Self-reported trauma memory											
Memory quality (TMQQ)	34	7.5	29	17	6.67	40	-	-	-	Y_t = -12.19, *p*=<.001*	.95
Memory centrality (CCES)	2.9	1.21	29	1.29	.71	39	-	-	-	Y_t = -7.77, *p*=<.001*	.88
Data driven processing (CDDPQ)	23.5	9	28	13	11	39	-	-	-	Y_t = -5.18, *p*=<.001*	.80
Trauma event narrative											
Disorganisation	-.25	1.13	27	-.24	1.04	38				Y_t = -0.37, *p*=.71	.08
Incoherence	3	3	27	2	2	37	-	-	-	Y_t = -1.98, *p*=.04	.36
Sensations	4.8	5.23	27	2.66		36	-	-	-	Y_t =-3.15, *p*=.003*	.50
Negative feelings	1.43	4.2	27	1.45	3.03	35	-	-	-	Y_t = -1.06, *p*=.28	.21
Context	1	1	27	1	0.5	37	-	-	-	U=492, *p*=.91	-.01[1]
Chronology	3	1	27	3	0	37	-	-	-	U=333.50, *p*=.003*	-.37[1]
Theme	1	1	27	2	2	37	-	-	-	U= 287.50, *p*=.002*	0.38[1]
Negative event narrative											
Disorganisation	-.13	1.23	27	-.27	1.43	37	-.41	1.19	36	F_t =1.67, *p*=.19	.25
Incoherence	4	2	27	3	2	36	3	1.75	36	F_t =4.05, *p*=.04	.39
Sensations	0	0	27	0	0	35	0	.89	36	H(2)=1.66, *p*=.44	.05[2]
Negative feelings	2.5	6.25	27	2.91	4.31	36	4.26	6.01	36	F_t =.55, *p*=.55	.16
Context	1	0	27	1	1	36	1	0	36	H(2)=.13, *p*=.94	-.02[2]
Chronology	2[a]	1	27	3[a]	.75	34	3[b]	0	36	H(2)=21.41, *p*=<.001*	.21[2]
Theme	1	1	27	2	1	35	2	1	36	H(2)=2.60, *p*=.27	.01[2]

Note: CCES = Child Centrality of Events Scale, CDDPQ = Child Data Driven Processing Questionnaire, TMQQ = Trauma Memory Quality Questionnaire.
*Indicates significance at Holm-Bonferroni corrected alpha level. [1] Effect size, *r*, Interpreted as small .10, medium .25, large ≥.40 (Rosenthal & Rosnow, 1991). [2] Effect size, η^2,Interpreted as small .01-.06, medium .06-.14, large ≥.14 (Tomczak & Tomczak, 2014). [ab] Indicates significant post-hoc group differences.

Table 10

Baseline Neurocognitive Function

Neurocognitive test	Trauma-exposed, PTSD			Trauma-exposed, Non-PTSD			Non-trauma-exposed			Statistical test for group	Effect size (ξ)
	Mdn	IQR	N	Mdn	IQR	N	Mdn	IQR	N		
IQ (WISC-IV)	95	16	29	101	17	40	101.5	13	36	$F_t = 3.40$, $p = .05$	.34
Verbal memory (CVLT-C)	48	20.5	29	54	13.5	40	54	18	36	$F_t = 1.07$, $p = .35$	.19
Verbal recall immediate (CMS stories subtest)	8	7	29	10	6	40	10.5	4	36	$F_t = 1.54$, $p = .23$	.26
Verbal recall delayed (CMS stories subtest)	8	7.5	28	10	5.75	40	10.5	4	36	$F_t = 0.62$, $p = .54$	.17
Verbal recognition (CMS stories subtest)	7	6.75	28	11	5.75	40	11	6.5	36	$F_t = 1.65$, $p = .21$	.25
Verbal working memory (Digit Span)	9	4	28	10	2.75	40	10	3	36	$F_t = 1.58$, $p = .22$	.22
Visual memory (CVMT)	10	40	28	30	50	40	30	57	35	$F_t = .87$, $p = .42$	.19
Sustained attention (SRT)	415.41	103.82	28	381.25	128.84	39	379.61	101.71	36	$F_t = 2.94$, $p = .06$	.31
Executive function (CMET)	108	82.25	29	128	88.75	40	137	96	36	$F_t = 58$, $p = .58$	.15

Note: CMET = Computerised Multiple Elements Test, CMS = Children's Memory Scale, CVLT-C = California Verbal Learning Test – Children's version, CVMT = Continuous Visual Memory Test, SRT = Simple response time task, WISC-IV = Wechsler Abbreviated Scale of Intelligence – Fourth Edition.

Post-Treatment Memory Characteristics and Neurocognitive Function

As shown in Table 11, there were significant between group differences in CPSS scores, indicating that youth who received treatment had significantly lower levels of self-reported PTSS compared to WL (p= <.001, ηp^2=.36). CT-PTSD participants also demonstrated significantly lower TMQQ scores compared to WL (p= <.001, ηp^2=.36), indicating decreased sensory content and sense of 'nowness', and greater verbal accessibility of trauma memories. Significantly lower CCES scores (p=.04, ηp^2=.17) were also observed, indicating decreased 'centrality' of the trauma memory in CT-PTSD participants compared to WL. Observed effect sizes for CPSS and TMQQ results were in the large range, whereas a medium effect was observed for CCES results.

There were also significant between group differences for incoherence in trauma narratives, indicating trauma narratives in CT-PTSD participants were more coherent compared to WL (p= .004, ηp^2=.42), with a large effect observed. There was a trending effect for chronology in trauma narratives (p= .03, ηp^2=.23), however this did not reach statistical significance at Holm-Bonferroni corrected alpha level (α=.008). There were no significant between group differences observed for any other trauma narratives characteristics or any negative event narrative characteristics. There were no significant differences between CT-PTSD and WL participants for any neurocognitive tests (see Appendix P).

Table 11

Post-Treatment Self-Report and Narrative Memory Characteristics

Variable	CT-PTSD Mdn	CT-PTSD IQR	CT-PTSD N	WL Mdn	WL IQR	WL N	Statistical test for group	η_p^2
PTSD symptoms								
CPSS	4	9.5	13	17	33	13	$F_{(1, 24)}$=11.45, *p*= <.001*	.36
Self-reported trauma memory								
Memory quality (TMQQ)	20	7	13	33	14.5	13	$F_{(1, 24)}$=12.23, *p*= <.001*	.36
Memory centrality (CCES)	2.14	1.43	13	2.86	1.93	13	$F_{(1, 24)}$=4.35, *p*= .04*	.17
Trauma event narrative								
Halligan disorganisation	-.25	2.48	10	-0.8	1.09	7	$F_{(1, 15)}$=.15, *p*=.70	.01
Halligan incoherence	2	3	10	4	3	7	$F_{(1, 15)}$=9.36, *p*=.004*	.42
Sensations	4.18	4.31	10	2.5	14.04	7	$F_{(1, 15)}$=1.24, *p*=.27	.13
Negative feelings	3.1	4.29	10	0	2.74	7	$F_{(1, 15)}$=1.88, *p*=.18	.12
Context	2	2	10	1	1	7	$F_{(1, 15)}$=2.44, *p*=.12	.16
Chronology	3	0	10	2	1	7	$F_{(1, 15)}$=4.96, *p*=.03	.23
Theme	2	1	10	1	2	7	$F_{(1, 15))}$=2.26, *p*=.14	.13
Negative event narrative								
Halligan disorganisation	-.37	1.89	10	-.06	2.43	4	$F_{(1, 12)}$=.26, *p*=.61	.02
Halligan incoherence	3	2.25	10	3.5	1	4	$F_{(1, 12)}$=.52, *p*=.47	.03
Sensations	0	3.62	10	2.33	4.73	4	$F_{(1, 12)}$=.25, *p*=.62	.03
Negative feelings	2.49	3.93	9	9.81	18.76	4	$F_{(1, 11)}$=2.41, *p*=.13	.22
Context	1.5	1.75	8	1	.75	4	$F_{(1, 10)}$=2.63, *p*=.11	.16
Chronology	3	1	10	2.5	1	4	$F_{(1, 12)}$=.31, *p*=.58	.02
Theme	2	1	10	1	.75	4	$F_{(1, 12)}$=.36, *p*=.55	.03

Note: CCES = Child Centrality of Events Scale, CPSS = Child PTSD Symptom Scale, CT-PTSD = Cognitive therapy for post-traumatic stress disorder, WL = Wait list, TMQQ = Trauma Memory Quality Questionnaire.
*Indicates significance at Holm-Bonferroni corrected alpha level

Discussion

The present study aimed to explore self-report and narrative memory characteristics, in addition to neurocognitive function, before and after psychological intervention in a sample of youth exposed to single-event trauma. The findings indicate significantly greater data-driven processing, as measured by the CDDPQ, in addition to greater self-reported sensory content sense of 'nowness' and difficulty with verbal retrieval in relation to trauma memories, as measured by the TMQQ, congruent with mechanisms proposed by cognitive models (Brewin et al., 1996; Ehlers & Clark, 2000). Significantly higher scores on the CCES also suggested that trauma memories formed a more 'central' part of identity and life story youth with PTSD, in line with the 'basic mechanisms' view (Rubin et al., 2008).

Trauma narratives of youth with PTSD were significantly more sensory laden, in congruence with cognitive models, but in contrast to previous research (McGuire et al., 2021; McKinnon et al., 2017; O'Kearney et al., 2007; Salmond et al., 2011). Significantly poorer chronological order and poorer structure, i.e. theme, was also observed, consistent with research observing temporal disruption in trauma narratives (McKinnon et al., 2017). Differences in sensory content and theme were specific to trauma narratives, whereas poorer chronology was observed in both trauma and negative event narratives. However, poorer chronology in the negative event narratives was observed between TE and non-TE groups, whereas a significant difference between TE groups was observed in trauma narratives, suggesting that poorer chronology was specifically relevant to PTSD in the trauma narratives. No significant differences in negative emotional content was observed in trauma narratives, in contrast to McKinnon et al. (2017). Contrary to our hypothesis, and studies using similar methodology (Salmond et al., 2011), we did not observe significant disorganisation in trauma narratives. However, Salmond et al., (2011) did not observe direct between-group differences in disorganisation, but instead found significant differences between trauma and negative event narratives within the PTSD participant group. The present study did not conduct within groups comparison between narratives. Reviews of adult literature have highlighted that sensory characteristics and disturbed temporal aspects of trauma narratives have been observed more consistently than disorganisation (Crespo & Fernandez-Lansac, 2016; O'Kearney & Perrott, 2006). The present study suggests that this assertion may also be relevant to youth populations. The discrepancy in the magnitude of the differences observed between TE groups in self-reported versus narrative characteristics of trauma memory is consistent with research demonstrating clear differences in self-reported memory, but not narrative characteristics, in youth with PTSD (McGuire et al., 2021). Additionally, research has indicated that the association between narrative characteristics and PTSS reduces over time (McKinnon et al., 2017) and Salmond et al. (2011) considered narrative characteristics only within the acute period following trauma. Given that the present study explored narrative characteristics only within the post-acute period, this may explain the limited differences observed in narrative characteristics. In line with our hypothesis, there were no significant differences between TE and non-TE groups on any neurocognitive tests. The observed null results within a sample of youth from matched socioeconomic backgrounds is congruent with research indicating that neurocognitive deficits observed in youth exposed to chronic trauma may be better explained by environmental risk factors rather than trauma exposure per se (Danese et al., 2017). Neurocognitive factors were therefore unlikely to affect ability to engage in CT-PTSD or underpin any observed differences in trauma narrative characteristics in this study. It would be beneficial for future research to replicate these results.

