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REVIEW ARTICLE

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Associations between the Trauma Memory Quality Questionnaire and posttraumatic stress symptoms in youth: A systematic review and meta-analysis

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Abstract

Cognitive models of posttraumatic stress disorder (PTSD) propose that trauma memory characteristics are implicated in the etiology of the disorder. Empirical support for cognitive models in youth is necessary to ensure psychological interventions are based on appropriate theory. This meta-analysis was conducted to quantitatively investigate the strength of the associations between self-reported trauma memory characteristics (e.g., sensory and temporal features), measured using the Trauma Memory Quality Questionnaire (TMQQ), and posttraumatic stress symptoms (PTSS) in children and adolescents. PsycINFO, MEDLINE, CINAHL, PTSDPubs, and ProQuest Dissertations and Theses Global were searched for relevant literature. In total, 11 studies ($N = 1{,}270$ participants) met the inclusion criteria for the random-effects meta-analysis. A large effect size was observed for the association between trauma memory characteristics and PTSS, $r = .51$, 95% CI [.44, .58], and was maintained in subgroup analyses of the prospective association between trauma memory characteristics and later PTSS ($k = 5$, $n = 6$ 28), $r = .51$, 95% CI [.42, .59]. A slightly larger effect size was observed in subgroup analyses of the cross-sectional association between trauma memory characteristics and concurrent PTSS ($k = 11$, $N = 1{,}270$), $r = .62$, 95% CI [.53, .70]. Sensitivity analyses on study quality, TMQQ alteration, chronic trauma exposure, geographical location, and PTSS measure supported the robustness of these results. 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 discussed.

Exposure to traumatic events is common in children and adolescents (Lewis et al., 2019). Many young people return to pretrauma levels of psychological functioning in the months following trauma exposure and do not experience symptoms that meet the criteria for psychiatric diagnoses (Hiller et al., 2016). However, a proportion of individuals may subsequently experience posttraumatic stress symptoms (PTSS), characterized by reexperiencing distressing memories, hyperarousal, and the avoidance of trauma reminders (Lewis et al., 2019; Sara & Lappin, 2017). High levels of PTSS within 1 month following a traumatic event are indicative of acute stress disorder (ASD), whereas the ongoing experience of PTSS that last more than 1 month after the event is indicative of posttraumatic stress disorder (PTSD; American Psychiatric Association, 2013). A substantial degree of natural recovery is still possible for children who meet the diagnostic criteria for ASD, and not all children with ASD develop PTSD (Kassam-Adams & Winston, 2004). It is important to understand the psychological factors involved in the development and maintenance of PTSS 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). Researchers have proposed that high levels of peritraumatic threat and data-driven processing, in which sensory and perceptual characteristics are prioritized over the meaning of the event, disrupt memory consolidation (Ehlers & Clark, 2000). The dual representation theory proposes that the disruption of memory consolidation during trauma results in the formation of sensation-based memory representations without typical associations with corresponding contextually bound memory representations (Brewin et al., 1996, 2010). This results in memories that are separate, fragmented, poorly elaborated into their autobiographical context, and subject to involuntary recall in the form of reexperiencing 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). Negative appraisals and avoidance are thought to hinder the adaptive processing of fragmented trauma memories, thus maintaining distressing reexperiencing symptoms (Brewin et al., 1996; Steil & Ehlers, 2000).

Meta analyses can provide robust empirical evidence for cognitive factors relevant to PTSD in youth. This is important to understand, as trauma-focused cognitive behavioral therapy (TF-CBT) aims to target the key processes involved in the maintenance of PTSD, as proposed by cognitive models. Although research in youth populations has been less extensive than in adults (LoSavio et al., 2017), meta-analytic findings 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). Additionally, there is evidence that TF-CBT protocols adapted for youth populations are effective in reducing PTSS (Mavranezouli et al., 2020). The provision of empirical support for the theoretical understanding of PTSD in youth is important to identifying or confirming relevant mechanisms of action can and distilling psychological interventions into their key elements to further improve the efficacy and efficiency of interventions.

Negative appraisals, cognitive avoidance, and 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 trauma can lead to a specific type of intrusive memory called a "flashback," that features strong sensory qualities and a sense of "nowness," which is argued to be specific to PTSD (Brewin, 2015; Bryant et al., 2011). An important element of TF-CBT is trauma narrative work, in which a detailed narrative of the traumatic event is constructed. Ehlers and Clark (2002) proposed that this process facilitates the elaboration of fragmented memories into one's wider autobiographical memory base, thus reducing reexperiencing symptoms. Given that trauma memory characteristics may represent a unique, defining feature of posttraumatic stress, this concept is particularly important to empirically explore in youth populations.