Post-treatment results indicated that youth who received CT-PTSD had significantly lower TMQQ scores, suggesting reduced self-reported sensory content and sense of 'nowness', greater verbal accessibility of trauma memories, and greater coherence in trauma narratives compared to WL, in line with cognitive models of PTSD. Greater coherence is interesting to note given that significant differences were not observed for this characteristic at baseline, although it is noted that there were some trending effects. CT-PTSD participants also had significantly lower CCES scores, suggesting the trauma memory had become a less central part of their life and identity, however a more moderate effect size was observed compared to differences in TMQQ scores and coherence. It is therefore difficult to definitively state whether the data provides greater support for the 'special mechanisms' view over the 'basic mechanisms' view. No other trauma narrative characteristics showed significant differences to WL, aligned with previous mixed findings for post-treatment narratives (Knutsen & Jensen, 2019).

There are several strengths of the current study. The trauma exposed control group established whether findings were specifically related to PTSD or broadly related to trauma exposure. The negative event narrative allowed us to understand whether narrative characteristics reflected a general recall style in those with PTSD when recalling negative emotional events, or whether these were specific to trauma memories. Matching participants on socioeconomic characteristics reduced the potential for this to confound the results and counterbalancing of the experimental battery instils confidence that order effects did not influence the results.

There are some potential limitations of the present study that need consideration. Trauma exposed participants within this sample experienced a single-event trauma with no clear antecedents. Whilst there is benefit to this, in allowing us to conclude that observed results were unlikely due to wider psychosocial or environmental factors, this also limits the generalisability of the results. Further research in youth with complex multiple trauma histories, e.g. maltreatment, is necessary to conclude whether a similar profile of results for self-report and narrative trauma memory characteristics would be observed in this population.

Furthermore, context, chronology and theme had a limited range of scores, potentially making them relatively insensitive measures. Limited variation in scores also meant it was not possible to apply robust statistical methods to these variables. However, it is interesting to note the significant findings for chronology and theme despite a potential lack of sensitivity and the reduced power of non-parametric analysis. The use of cross-sectional group comparisons meant that it was not possible to comment on the extent to which certain factors were associated with PTSS or how this relationship may change over time. It is acknowledged that the post-treatment analysis had relatively low power and findings are only presented here tentatively, with the recommendation that this is explored further by future research. As a broader recommendation, it would be beneficial to reduce heterogeneity of narrative coding schemes, as this may contribute to mixed findings observed across studies (O'Kearney & Perrott, 2006). Advancements in technology could be harnessed for these purposes, such as use of artificial intelligence algorithms to reduce subjectivity and human error.

As briefly demonstrated here, elaborated further in Meiser-Stedman et al., (2017) and confirmed by a recent network analysis (Mavranezouli et al., 2020), TF-CBT demonstrates efficacy in significantly reducing PTSS in youth with PTSD. Cognitive theory suggests this is, in part, due to elaboration and subsequent reintegration of trauma memories. However, as noted by other authors, *perceptions* of trauma memory characteristics may represent a more important factor than narrative memory characteristics themselves (Bray et al., 2018; McGuire et al., 2021; McKinnon et al., 2017). It would be interesting to explore whether this may be related to negative appraisals, a cognitive factor consistently identified as important in the aetiology of PTSD (Gómez de La Cuesta et al., 2019; Mitchell et al., 2017). Negative appraisals related to the trauma event and trauma symptoms could potentially influence perceived intensity of these symptoms, which may impact self-report measures such as the

TMQQ. It may be the case that challenging negative *perceptions* of trauma memory characteristics during the narrative exposure elements of treatment may be an important target for psychological interventions. Additionally, responses on the TMQQ may pertain to flashbacks, a specific form of intrusive memory, whereas narrative recall of the trauma memory is qualitatively different in that it is *voluntarily* recalled. Particularly as sensory content is hypothesised to be a defining feature of flashbacks, and items in the TMQQ are weighted more towards sensory elements of trauma memories than disorganisation or coherence of these memories. A reduction in TMQQ scores post-treatment may therefore reflect reintegration, and thus reduction, in involuntarily recalled intrusive memories, but this may not be captured by voluntarily recalled narratives of the trauma. It may be beneficial for future research to explore whether an association between self-reported memory characteristics and PTSS is mediated by negative appraisals and determine with greater precision what TMQQ scores represent. This is important, as identifying mechanisms of action can help to refine key elements of psychological treatments to improve their efficacy.

In conclusion, the current results add to an emerging pattern of results within the field of trauma memory in youth, with mixed findings regarding trauma narratives but more consistent findings regarding self-reported memory characteristics, as measured by the TMQQ (McGuire et al., 2021; McKinnon et al., 2017). Null findings in neurocognitive function suggest this did not underpin differences in memory characteristics or affect response to treatment. TMQQ scores highlight an important factor in the aetiology of PTSD, however further research is necessary to elucidate cognitive factors represented by these scores, so that these findings may be translated into clinical practice.

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Chapter Four: Thesis Portfolio Discussion and Critical Evaluation

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Summary of Findings

The meta-analysis is the first of its kind to conduct a quantitative synthesis of data pertaining to the strength of the relationship between trauma memory characteristics and PTSS in youth. The large estimated effect size observed in the main analysis (r=. 52, 95% CI=.44-.58) indicated a strong relationship between trauma memory characteristics and PTSS, whereby higher scores on the TMQQ were related to higher levels of PTSS. Higher scores on the TMQQ reflect greater visual and sensory content within trauma memories, a sense that the traumatic event is happening again in the present moment, and difficulties with voluntary verbal recall of these memories. It is noted that there were several particularly large effect sizes (r≥.70) within the cross-sectional analyses which may have contributed to higher pooled estimated effect sizes and high estimates of heterogeneity. The acute, prospective and main analyses showed similar results, with estimated effect sizes in the large range. Confidence intervals indicated that there was a 95% chance that the true pooled effect size fell within the medium to large range for these analyses. The similarity of results observed for the sensitivity analyses suggested that low quality studies, altered versions of the TMQQ, LMIC populations, non single-event trauma, and PTSS measure were unlikely to have substantially influenced the results of the main analysis.

Overall, results from the meta-analysis indicate a strong relationship between trauma memory characteristics and concurrent and future PTSS. However, there is an assumption within this interpretation that scores on the TMQQ directly map onto trauma memory characteristics proposed to be important by cognitive models. However, as previously highlighted, TMQQ scores may reflect an individual's *perception* of trauma memory characteristics, rather than providing an objective measure of these characteristics, and/or may relate to flashbacks, a specific type of intrusive memory. The discussion recommended additional research utilising both narrative and self-report methodology to provide further clarification as to whether these methods seem to produce differing results. It was also noted that the majority of included studies focused on the acute phase and it would be helpful for research to explore trauma memory characteristics within the post-acute phase.

The empirical study helpfully attends to these points. The study aimed to explore trauma memory characteristics, using both self-report and narrative methodologies, in a youth sample exposed to single-event trauma. The data afforded the opportunity to explore these characteristics not only in the post-acute phase, but also post-treatment. Significantly greater scores on self-report measures, including the TMQQ, were seen at baseline for youth with PTSD compared to TE non-PTSD youth. Trauma narratives of youth with PTSD contained significantly greater sensory content and had significantly poorer chronological order and poorer theme, i.e. structure, compared to their TE non-PTSD counterparts. Poorer scores for chronology and theme could be argued to reflect poorer coherence of trauma narratives, given that these are conceptualised to be dimensions of coherence. However, there were no significant between group differences for overall assessor-rated coherence of the trauma narratives at baseline, making it difficult to draw definitive conclusions. To further complicate this picture, significant between group differences are observed for coherence post-treatment, but were not observed for sensory content, chronology or theme post-treatment. The observed differences in overall coherence may reflect 'rehearsal' of a detailed version of the narrative during the narrative exposure element of treatment. The lack of significant differences in sensory content, chronology, and theme within trauma narratives post-treatment, despite a reduction in PTSS, potentially raises a question as to whether specific trauma memory characteristics are necessary targets during clinical interventions. It is important to highlight that the post-treatment data is interpreted tentatively given the relatively small sample size. Further research would be beneficial in understanding trauma memory characteristics post-treatment.

The empirical study also explored neurocognitive functioning alongside memory characteristics. Research on neurocognitive functioning in youth with PTSD is dominated by multiply traumatised samples, and a lack of research in this area pertaining to single-event trauma has made it difficult to conclude whether difficulties in neurocognitive functioning are also relevant to this population. This was important to clarify, as difficulties in neurocognitive functioning, particularly relating to verbal or visual memory, could theoretically contribute to altered memory characteristics. This also bears relevance to psychological interventions for PTSD, as outlined in the empirical paper, as the ability to construct a detailed narrative and incorporate new learning is integral to the treatment process and may be hampered by neurocognitive difficulties. Analysing narrative, self-report, and neurocognitive data alongside each other helped to address these important questions. The lack of between group differences in neurocognitive functioning suggested that differences observed in trauma narrative characteristics were unlikely to be underpinned by *neurocognitive* factors, and thus more likely underpinned by *cognitive* factors. This also suggested that engagement in psychological interventions was unlikely to be detrimentally affected by neurocognitive function. However, it is worth considering that youth within the study were diagnosed with PTSD within a relatively short time frame, two to six months, following the index trauma event. Therefore, it cannot be assumed that the observed results regarding neurocognitive functioning in the current study would generalise to youth exposed to single-event trauma who have experienced PTSD for a more protracted period of time, such as over several years. Further longitudinal research would be necessary to provide a definitive conclusion.

Overall, the results from the empirical paper add to a growing body of research which has observed more ‘clear cut’ results regarding the TMQQ, alongside mixed findings for trauma memory characteristics captured by narrative methodology (McGuire et al., 2021;

McKinnon et al., 2017). The results of the empirical paper support the preliminary suggestion within the meta-analysis that trauma memory characteristics, as measured by the TMQQ, remain relevant to the aetiology of PTS in the post-acute phase. Additionally, reduced TMQQ scores post-treatment, compared to limited changes in trauma narrative characteristics post-treatment, potentially suggests that the TMQQ may capture more relevant cognitive processes which are important to the theoretical and clinical understanding of PTSD in youth. However, as highlighted in both the meta-analysis and empirical paper, it is important for future research to investigate what the TMQQ may be measuring and its interaction with other cognitive factors.

Strength and Limitations

There are several strengths of the meta-analysis presented within this portfolio. The use of a single, standardised questionnaire pertaining to trauma memory characteristics greatly reduced the degree of methodological heterogeneity between studies included in the analysis. Additionally, the use of validated PTSS measures also ensured consistency in this construct across studies. Most of the observed heterogeneity within the main analysis was accounted for by a single effect size which was acting as an outlier, as evidenced by the leave-one-out diagnostic analysis. Subgroup analyses facilitated the opportunity to look at cross-sectional, prospective and acute data separately. This facilitated exploration of the relationship between TMQQ scores and concurrent PTSS, in addition to the prospective relationship between TMQQ scores and subsequent PTSS. Therefore, despite the cross-sectional nature of the data, the subgroup analyses provide some preliminary exploration of this relationship over different time points. Quantitative synthesis of results across multiple studies provided an objective numerical representation of the relationship between trauma memory characteristics, as measured by the TMQQ, and PTSS. This presents an important contribution to the understanding of trauma memory in youth, as the strength of the relationship between trauma memory characteristic and PTSS has not previously been quantitatively synthesised. This helps to contribute to a growing body of meta analyses examining various cognitive factors and their relationship to PTSS in youth (Memarzia et al., 2021; Mitchell et al., 2017; Trickey et al., 2012).

It is important that potential limitations of the meta-analysis are also considered. The number of studies included in the final analysis was relatively modest, however the combined sample size of 1270 was not nugatory for a clinical population that is challenging to recruit. The modest number of studies was carefully considered during the analysis, hence the decision not to perform moderator analyses. Grouping together acute and post-acute data within the main analysis diverged from the original analysis plan, however this maximised the number of studies which could be included. Additionally, subgroup analyses facilitated the opportunity to separate these data and a similar profile of results was observed. It is noted that most studies administered the TMQQ within the acute phase. It is therefore possible that different results may have been observed if more post-acute TMQQ data had been available. Whilst using a single self-report questionnaire had the benefit of reducing methodological heterogeneity, there is an assumption that the TMQQ directly maps onto relevant trauma memory characteristics outlined by cognitive models. However, as previously discussed, the TMQQ may be influenced by other cognitive processes and/or self-report bias, and items within the TMQQ are more heavily weighted towards sensory elements of trauma memories. Therefore, whilst it can be stated with relative confidence that there is a strong relationship between TMQQ scores and PTSS, less definitive conclusions can be drawn as to whether this precisely represents the relationship between trauma memory characteristics, hypothesised to be important by cognitive models, and PTSS.

Several strengths can be highlighted for the empirical paper. It was of incredible benefit to use pre-existing data from the ASPECTS study, as it would not have been possible to recruit the participant sample within the time frame of this thesis project. The ASPECTS study was meticulously designed and conducted by numerous well-established authors in the field of child PTSD. The repeated administration of narrative and self-report measures of trauma memory post-treatment was beneficial given the limited amount of research exploring changes in cognitive factors following psychological intervention. Investigating neurocognitive functioning in single-event trauma, alongside narrative and self-reported trauma memory characteristics, also added a novel contribution to the field. As data collection and coding of narratives had already been completed for the study, I was able to focus my time and efforts on the analysis process. It was recognised that the data did not meet the assumptions for parametric analyses, however it was also considered that non-parametric analyses would have afforded reduced power. Therefore, the application of robust statistical methods, in the form of bootstrapping and trimming, helped to effectively circumnavigate these difficulties.

Several limitations of the empirical paper also merit consideration. It can be argued that the total sample was relatively modest, however this was similar to other studies investigating trauma narratives in youth populations (McKinnon et al., 2017; Salmond et al., 2011). As previously noted, the measures of context, chronology and theme were relatively insensitive and it was not possible to apply robust statistical methods to these variables. The application of trimming methods to chronology would have removed the lower range of scores and perhaps altered the data quite substantially given the ceiling effect, therefore a different result may have been observed if this had been possible. Despite the application of robust statistical methods, the underlying non-parametric nature of the data was held in mind during the analysis process. It was felt that use of a mixed ANOVA model may have pushed the data beyond what could meaningfully be interpreted from it. Therefore, between groups analyses were conducted instead. This, however, meant that it was not possible to look at within-group differences and interaction effects, which may have been important given the significant interaction effects observed in other similar studies (Salmond et al., 2011). It is also noted that the post-treatment data has limited power, despite the application of multiple imputation. As stated throughout the portfolio, only tentative interpretations and conclusions are offered.

A strength of the portfolio is the complementary nature of both the meta-analysis and empirical paper. Together, they facilitated an in-depth investigation of trauma memory characteristics, using both narrative and self-report methodology, explored across various time points, enabling investigation of multiple different theories pertaining to trauma memory. An overarching conclusion from both papers is that the TMQQ seems to capture something particularly important and relevant to the aetiology of PTS in youth, but further research would be beneficial to establish greater clarity on what these scores represent. Considering the limitations of the work as a whole, both papers use cross-sectional analysis, making it difficult to draw definitive conclusions as to the prospective relationship between trauma memory characteristics and PTSS over time. This is important as previous research has suggested that the strength of the relationship between TMQQ scores and PTSS may reduce over time, particularly when the contribution of other cognitive factors is included (McGuire et al., 2021; McKinnon et al., 2017). Additionally, whilst there is benefit in isolating one particular cognitive factor so that this may be examined in detail, it is acknowledged that this neglects to some extent the complex interplay between multiple cognitive factors as outlined in cognitive models. As previously highlighted, a broader limitation within the field of trauma memory research is the predominant focus on single-event trauma, particularly medical illness and injury, in western populations. This limits the generalisability of findings from both the meta-analysis and empirical paper. Research has demonstrated that certain forms of trauma, such as assault and interpersonal traumas, may be associated with higher levels of PTSS (Meiser-Stedman et al., 2019) and confer greater risk for the development of PTSD (Walker et al., 2020). It has also been indicated that trauma memories may be influenced by cultural factors (Jobson, 2011). This exemplifies the importance of broadening the population included within this field of research, to establish whether a similar profile of results can be observed across a greater variety of trauma types, including more chronic forms of trauma exposure, and in LMIC populations.

Theoretical & Clinical Implications

Whilst the ‘special mechanisms’ view argues for the existence of separate memory representations and impaired voluntary recall of the trauma memory, the ‘basic mechanism’ view hypothesises that both voluntary and involuntary recall of the trauma memory is enhanced in PTSD. These two forms of recall are not distinguished by separate memory systems, but instead represent a difference in *retrieval* from the *same* memory system. It is proposed that involuntary recall involves an uncontrolled, ‘spreading’ form of activation, whereas voluntary recall involves a controlled narrative search for a relevant memory (Rubin et al., 2008). As the current study does not provide in-depth data pertaining to the neural bases of trauma memory representations and the way in which these memories are retrieved, it is difficult to comment upon these aspects of the ‘special mechanisms’ and ‘basic mechanisms’ view. However, greater CCES scores at in participants with PTSD at baseline is congruent with the suggestion that the ‘centrality’ of trauma events may be related to PTSS. Similarly, reduced CCES scores alongside a reduction in PTSS in participants receiving CT-PTSD also provides some support for this hypothesis within the 'basic mechanisms' view. . The ‘basic mechanisms’ view suggests that memories associated with ‘intense affect’ are subject to repeated rehearsal and subsequently demonstrate *greater* narrative coherence compared to ‘neutral’ memories. This is in contrast to the *reduced* coherence of trauma narratives as proposed by the special mechanisms view (Rubin et al., 2008). It is noted that coherence of trauma narratives for the PTSD group at baseline did not show statistically significant results, however the data tentatively indicated *reduced* coherence of trauma narratives as opposed to *increased* coherence, which was thus less congruent with this tenet of the 'basic mechanisms' view. The results observed for the TMQQ within the meta-analysis and empirical paper were congruent with the 'special mechanisms' view, which aligns with cognitive models and suggests that specific trauma memory characteristics are relevant to the aetiology of PTSD. Mixed findings in the trauma narratives make it difficult to suggest that the data provides unequivocal support for the 'special mechanisms' view. However, as is highlighted in the empirical paper, it may be the case that the TMQQ captures *involuntary* memories in the form of flashbacks, whereas trauma narratives pertain to *voluntarily* recalled memories of the event. It is interesting to consider whether this perhaps supports the hypothesis from the 'basic mechanisms' view that voluntary recall of the memory remains somewhat intact and fundamentally differs from involuntary recall of the memory. As previously highlighted, the 'basic mechanisms' view may lend itself more to an academic understanding of memory processes more broadly, whereas the 'special mechanisms' view perhaps has greater relevance to the clinical understanding of PTSD and treatment development.

Between-groups differences in the sensory content of trauma narratives are interesting to note, as it is suggested that strong sensory qualities are a defining feature of flashbacks, a form of intrusive memory hypothesised to be unique and specific to PTSD (Brewin, 2015). It can be argued that whilst the 'basic mechanisms' view proposes an explanation for the emotional impact of flashbacks, it rather neglects to comment on the dominance of sensory content within these memories. The dual process theory of PTSD hypothesises that this phenomenon arises due to trauma memories being represented within in a separate sensory-based memory system (Brewin et al., 1996, 2010). It is worth highlighting again that items within the TMQQ are weighted more towards sensory elements of trauma memories, potentially adding further weight to the suggestion that the TMQQ may be capturing flashback memories specifically. However, the observed differences in the sensory content of the narratives potentially raises the question as to whether narrative methodology is in fact able to capture characteristics relevant to flashbacks, despite the voluntary nature of the recall. The lack of sensory differences within trauma narratives post-treatment, despite clear differences in PTSS, can also be explained according to the dual process theory. The theory argues that intrusive memories, in the form of flashbacks, arise due to a lack of association between sensory-based, S-Reps, and contextually-bound, C-Reps, memory representations (Brewin et al., 2010). Therefore, the sensory characteristics of trauma memories themselves need not necessarily change, but instead symptom reduction can be achieved by creating an association between sensory and contextual memory representations, to provide an autobiographical context for these sensory-laden memories. This may be one of the mechanisms through which trauma narrative work during treatment facilitates symptom reduction.

It is beneficial to consider how trauma memory characteristics may interact with other relevant cognitive factors. Previous analysis of the ASPECTS dataset, investigating the role of various cognitive processes, indicated that both trauma memory quality and negative appraisals accounted for variance in post-acute PTSS (Meiser-Stedman et al., 2019). However, only negative appraisals remained a significant predictor when baseline PTSS was accounted for. This suggested that negative appraisals had a role in maintaining PTSS symptoms once they had become established, whereas the same role was not observed for trauma memory quality. The analysis clarified that negative appraisals were not acting as a ‘proxy’ measure for depression, i.e. indicating that PTSS was not maintained by ‘global’ negative appraisals but instead by negative appraisals specifically related to the trauma event and trauma symptoms. Additionally, it was found that changes in negative appraisals during treatment mediated symptom reduction within the ASPECTS trial participants, whereas changes in trauma memory characteristics did not (Meiser-Stedman et al., 2017). Given that the TMQQ may be capturing *perceptions* of memory characteristics, this could plausibly be influenced by negative appraisals of trauma symptoms and it could be particularly interesting to consider how these factors may interact. A young person may appraise the sensory qualities and 'nowness' of a flashback memory as particularly disturbing and as evidence that there is something seriously wrong with them. This is likely to generate distress and a young person may try to avoid thinking about the event at all, for fear of eliciting a flashback. It is hypothesised that cognitive avoidance prevents the effective processing of the trauma memory (Ehlers & Clark, 2000) and can even increase the occurrence of intrusive memories (Shipherd & Beck, 2005). This is supported by previous research indicating that negative appraisals of trauma-related intrusions accounted for a proportion of the variance of intrusion-related distress, strategies used to escape instructions, and PTSD severity (Steil & Ehlers, 2000). Therefore, it may be the case that whilst trauma memory characteristics, particularly those associated with flashbacks, are relevant to the *onset* of PTS, they become less relevant in terms of understanding the *maintenance* of PTSS. Instead, negative appraisals and cognitive avoidance may be the primary processes maintaining an ongoing sense of threat and distress, by preventing integration of the trauma memory into other autobiographical memories. These cognitive processes therefore represent more logical targets for psychological interventions rather than trauma memory characteristics themselves. However, it is noted that it is not possible to draw definitive conclusions on the interactions between cognitive processes based on the results presented within this portfolio, which focus solely on trauma memory characteristics. It is important for future research to clarify these theoretical hypotheses, to identify the most relevant cognitive processes to address in psychological interventions.

Current TF-CBT protocols, which typically include narrative exposure to traumatic events, may be well-placed to address negative appraisals and cognitive avoidance, thus facilitating reintegration of the trauma memory and symptom reduction. However, TF-CBT typically requires at least ten to twelve 90-minute sessions (Smith et al., 2014) and is thus time consuming, for both therapist and client, and potentially costly to the NHS. Therefore, there is increasing interest in low intensity treatments, such as guided self-help, to provide equally efficacious, cheaper, and more accessible alternatives to traditional psychotherapy (Stallard, 2017). This is particularly important to consider given the relatively high prevalence estimates, between 10 and 25%, of PTSD in youth populations (Watson, 2019). It could be interesting to understand whether psychoeducation around trauma memories, flashbacks, and maladaptive coping strategies, could provide utility as a preventative intervention within the acute phase post-trauma. Additionally, if the findings from the empirical paper indicating that neurocognitive functioning is preserved in individuals with PTSD can be successfully replicated, this can assure clinicians that it is unlikely to be necessary to address neurocognitive function in interventions for single-event trauma. Furthermore, psychoeducational interventions can reassure youth that fragmented memories of the trauma are not indicative of deterioration in their overall neurocognitive functioning. Previous research provides some limited evidence that web-based provision of psychoeducational material in the acute phase may reduce subsequent PTSS (Kenardy et al., 2015), however further replication of these findings are necessary for definitive conclusions to be drawn. Interestingly, previous research has suggested that cognitive therapy without narrative exposure, but including cognitive restructuring, could yield long-term symptom reduction equal to that of TF-CBT including exposure (Nixon et al., 2017). Subsequently, it has been suggested that psychological interventions for PTSD could focus less on constructing a coherent trauma narrative and perhaps more on psychoeducation and appraisals of PTSS (Bray et al., 2018), which could translate into a low intensity intervention. However, it is worth noting that the study by Nixon et al. (2017) had relatively low power. Therefore it would beneficial for future research to replicate the results to provide further clarification as to whether treatment protocols without narrative exposure may achieve equally effective outcomes to traditional TF-CBT. Conversely, research in adult populations has suggested that brief written exposure therapy, which does not explicitly address negative appraisals or beliefs around trauma memories, may achieve similar outcomes to traditional TF-CBT (Thompson-Hollands et al., 2019). There is also some evidence, albeit limited, in youth populations supporting the efficacy of the Children's War Foundation 'Writing for Recovery' protocol (Yule et al., 2005) as a brief, group intervention to support youth after major disasters (Kalantari et al., 2012). It could be interesting for future research to understand whether similar findings can be observed for different types of trauma in youth populations and whether this may translate into an effective low intensity intervention. Taken together, this research suggests that brief interventions which aim to target just one cognitive process, namely negative appraisals or cognitive avoidance, can potentially facilitate significant reduction in PTSS. It could be interesting for future research to investigate changes in the core cognitive processes of negative appraisals, cognitive avoidance, and trauma memory characteristics during brief interventions to further understand the mechanisms of action through which these interventions exert their beneficial effects. It would also be beneficial for future research to explore whether there is a 'time frame' in which low intensity interventions should ideally be delivered and clarify whether there are some individuals for whom low intensity PTSD interventions do not provide sufficient symptom relief.

Future Research

It has been suggested that some of the mixed findings between studies using narrative methodology may be due to heterogeneity in coding protocols (Crespo & Fernandez-Lansac, 2016). The degree of subjectivity and human error associated with the coding of narratives is often addressed by using at least two blind raters and evaluating interrater reliability. However, this could be further improved by harnessing advancements in technology such as artificial intelligence and machine learning in the narrative coding process. Additionally, the majority of research has investigated narratives within the acute period, a time during which symptoms may be particularly intense and liable to change. Therefore, it may be beneficial for future research to prospectively explore narratives across both the acute and post-acute phase (as in McKinnon et al., 2017) to clarify whether there are any observable changes in narratives across these time periods. It would also be beneficial for more research to investigate narratives post-treatment and clarify whether changes in narratives mediate symptom change, as there have been limited and mixed findings in this area (Knutsen & Jensen, 2019).

Alternatively, it could be argued that narrative methodology in its current form may not be the most effective way of investigating relevant trauma memory characteristics. Firstly, this is based on the observation that the TMQQ has demonstrated more consistent, predictable results across several studies. Secondly, flashbacks represent a unique form of intrusive memory and are one of the most reliable indicators discriminating PTSD from other psychological disorders (Brewin et al., 2009). They have been defined as markedly different from other memories of the traumatic event that are voluntarily retrieved at will (Hellawell & Brewin, 2004). Therefore, it can logically be proposed that voluntary recall of a traumatic memory may not necessarily provide a valid representation of flashbacks. It would be beneficial for future research to distinguish between voluntarily recalled memories, intrusive memories, and flashbacks of the trauma event which are defined by strong sensory impressions and a sense of 'nowness' (Brewin, 2015). As previously highlighted, it may be the case that the TMQQ is more able to capture features of trauma memory that are associated with experiences of flashbacks. However, self-report methodology is not without its own limitations, as it relies on retrospective reporting which may be affected by recall bias (Priebe et al., 2013). It is therefore important for future research to explore more valid methods for empirically investigating memory characteristics of flashbacks. Previous research has demonstrated that participants were able to identify specific sections of their trauma narratives which were accompanied by flashbacks (Hellawell & Brewin, 2004). Further research indicated that these sections were rated as more negative and arousing (Brewin et al., 2012) and accompanied by short-term increases in heart rate (Chou et al., 2018). This suggests that narrative methodology could be refined by asking participants to review their trauma narratives and clarify flashback points, perhaps in addition to providing qualitative information regarding their experience of this phenomenon. Additionally, wearable technology could be used to track heart rate during narrative recall. This additional data would facilitate more in-depth exploration of flashback experiences during narrative tasks. Research in adults has also exemplified the utility of using electronic diaries to provide 'real-time' assessment of flashback experiences (Priebe et al., 2013), which could also be beneficial in youth populations.

Throughout the portfolio, it is highlighted that a greater understanding of what TMQQ scores represent would be beneficial in interpreting the observed results. The original TMQQ paper highlights that the TMQQ is unlikely to be acting as a proxy measure of re-experiencing symptoms in general and does seem to capture something specific to the nature of trauma memories (Meiser-Stedman, Smith, et al., 2007). Collection of qualitative data alongside the TMQQ would be beneficial in clarifying what young people understand from the questionnaire and whether this is capturing experiences of flashbacks. A question also remains as to whether TMQQ scores represent an 'objective' account of trauma memory characteristics, or whether this represents young people's *perceptions* of the quality of their trauma memories. Network analysis is becoming increasingly popular within the field of PTSD research (Isvoranu et al., 2021) and future research could consider network analysis in which each item of the TMQQ and core PTS symptom clusters form 'nodes' in the network. This would be beneficial in exploring whether specific TMQQ items emerge as central nodes within the network and would facilitate more detailed understanding of how each item relates to PTS symptoms, particularly re-experiencing symptoms. It would be beneficial to explore whether separate clusters emerge for TMQQ items and re-experiencing symptoms, thus helping to clarify whether these are distinct constructs and confirming that the strong relationship between the TMQQ and PTSS is not solely related to an overlap with diagnostic criterion. Furthermore, network analysis including TMQQ items, items from a negative appraisal scale, and core PTS symptom clusters could help to clarify the relationship between these constructs. Whilst this would be exploratory due to its correlational nature, it may provide a preliminary indication as to the relationship between TMQQ items and negative appraisals, and thus whether negative appraisals may potentially influence scores on the TMQQ. Further research measuring key cognitive processes, including trauma memory characteristics, negative appraisals and cognitive avoidance, throughout treatment would also be beneficial. It would be interesting to understand whether changes in one cognitive factor seems to precede changes in other cognitive factors and to clarify whether specific treatment elements, such as narrative exposure, affect change in cognitive processes as currently hypothesised. This could potentially follow a similar design to the work of Kleim et al. (2012), which demonstrated that reduction in negative appraisals temporally preceded PTSS reduction in adults, but replicated within youth populations and investigating multiple cognitive processes simultaneously. This could also provide a greater understanding of which cognitive factors mediate symptom reduction, thus identifying the most important factors to address during psychological interventions.

Overall conclusions

Overall, the work presented within this portfolio highlights that the TMQQ is able to capture memory characteristics that are particularly relevant to the aetiology of PTSD and that these memory characteristics are more likely to be underpinned by cognitive factors than neurocognitive factors. It is highlighted that flashbacks represent a unique and particularly important symptom in PTSD and should thus be a focus for future research. It is important to clarify whether the TMQQ is capturing memory characteristics relevant to flashback experiences and future research may also consider refining narrative methodology, so that both methods may be used to adequately capture flashback experiences. Additionally, it is important to clarify the role of other cognitive factors, such as negative appraisals, in relation to trauma memory characteristics. Advancing understanding in these areas can help to identify key cognitive processes to be targeted in psychological interventions and potentially identify targets for earlier preventative interventions. This knowledge can be used to further refine the efficiency and efficacy of psychological treatments for PTSD in young people.

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Appendices

Appendix A: Author Guidelines for Journal of Traumatic Stress

Author Guidelines

To read the journal's position on open science practices, please find the full statement **here**.

Sections

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State of the Art Article	Overview of developments in the field or current lines of thought; synthesizes multiple sources of information and has long list of references	7,500 words, including abstract, references, tables, and figures	Yes	Data Availability Statement IRB Statement
Commentary	Evidence-based opinion piece on a recently published *JTS* article	1,000 words, including references, tables, and figures	No	N/A

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Appendix B: Trauma Memory Quality Questionnaire

Memory Questionnaire (TMQQ)

This is a questionnaire all about your memories of the frightening event. We would like to know what your memories feel and seem like. Please read each sentence and tell us how much you agree with each one, by ticking one box.

		Don't agree at all	*Don't agree a bit*	*Agree a bit*	*Completely agree*
1.	My memories of the frightening event are mostly pictures or images.	[ ]	[ ]	[ ]	[ ]
2.	I can't seem to put the frightening event into words.	[ ]	[ ]	[ ]	[ ]
3.	When I have memories of what happened I sometimes hear things in my head that I heard during the frightening event.	[ ]	[ ]	[ ]	[ ]
4.	When I remember the frightening event I feel like it is happening right now.	[ ]	[ ]	[ ]	[ ]
5.	When I think about the frightening event I can sometimes smell things that I smelt when the frightening event happened.	[ ]	[ ]	[ ]	[ ]
6.	I can talk about what happened very easily.	[ ]	[ ]	[ ]	[ ]
7.	I remember the frightening event as a few moments, and each moment is a picture in my mind.	[ ]	[ ]	[ ]	[ ]
8.	My memories of the frightening event are like a film that plays over and over.	[ ]	[ ]	[ ]	[ ]
9.	My memories of the frightening event are very clear and detailed.	[ ]	[ ]	[ ]	[ ]
10.	Remembering what happened during the frightening event is just like looking at photographs of it in my mind.	[ ]	[ ]	[ ]	[ ]

11. When memories come to mind of what happened, I feel my body is in the same position as when the frightening event occurred.	[ ]	[ ]	[ ]	[ ]

Scoring:

1, 2, 3, 4. Higher scores indicate more "toxic" memories. **NB:** *Item 6 is reverse coded.*

Citing this measure:

This measure was published here:

Meiser-Stedman, R., Smith, P., Yule, W., & Dalgleish, T. (2007). The Trauma Memory Quality Questionnaire: preliminary development and validation of a measure of trauma memory characteristics for children and adolescents. *Memory, 15*, 271-279.

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Appendix C: Table 3. Rule-Based Data Extraction for Main and Subgroup Analyses

Table 3

Rule-Based Data Extraction for Main and Subgroup Analyses

Study	*r*	Rule
Main analysis		
Bray et al., 2018	.43	C
Dow et al., 2019	.45	D
Hiller et al., 2019	.39	B
Hiller et al., 2021	.50	A
McKinnon et al., 2008	.76	D
McKinnon et al., 2017	.50	B
Meiser-Stedman et al., 2007	.50	B
Meiser-Stedman et al., 2019	.62	B
Mordeno et al., 2018	.51	D
Peltonon et al., 2017	.45	C
Salmond et al., 2011	.42	D
Prospective analysis		
Hiller et al., 2019	.39	B
Hiller et al., 2021	.50	A
McKinnon et al., 2017	.50	B
Meiser-Stedman et al., 2007	.50	B
Meiser-Stedman et al., 2019	.62	B
Acute analysis		
Bray et al., 2018	0.31	D
Dow et al., 2019	0.45	D
Hiller et al., 2019	0.39	B
McKinnon et al., 2008	0.76	D
McKinnon et al., 2017	0.50	B
Meiser-Stedman et al., 2007	0.50	B
Meiser-Stedman 2019	0.62	B
Mordeno et a., 2018	0.51	D
Salmond et al., 2011	0.42	D
Cross-sectional analysis		
Bray et al., 2018	.43	C
Dow et al., 2019	.45	D
Hiller et al., 2019	.75	D
Hiller et al., 2021	.65	C
McKinnon et al., 2008	.76	D
McKinnon et al., 2017	.67	D
Meiser-Stedman et al., 2007	.78	D
Meiser-Stedman et al., 2019	.70	D
Mordeno et al., 2018	.51	D
Peltonon et al., 2017	.45	C
Salmond et al., 2011	.42	D
Acute cross-sectional analysis		
Bray et al., 2018	.31	D
Dow et al., 2019	.45	D

Table 3

Rule-Based Data Extraction for Main and Subgroup Analyses

Study	*r*	Rule
Hiller et al., 2019	.39	B
McKinnon et al., 2008	.76	D
McKinnon et al., 2017	.50	B
Meiser-Stedman et al., 2007	.50	B
Meiser-Stedman et al., 2019	.62	B
Mordeno et al., 2018	.51	D
Salmond et al., 2011	.42	D

Appendix D: Table 4. Quality Assessment and Risk of Bias Tool

Table 4

Quality Assessment and Risk of Bias Tool

Q1: Was the study population clearly defined?	
Clear description of location, gender, ethnicity, trauma characteristics & other demographics	Low risk
Unclear description or not reported	High risk
Q2: Was sampling carried out appropriate to the study design, such that the likelihood of sampling bias was minimised as far as possible?	
All appropriate participants invited to participate, e.g. invite consecutive emergency department admissions to participate, or random sampling of individuals exposed to a traumatic event	Low risk
Convenience sampling or self-referral to study via poster/other information leaflet	High risk
Q3: Was the likelihood of non-response bias minimised as far as possible?	
Response rate of at least 40% or an analysis performed that showed no significant difference in relevant demographic characteristics between responders and non-responders	Low risk
Response rate <40% and/or analysis of differences between responders and non-responders not reported	High risk
Q4: Were all participants selected or recruited from the same or similar populations? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	
All participants recruited from the same source (e.g. A&E department, or multiple A&E departments within a specified geographical location) AND inclusion & exclusion criteria clearly reported and used for all participants involved	Low risk
Participants recruited from various, distinct locations, and/or inclusion & exclusion criteria not clearly reported or utilised	High risk
Q5: Was a sample size justification or power description provided?	
Sample size calculation using GPower or similar software	Low risk
No sample size calculation	High risk
Q6: For prospective studies only: was loss to follow-up 20% or less?	
Loss <20%	Low risk
Loss >20% or number lost to follow up not reported	High risk

Appendix E: Table 5. Results of Leave-one-out Diagnostic Analysis

Table 5

Results of Leave-one-out Diagnostic Analysis

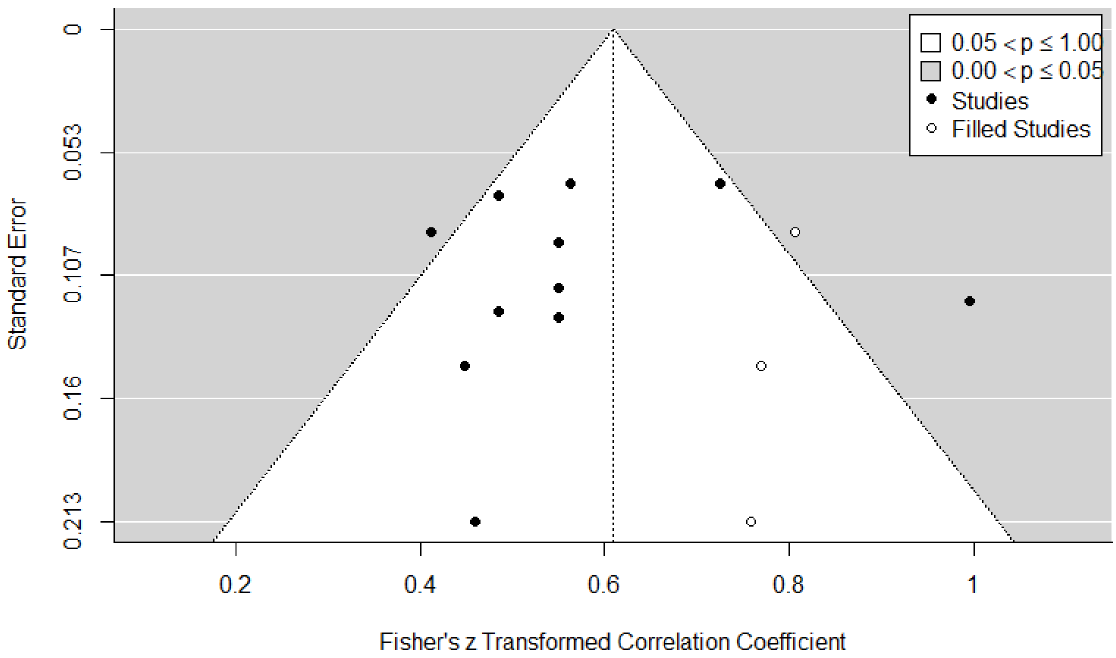
Study excluded	Q	I^2 (%)
Bray et al., 2018	24.31*	64.59
Dow et al., 2019	24.02*	64.76
Hiller et al., 2019	20.73	58.37
Hiller et al., 2021	24.52*	65.42
McKinnon et al., 2008	11.11	31.85
McKinnon et al., 2017	24.57*	65.73
Meiser-Stedman et al., 2007	24.55*	65.71
Meiser-Stedman et al., 2019	18.57	54.78
Mordeno 2018	24.57*	64.10
Peltonen et al., 2017	22.70*	62.21
Salmond et al., 2011	23.81*	64.22

Note: *significant at p<.01

Appendix F: Figure 4. Funnel Plot of Fisher's Z Transformed Correlation Coefficients

Figure 4

Funnel Plot of Fisher's Z Transformed Correlation Coefficients Showing the Symmetry of the Data in Relation to Publication Bias and any Potentially Missing Studies



Appendix G: References for Studies Included in the Meta-Analysis but not Cited In-Text

Dow, B. L., Kenardy, J. A., Long, D. A., & Le Brocque, R. M. (2019). Cognitive/affective factors are associated with children's acute posttraumatic stress following pediatric intensive care. *Psychological Trauma : Theory, Research, Practice and Policy*, *11*(1), 55–63. https://doi.org/10.1037/tra0000349

Hiller, R. M., Creswell, C., Meiser-Stedman, R., Lobo, S., Cowdrey, F., Lyttle, M. D., … Halligan, S. L. (2019). A longitudinal examination of the relationship between trauma-related cognitive factors and internalising and externalising psychopathology in physically injured children. *Journal of Abnormal Child Psychology*, *47*(4), 683–693. https://doi.org/10.1007/s10802-018-0477-8

Hiller, R. M., Meiser-Stedman, R., Elliott, E., Banting, R., & Halligan, S. L. (2021). A longitudinal study of cognitive predictors of (complex) post-traumatic stress in young people in out-of-home care. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *62*(1), 48–57. https://doi.org/10.1111/jcpp.13232

McKinnon, A., Nixon, R., & Brewer, N. (2008). The influence of data-driven processing on perceptions of memory quality and intrusive symptoms in children following traumatic events. *Behaviour Research and Therapy*, *46*(6), 766–775. https://doi.org/10.1016/j.brat.2008.02.008

Mordeno, I. G., Galela, D. S., Nalipay, M. J. N., & Cue, M. P. (2018). Centrality of event and mental health outcomes in child and adolescent natural disaster survivors. *Spanish Journal of Psychology*, *21*, E61. https://doi.org/10.1017/sjp.2018.58

Peltonen, K., Kangaslampi, S., Saranpää, J., Qouta, S., Punamäk, R.-L., & Punamäki, R.-L. (2017). Peritraumatic dissociation predicts posttraumatic stress disorder symptoms via dysfunctional trauma-related memory among war-affected children. *European Journal*

of Psychotraumatology, *8*(sup3), 1375828.
https://doi.org/http://dx.doi.org/10.1080/20008198.2017.1375828

Appendix H: Author Guidelines for Journal of Psychopathology and Clinical Science

Submission

To submit to the editorial office of Angus MacDonald, III, please submit manuscripts electronically through the Manuscript Submission Portal in Microsoft Word or Open Office format.

Prepare manuscripts according to the *Publication Manual of the American Psychological Association* using the 7th edition. Manuscripts may be copyedited for bias-free language (see Chapter 5 of the *Publication Manual*). APA Style and Grammar Guidelines for the 7th edition are available.

Angus MacDonald, III, PhD
Editor, *Journal of Psychopathology and Clinical Science*
Department of Psychology
University of Minnesota
75 E River Rd
Minneapolis, MN 55455

General correspondence may be directed to the editor's office.

The *Journal of Psychopathology and Clinical Science* is now using a software system to screen submitted content for similarity with other published content. The system compares the initial version of each submitted manuscript against a database of 40+ million scholarly documents, as well as content appearing on the open web. This allows APA to check submissions for potential overlap with material previously published in scholarly journals (e.g., lifted or republished material).

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Masked reviews are optional and must be specifically requested in the cover letter accompanying the submission. For masked reviews, the manuscript must include a separate title page with the authors' names and affiliations, and these ought not to appear anywhere else in the manuscript.

Footnotes that identify the authors must be typed on a separate page.

Make every effort to see that the manuscript itself contains no clues to authors' identities, including grant numbers, names of institutions providing IRB approval, self-citations, and links to online repositories for data, materials, code, or preregistrations (e.g., Create a View-only Link for a Project).

Types of articles

Brief report

The manuscript should not exceed 5,000 words when including the abstract, body of the text, tables, table captions, figure captions, footnotes, author notes, appendices, and references in a word count.

Note that supplementary materials and figures are not included in the word count.

Brief reports can have a maximum of two figures (there is no table limit).

Regular article

The manuscript should not exceed 9,000 words when including the abstract, body of the text, tables, table captions, figure captions, footnotes, author notes, appendices, and references in a word count.

Note that supplementary materials and figures are not included in the word count.

Extended article

Extended articles are published within regular issues of the journal (they are not free-standing). This article type is reserved for manuscripts that require extended exposition beyond the length of a regular article (e.g., reporting results of multiple experiments, multifaceted longitudinal studies, cross-disciplinary investigations, or studies that are extraordinarily complex in terms of methodology or analysis).
Extended article submissions are expected to be precleared by contacting the editorial office to determine the appropriateness for this format. When seeking preclearance, please provide a description of your manuscript and its significance.
Other submissions that exceed 9,000 words will be returned for shortening.

Commentary

Commentaries on articles previously published in the *Journal of Psychopathology and Clinical Science* are also considered for publication. Commentaries should contain original data relevant to the topic at hand. They are subject to the same process of peer review and the same editorial criteria and standards as any other manuscript. If a commentary is deemed acceptable for publication, authors of the original submission are given the opportunity to reply to the commentary.
Commentaries may be no more than half the length of the original article, and replies may be no more than half the length of the commentary. A commentary and reply will be published together. Except under rare circumstances, there will be only one round of comment and reply.

Replications and Registered Reports

The *Journal of Psychopathology and Clinical Science* publishes direct replications. Submissions should include "A Replication of XX Study" in the subtitle of the manuscript as well as in the abstract.
The *Journal of Psychopathology and Clinical Science* also publishes Registered Reports. Registered reports require a two-step review process. The first step is the submission of the registration manuscript. This is a partial manuscript that includes hypotheses, rationale for the study, experimental design, and methods. The partial manuscript will be reviewed for rigor and methodological approach.
If the partial manuscript is accepted, this amounts to provisional acceptance of the full report regardless of the outcome of the study. The full manuscript will be reviewed for adherence to the preregistered design (deviations should be reported in the manuscript).

Cover letters

All cover letters must contain the following:

- a statement that the material is original—if findings from the dataset have been previously published or are in other submitted articles, please include the following information:
    - Is the present study a new analysis of previously analyzed data? If yes, please describe differences in analytic approach.
    - Are some of the data used in the present study being analyzed for the first time? If yes, please identify data (constructs) that were not included in previously published or submitted manuscripts.
    - Are there published or submitted papers from this data set that address related questions? If yes, please provide the citations, and

describe the degree of overlap and the unique contributions of your submitted manuscript.

- if the manuscript has been pre-posted online prior to peer review, this fact should be stated in the acknowledgments and the URL for the posting should be included in the acknowledgments as well;
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- the complete telephone and fax numbers of the same;
- the proposed category under which the manuscript was submitted;
- a statement that the authors complied with APA ethical standards in the treatment of their participants and that the work was approved by the relevant Institutional Review Board(s);
- whether or not the manuscript has been or is posted on a website;
- that APA style (Publication Manual, 7th edition) has been followed;
- the disclosure of any conflicts of interest with regard to the submitted work; and
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Articles are eligible for open science badges recognizing publicly available data, materials, and/or preregistration plans and analyses. These badges are awarded on a self-disclosure basis.

At submission, authors must confirm that criteria have been fulfilled in a signed badge disclosure form (PDF, 42KB) that must be submitted as supplemental material. If all criteria are met as confirmed by the editor, the form will then be published with the article as supplemental material.

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All data necessary to reproduce the reported results that are digitally shareable are made publicly available. Information necessary for replication (e.g., codebooks or metadata) must be included.

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All materials necessary to reproduce the reported results that are digitally shareable, along with descriptions of non-digital materials necessary for replication, are made publicly available.

Preregistered:
At least one study's design has been preregistered with descriptions of (a) the research design and study materials, including the planned sample size; (b) the motivating research question or hypothesis; (c) the outcome variable(s); and (d) the predictor variables, including controls, covariates, and independent variables. Results must be fully disclosed. As long as they are distinguished from other results in the article, results from analyses that were not preregistered may be reported in the article.

Preregistered+Analysis Plan:
At least one study's design has been preregistered along with an analysis plan for the research—and results are recorded according to that plan.

Note that it may not be possible to preregister a study or to share data and materials. Applying for open science badges is optional.

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Prepare manuscripts according to the *Publication Manual of the American Psychological Association* using the 7th edition. Manuscripts may be copyedited for bias-free language (see Chapter 5 of the *Publication Manual*).
Double-space all copy. Other formatting instructions, as well as instructions on preparing tables, figures, references, metrics, and abstracts, appear in the *Manual*. Additional guidance on APA Style is available on the APA Style website.

Below are additional instructions regarding the preparation of display equations, computer code, and tables.

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We strongly encourage you to use MathType (third-party software) or Equation Editor 3.0 (built into pre-2007 versions of Word) to construct your equations, rather than the equation support that is built into Word 2007 and Word 2010. Equations composed with the built-in Word 2007/Word 2010 equation support are converted to low-resolution graphics when they enter the production process and must be rekeyed by the typesetter, which may introduce errors.

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- Select MathType or Equation Editor 3.0 in the drop-down menu.

If you have an equation that has already been produced using Microsoft Word 2007 or 2010 and you have access to the full version of MathType 6.5 or later, you can convert this equation to MathType by clicking on MathType Insert Equation. Copy the equation from Microsoft Word and paste it into the MathType box. Verify that your equation is correct, click File, and then click Update. Your equation has now been inserted into your Word file as a MathType Equation.

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"This study suggests that some approaches to subtyping eating disorders in adolescence, specifically those that include _____, _____, and _____, may be more useful than _____in predicting outcomes in young adulthood."

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References

List references in alphabetical order. Each listed reference should be cited in text, and each text citation should be listed in the references section.

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Authored book

Brown, L. S. (2018). *Feminist therapy* (2nd ed.). American Psychological Association. https://doi.org/10.1037/0000092-000

Chapter in an edited book

Balsam, K. F., Martell, C. R., Jones. K. P., & Safren, S. A. (2019). Affirmative cognitive behavior therapy with sexual and gender minority people. In G. Y. Iwamasa & P. A. Hays (Eds.), *Culturally responsive cognitive behavior therapy: Practice and supervision* (2nd ed., pp. 287–314). American Psychological Association. https://doi.org/10.1037/0000119-012

All data, program code and other methods must be appropriately cited in the text and listed in the references section.

Data set citation

Alegria, M., Jackson, J. S., Kessler, R. C., & Takeuchi, D. (2016). Collaborative Psychiatric Epidemiology Surveys (CPES), 2001–2003 [Data set]. Inter-university Consortium for Political and Social Research. https://doi.org/10.3886/ICPSR20240.v8

Software/Code citation

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, 36(3), 1–48. https://www.jstatsoft.org/v36/i03/

Wickham, H. et al., (2019). Welcome to the tidyverse. *Journal of Open Source Software, 4*(43), 1686, https://doi.org/10.21105/joss.01686

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Graphics files are welcome if supplied as Tiff or EPS files. Multipanel figures (i.e., figures with parts labeled a, b, c, d, etc.) should be assembled into one file.

The minimum line weight for line art is 0.5 point for optimal printing.

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Preregistration of studies and specific hypotheses can be a useful tool for making strong theoretical claims. Likewise, preregistration of analysis plans can be useful for distinguishing confirmatory and exploratory analyses. We encourage investigators to preregister their studies and analysis plans prior to conducting the research (e.g., ClinicalTrials.gov or the Preregistration for Quantitative Research in Psychology template) via a publicly accessible registry system (e.g., OSF, ClinicalTrials.gov, or other trial registries in the WHO Registry Network).

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Other information

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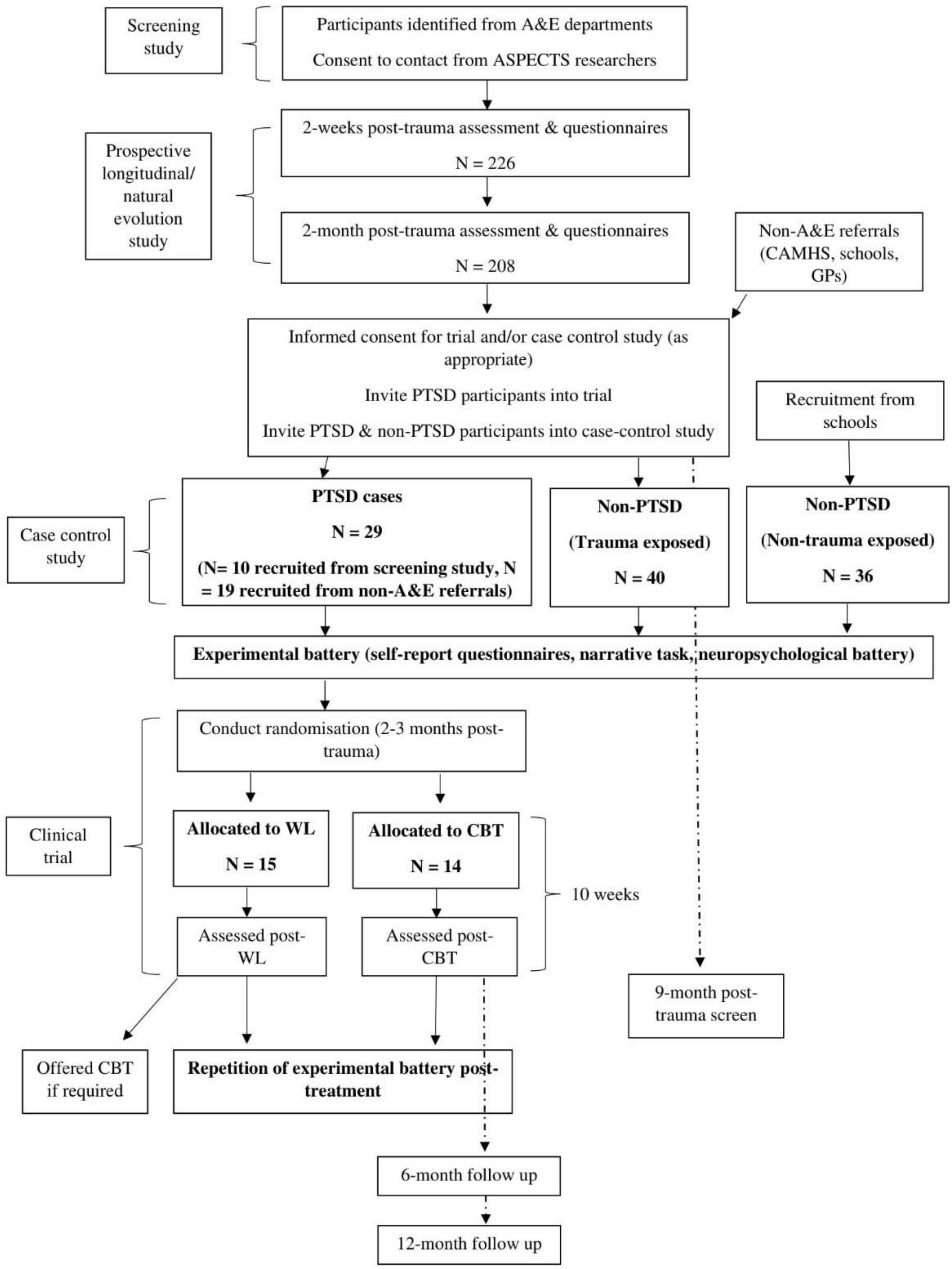
Appendix I: Additional Material for Submission to Journal of Psychopathology and Clinical Science - General Scientific Summary

This study suggests that certain characteristics of trauma memories, including dominance of sensory information, a sense of 'nowness' and difficulty verbally accessing the memory, are implicated in the aetiology of post-traumatic stress disorder in children and adolescents. These specific memory characteristics seem to be underpinned by cognitive factors more so than broader difficulties with neurocognitive memory function.

Appendix J: Figure 5. ASPECTS Study Recruitment and Procedure Flow Diagram

Figure 5

ASPECTS Study Recruitment and Procedure Flow Diagram



Note: Participants and data relevant to the current study are highlighted in bold.

Appendix K: Narrative Task Instructions

Trauma exposed non-PTSD and PTSD individuals received the following instructions prior to telling their trauma narratives*: "Please listen carefully to the following instructions. In a moment I would like you to tell me a story about your _________ (accident, assault, injury etc). Please tell me about how you felt, what you saw, who was there with you, everything. I would like you to describe this event to me as if it is happening right now. I would like you to tell me as many things that you can remember that happened during the __________. Things like what happened around you, how you were feeling, and what you were thinking during the accident".* One standardised prompt was provided after the initial response: *"Can you tell me any more about your frightening event?"*

Prior to telling their negative event narrative, participants received the following instructions: *"Now I would like you to try and think of a negative event that you have experienced in the past 3 months. This could be anything from getting into trouble at school to having an argument with a friend. The most important thing is that you choose an event which made you feel unhappy, scared, sad, angry or worried".* Trauma exposed children only also received the instruction*: "This event should not be as scary as your recent trauma".* The experimenter continued: *"Have you experienced a negative event in the past 3 months?"* __________. If the participants had difficulty recalling an event, they were given a calendar and the experimenter helped them to consider different events which had occurred in the past month. *"Please listen to the following instructions carefully. In a moment I would like you to tell me a story about ___________, how you felt, what you saw, who was there with you, everything. I would like you to describe the event to me as if it were happening right now. I would like you to tell me as many things that you can remember that happened during ________. Things like what happened around you, how you were feeling, and what you were* *thinking during* ________. One standardised prompt was provided after the initial response:

"Can you tell me any more about your negative event?"

Appendix L: Counterbalancing Conditions for Trauma Exposed and Non-Trauma Exposed Participants

Table 7

Order of Presentation of Tasks Within Experimental Battery for Trauma Exposed Participants

Condition	Task 1: Narrative	Task 2: Narrative	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9
1	Trauma	Neg event	CVLT-A	CMS	CVMT	Gamer task	SRT - 1	WASI	Digit span
2	Trauma	Neg event	CVLT-S	CMS	CVMT	Gamer task	SRT - 2	WASI	Digit span
3	Trauma	Neg event	CVLT-S	CMS	CVMT	Gamer task	SRT - 1	WASI	Digit span
4	Trauma	Neg event	CVLT-A	CMS	CVMT	Gamer task	SRT - 2	WASI	Digit span
5	Neg event	Trauma	CVLT-A	CMS	CVMT	Gamer task	SRT - 1	WASI	Digit span
6	Neg event	Trauma	CVLT-S	CMS	CVMT	Gamer task	SRT - 2	WASI	Digit span
7	Neg event	Trauma	CVLT-S	CMS	CVMT	Gamer task	SRT - 2	WASI	Digit span
8	Neg event	Trauma	CVLT-A	CMS	CVMT	Gamer task	SRT - 1	WASI	Digit span

Note: CMS = Children's Memory Scale, CVLT-A = California Verbal Learning Test - alternate version, CVLT-S = California Verbal Learning Test - standard version, CVMT = Continuous Visual Memory Test, SRT-1 = Simple response time task – version 1, SRT-2 = Simple response time task – version 2, WASI = Wechsler Abbreviated Scale of Intelligence.

Appendix L (continued)

Table 8

Order of Presentation of Tasks Within Experimental Battery for Non-Trauma Exposed Participants

Condition	Task 1: Narrative	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8
1	Neg event	CVLT-A	CMS	CVMT	Gamer task	SRT - 1	WASI	Digit span
2	Neg event	CVLT-S	CMS	CVMT	Gamer task	SRT - 2	WASI	Digit span
3	Neg event	CVLT-S	CMS	CVMT	Gamer task	SRT - 1	WASI	Digit span
4	Neg event	CVLT-A	CMS	CVMT	Gamer task	SRT - 2	WASI	Digit span

Note: CMS = Children's Memory Scale, CVLT-A = California Verbal Learning Test - alternate version, CVLT-S = California Verbal Learning Test - standard version, CVMT = Continuous Visual Memory Test, SRT-1 = Simple response time task – version 1, SRT-2 = Simple response time task – version 2, WASI = Wechsler Abbreviated Scale of Intelligence.

Appendix M: R Script for Analysis of Empirical Paper Baseline Data

```
library(WRS2)

setwd("name")
mydata = read.csv("aspects baseline.csv")

#self-report questionnaires

yuenbt(wk0_tmqq~group, data = mydata, nboot=1000)

yuenbt(wk0_cces~group, data = mydata, nboot=1000)

yuenbt(cddpq~group, data = mydata, nboot=1000)


#trauma narratives

yuenbt(wk0tr_disorganisation ~group, data = mydata, nboot=1000)

yuenbt(wk0tr_coherence ~group, data = mydata, nboot=1000)

yuenbt(wk0tr_sensations ~group, data = mydata, nboot=1000)

yuenbt(wk0tr_negfeelings ~group, data = mydata, nboot=1000)

yuenbt(wk0tr_context ~group, data = mydata, nboot=1000)

yuenbt(wk0tr_chronology ~group, data = mydata, nboot=1000)

yuenbt(wk0tr_theme ~group, data = mydata, nboot=1000)


#neg event narratives

t1waybt(wk0ng_utterances~group, data = mydata, nboot=1000)

t1waybt(wk0ng_disorganisation~group, data = mydata, nboot=1000)

t1waybt(wk0ng_coherence~group, data = mydata, nboot=1000)

t1waybt(wk0ng_context~group, data = mydata, nboot=1000)

t1waybt(wk0ng_chronology~group, data = mydata, nboot=1000)

t1waybt(wk0ng_theme~group, data = mydata, nboot=1000)

t1waybt(wk0ng_sensations~group, data = mydata, nboot=1000)

t1waybt(wk0ng_negfeelings~group, data = mydata, nboot=1000)


#neuropsych

t1waybt(wk0_iq~group, data = mydata, nboot=1000)

t1waybt(wk0_cvlt~group, data = mydata, nboot=1000)

t1waybt(wk0_digitspan~group, data = mydata, nboot=1000)
```

```
t1waybt(wk0_storiesimm~group, data = mydata, nboot=1000)

t1waybt(wk0_storiesdelrecall~group, data = mydata, nboot=1000)

t1waybt(wk0_storiesdelrecog~group, data = mydata, nboot=1000)

t1waybt(wk0_cvmt~group, data = mydata, nboot=1000)

t1waybt(wk0_srt~group, data = mydata, nboot=1000)

t1waybt(wk0_gamertask~group, data = mydata, nboot=1000)

#post-hoc tests for neg event

mcppb20(wk0ng_utterances~group, data = mydata, nboot=1000)

mcppb20(wk0ng_disorganisation~group, data = mydata, nboot=1000)

mcppb20(wk0ng_coherence~group, data = mydata, nboot=1000)

mcppb20(wk0ng_context~group, data = mydata, nboot=1000)

mcppb20(wk0ng_chronology~group, data = mydata, nboot=1000)

mcppb20(wk0ng_theme~group, data = mydata, nboot=1000)

mcppb20(wk0ng_sensations~group, data = mydata, nboot=1000)

mcppb20(wk0ng_negfeelings~group, data = mydata, nboot=1000)

#post-hoc tests for neuropsych

mcppb20(wk0_iq~group, data = mydata, nboot=1000)

mcppb20(wk0_cvlt~group, data = mydata, nboot=1000)

mcppb20(wk0_digitspan~group, data = mydata, nboot=1000)

mcppb20(wk0_storiesimm~group, data = mydata, nboot=1000)

mcppb20(wk0_storiesdelrecall~group, data = mydata, nboot=1000)

mcppb20(wk0_storiesdelrecog~group, data = mydata, nboot=1000)

mcppb20(wk0_cvmt~group, data = mydata, nboot=1000)

mcppb20(wk0_srt~group, data = mydata, nboot=1000)

mcppb20(wk0_gamertask~group, data = mydata, nboot=1000)
```

Appendix N: Table 12. Non-Parametric Results for Baseline Memory Characteristics and Neurocognitive function

Table 12

Non-Parametric Analysis of Self-Report and Narrative Memory Characteristics

	Trauma-exposed, PTSD			Trauma-exposed, Non-PTSD			Non-trauma-exposed			
Variable	Mdn	IQR	N	Mdn	IQR	N	Mdn	IQR	N	Statistical test for group
Self-reported trauma memory										
Memory quality (TMQQ)	34	7.5	29	17	6.67	40	-	-	-	U= 20.50, *p*=<.001*
Memory centrality (CCES)	2.9	1.21	29	1.29	.71	39	-	-	-	U= 77.50, *p*=<.001*
Data driven processing (CDDPQ)	23.5	9	28	13	11	39	-	-	-	U=149, *p*=<.001*
Trauma event narrative										
Disorganisation	-.25	1.13	27	-.24	1.04	38				U= 486.50, *p*=.72
Incoherence	3	3	27	2	2	37	-	-	-	U=379, *p*=.09
Sensations	4.8	5.23	27	2.66		36	-	-	-	U= 289.50, *p*=.006*
Negative feelings	1.43	4.2	27	1.45	3.03	35	-	-	-	U=399, *p*=.28.
Negative event narrative										
Disorganisation	-.13	1.23	27	-.27	1.43	37	-.41	1.19	36	H=4.17, *p*=.13
Incoherence	4	2	27	3	2	36	3	1.75	36	H=5.63, *p*=.06
Sensations	0	0	27	0	0	35	0	.89	36	H=1.66, *p*=.44
Negative feelings	2.5	6.25	27	2.91	4.31	36	4.26	6.01	36	H=1.01, *p*=.60

Note: CCES = Child Centrality of Events Scale, CDDPQ = Child Data Driven Processing Questionnaire, PTSD = post-traumatic stress disorder, TMQQ = Trauma Memory Quality Questionnaire.

Appendix N (continued)

Table 13

Non-Parametric Analysis of Neurocognitive Function

Neurocognitive test	Trauma-exposed, PTSD			Trauma-exposed, Non-PTSD			Non-trauma-exposed			Statistical test for group
	Mdn	IQR	N	Mdn	IQR	N	Mdn	IQR	N	
IQ (WASI)	95	16	29	101	17	40	101.5	13	36	H=5.61, *p*=.06
Verbal memory (CVLT-C)	48	20.5	29	54	13.5	40	54	18	36	H=1.62, *p*=.44
Verbal recall immediate (CMS stories subtest)	8	7	29	10	6	40	10.5	4	36	H=3.09, *p*=.21
Verbal recall delayed (CMS stories subtest)	8	7.5	28	10	5.75	40	10.5	4	36	H=1.65, *p*=.44
Verbal recognition (CMS stories subtest)	7	6.75	28	11	5.75	40	11	6.5	36	H=3.46, *p*=.18
Verbal working memory (Digit Span)	9	4	28	10	2.75	40	10	3	36	H=2.43, *p*=.30
Visual memory (CVMT)	10	40	28	30	50	40	30	57	35	H=2.43, *p*=.30
Sustained attention (SRT)	415.41	103.82	28	381.25	128.84	39	379.61	101.71	36	H=6.97, *p*=.03
Executive function (CMET)	108	82.25	29	128	88.75	40	137	96	36	H=.48, *p*=.79

Note: CMET = Computerised Multiple Elements Test, CMS = Children's Memory Scale, CVLT-C = California Verbal Learning Test – Children's version, CVMT = Continuous Visual Memory Test, SRT = Simple response time task, WASI = Wechsler Abbreviated Scale of Intelligence.

Appendix O: R Script for Analysis of Empirical Paper Post-Treatment Data

```
library(mice)
library(miceadds)
setwd("name")

##MI CPSS
mydata = read.csv("treatment_cpss.csv")
md.pattern(mydata)
imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)
summary(imp_mydata)
imp_mydata$imp$wk10_cpss
mi.anova(mi.res=imp_mydata, formula=" wk10_cpss ~ tgroup + wk0_cpss")

##MI - TMQQ
mydata = read.csv("treatment_tmqq.csv")
md.pattern(mydata)
imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)
summary(imp_mydata)
imp_mydata$imp$wk10_tmqq
mi.anova(mi.res=imp_mydata, formula=" wk10_tmqq ~ tgroup + wk0_tmqq")

##MI - CCES
mydata = read.csv("treatment_cces.csv")
md.pattern(mydata)
imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)
summary(imp_mydata)
imp_mydata$imp$wk10_cces
mi.anova(mi.res=imp_mydata, formula=" wk10_cces ~ tgroup + wk0_cces")

### MI - trauma disorganisation
```

```
mydata = read.csv("treatment_TR_disorganisation.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10tr_disorganisation

mi.anova(mi.res=imp_mydata, formula=" wk10tr_disorganisation ~ tgroup +
wk0tr_disorganisation")


### MI - trauma coherence

mydata = read.csv("treatment_TR_coherence.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10tr_coherence

mi.anova(mi.res=imp_mydata, formula=" wk10tr_coherence ~ tgroup +
wk0tr_coherence ")


### MI - trauma sensations

mydata = read.csv("treatment_TR_sensations.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10tr_sensations

mi.anova(mi.res=imp_mydata, formula=" wk10tr_sensations ~ tgroup +
wk0tr_sensations ")


### MI - trauma neg feelings

mydata = read.csv("treatment_TR_negfeelings.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10tr_negfeelings
```

```
mi.anova(mi.res=imp_mydata, formula=" wk10tr_negfeelings ~ tgroup +
wk0tr_negfeelings")


### MI - trauma context

mydata = read.csv("treatment_TR_context.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10tr_context

mi.anova(mi.res=imp_mydata, formula=" wk10tr_context ~ tgroup +
wk0tr_context ")


### MI - trauma chronology

mydata = read.csv("treatment_TR_chronology.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10tr_chronology

mi.anova(mi.res=imp_mydata, formula=" wk10tr_chronology ~ tgroup +
wk0tr_chronology")


### MI - trauma theme

mydata = read.csv("treatment_TR_theme.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10tr_theme

mi.anova(mi.res=imp_mydata, formula=" wk10tr_theme ~ tgroup + wk0tr_theme
")


### MI - neg disorganisation

mydata = read.csv("treatment_NG_disorganisation.csv")

md.pattern(mydata)
```

```
imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10ng_disorganisation

mi.anova(mi.res=imp_mydata, formula=" wk10ng_disorganisation ~ tgroup +
wk0ng_disorganisation ")


### MI - neg coherence

mydata = read.csv("treatment_NG_coherence.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10ng_coherence

mi.anova(mi.res=imp_mydata, formula=" wk10ng_coherence ~ tgroup +
wk0ng_coherence ")

### MI - neg sensations

mydata = read.csv("treatment_NG_sensations.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10ng_sensations

mi.anova(mi.res=imp_mydata, formula=" wk10ng_sensations ~ tgroup +
wk0ng_sensations ")


### MI - neg neg feelings

mydata = read.csv("treatment_NG_negfeelings.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10ng_negfeelings

mi.anova(mi.res=imp_mydata, formula=" wk10ng_negfeelings ~ tgroup +
wk0ng_negfeelings ")
```

```
### MI - neg context

mydata = read.csv("treatment_NG_context.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10ng_context

mi.anova(mi.res=imp_mydata, formula=" wk10ng_context ~ tgroup +
wk0ng_context ")


### MI - neg chronology

mydata = read.csv("treatment_NG_chronology.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10ng_chronology

mi.anova(mi.res=imp_mydata, formula=" wk10ng_chronology ~ tgroup +
wk0ng_chronology ")


### MI - neg theme

mydata = read.csv("treatment_NG_theme.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10ng_theme

mi.anova(mi.res=imp_mydata, formula=" wk10ng_theme ~ tgroup + wk0ng_theme
")


### MI - cvlt

mydata = read.csv("treatment_cvlt.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101

summary(imp_mydata)
```

```
imp_mydata$imp$wk10_cvlt

mi.anova(mi.res=imp_mydata, formula=" wk10_cvlt ~ tgroup + wk0_cvlt ")


### MI - stories imm

mydata = read.csv("treatment_storiesimm.csv")

md.pattern(mydata

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10_storiesimm

mi.anova(mi.res=imp_mydata, formula=" wk10_storiesimm ~ tgroup +
wk0_storiesimm ")


### MI - stories del recall

mydata = read.csv("treatment_storiesdelrecall.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101

summary(imp_mydata

imp_mydata$imp$wk10_storiesdelrecall

mi.anova(mi.res=imp_mydata, formula=" wk10_storiesdelrecall ~ tgroup +
wk0_storiesdelrecall")


### MI - stories del recog

mydata = read.csv("treatment_storiesdelrecog.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10_storiesdelrecog

mi.anova(mi.res=imp_mydata, formula=" wk10_storiesdelrecog ~ tgroup +
wk0_storiesdelrecog ")

### MI - digit span
mydata = read.csv("treatment_digitspan.csv")

md.pattern(mydata)
```

```
imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10_digitspan

mi.anova(mi.res=imp_mydata, formula=" wk10_digitspan ~ tgroup +
wk0_digitspan ")


### MI - cvmt

mydata = read.csv("treatment_cvmt.csv")

md.pattern(mydata)

 imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10_cvmt

mi.anova(mi.res=imp_mydata, formula=" wk10_cvmt ~ tgroup + wk0_cvmt ")

### MI - SRT

mydata = read.csv("treatment_srt.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10_srt

mi.anova(mi.res=imp_mydata, formula=" wk10_srt ~ tgroup + wk0_srt ")


### MI - CMET

 mydata = read.csv("treatment_gamertask.csv")

md.pattern(mydata)

imp_mydata <- mice(mydata, m=10, method = 'pmm', seed = 101)

summary(imp_mydata)

imp_mydata$imp$wk10_gamertask

mi.anova(mi.res=imp_mydata, formula=" wk10_gamertask ~ tgroup +
wk0_gamertask ")
```

Appendix P: Table 14. Post-Treatment Neurocognitive Function Results

Table 14

Post-Treatment Neurocognitive Function

	CT-PTSD			WL				
Neurocognitive test	Mdn	IQR	N	Mdn	IQR	N	Statistical test for group	η_p^2
Verbal memory (CVLT-C)	49	17.50	13	52.50	21.75	8	$F_{(1, 19)}$=.27, *p*= .60	.02
Verbal recall immediate (CMS stories subtest)	10.50	6.75	12	9	6.50	9	$F_{(1, 19)}$=1.65, *p*=.20	.09
Verbal recall delayed (CMS stories subtest)	11.50	7.25	12	8	7	9	$F_{(1, 19)}$=4.45, *p*=.04	.17
Verbal recognition (CMS stories subtest)	11	7.25	12	11	10	9	$F_{(1, 19)}$=1.44, *p*=.23	.08
Verbal working memory (Digit Span)	7	6	13	8	5.50	8	$F_{(1, 12)}$=.13, *p*=.72	.01
Visual memory (CVMT)	40	70	13	15	17.50	8	$F_{(1, 19)}$=1.56, *p*=.22	.10
Sustained attention (SRT)	393.98	140.16	13	417.11	207.93	8	$F_{(1, 19)}$=.18, *p*=.67	.02
Executive function (CMET)	97	69.50	13	100.50	117.88	8	$F_{(1, 19)}$=.34, *p*=.56	.02

Note: CMET = Computerised Multiple Elements Test, CMS = Children's Memory Scale, CVLT-C = California Verbal Learning Test – Children's version, CVMT = Continuous Visual Memory Test, SRT = Simple response time task.