Narrative recall and self-report questionnaires are the predominant methods used to investigate trauma memory characteristics. Narrative methodology involves written or verbal recollection of a traumatic event. Trauma narratives are subsequently coded for relevant memory characteristics, as specified by cognitive theory, including fragmentation, disorganization, temporal disruption, and sensory features. Research utilizing this methodology in youth has produced 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 standardized questionnaires pertaining to trauma memory characteristics, such as the Trauma Memory Quality Questionnaire (TMQQ; Meiser-Stedman et al., 2007). The TMQQ was developed specifically for youth populations as a measure of trauma memory characteristics highlighted by cognitive theory (Brewin et al., 1996; Ehlers & Clark, 2000). Items in the questionnaire refer to the visual quality, nonvisual

sensory quality, temporal context, and verbal accessibility of trauma memories (see Supplementary Materials). Higher scores on the TMQQ reflect more visual and sensory content in trauma memories, a sense of nowness, and difficulty verbally accessing trauma memories. Questionnaire items relate to memory characteristics specifically rather than the frequency of trauma memories or the way in which these memories are elicited, and the measure has demonstrated good psychometric properties (Meiser-Stedman, et al., 2007). No other self-report measures of trauma memory characteristics in youth have been as widely used and validated as the TMQQ.

Research combining narrative and self-report methods has shown 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 posttrauma period (McGuire et al., 2021; McKinnon et al., 2017) in addition to predicting the later development of PTSD (McGuire et al., 2021; Meiser-Stedman et al., 2009, 2019). Although it could be argued that narrative recall offers a more detailed investigation of trauma memory characteristics, young people may limit what they choose to disclose, particularly given the established role of cognitive avoidance in posttraumatic stress (Ehlers & Clark, 2000; McGuire et al., 2021). Additionally, heterogeneity between methodologies used to code narratives across studies has made it challenging to conduct quantitative syntheses of findings in this area, and currently, only narrative syntheses are available (Crespo & Fernandez-Lansac, 2016; O'Kearney & Perrott, 2006). The majority of the studies included in these reviews feature adult samples, and, as yet, no systematic reviews exist pertaining to trauma memory characteristics in youth.

The administration of a standardized self-report questionnaire, such as the TMQQ, offers reduced heterogeneity between studies compared to narrative methodology and, thus, affords the opportunity to quantitatively synthesize the literature exploring the associations between trauma memory characteristics and PTSS. The current study represents the first systematic review and meta-analysis of the association between trauma memory characteristics, as measured using the TMQQ, and PTSS in youth. In line with cognitive theory, we expected to find a strong relation between TMQQ scores and PTSS whereby higher TMQQ scores would be associated with higher levels of PTSS. Further, this review explores the association between the TMQQ and PTSS in both the acute (i.e., ASD) and postacute (i.e., PTSD) phases following trauma exposure. This can elucidate whether trauma memory characteristics are an important factor in the initial development of PTSS and whether they remain an important factor in the subsequent maintenance of trauma-related symptoms.

METHOD

Search strategy

This review was prospectively registered with PROSPERO (February 3, 2021; CRD42021221552). A systematic search for relevant publications was conducted in the following psychological and medical literature databases: PsycINFO, MEDLINE, CINAHL, and PTSDPubs. We also searched the ProQuest Dissertations and Theses Global database to identify unpublished literature. In addition, a citation search for the TMQQ and a hand search of reference lists from the included studies were carried out to identify any further relevant studies. Articles published between 2007, when the TMQQ was first published, and March 2021 were considered eligible. 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 the relevancy of the identified literature.

The following inclusion criteria were applied: exposure to a traumatic event that met the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM–5*; American Psychiatric Association, 2013) Criterion A definition, use of the TMQQ, use of a validated measure of PTSS, and mean participant age less than 18 years. The following exclusion criteria were applied: studies not published in English, book chapters, qualitative studies, single case studies, datasets that were 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 compared meaningfully to the original. Treatment trials or samples that only included youth selected for high levels of PTSS or with a diagnosis of PTSD were also excluded, as these had the potential to artificially narrow the variance in PTSS across the entire included sample. Additionally, treatment-seeking youth and trauma-exposed youth may represent subtly different populations. Clinical trials were included only if baseline

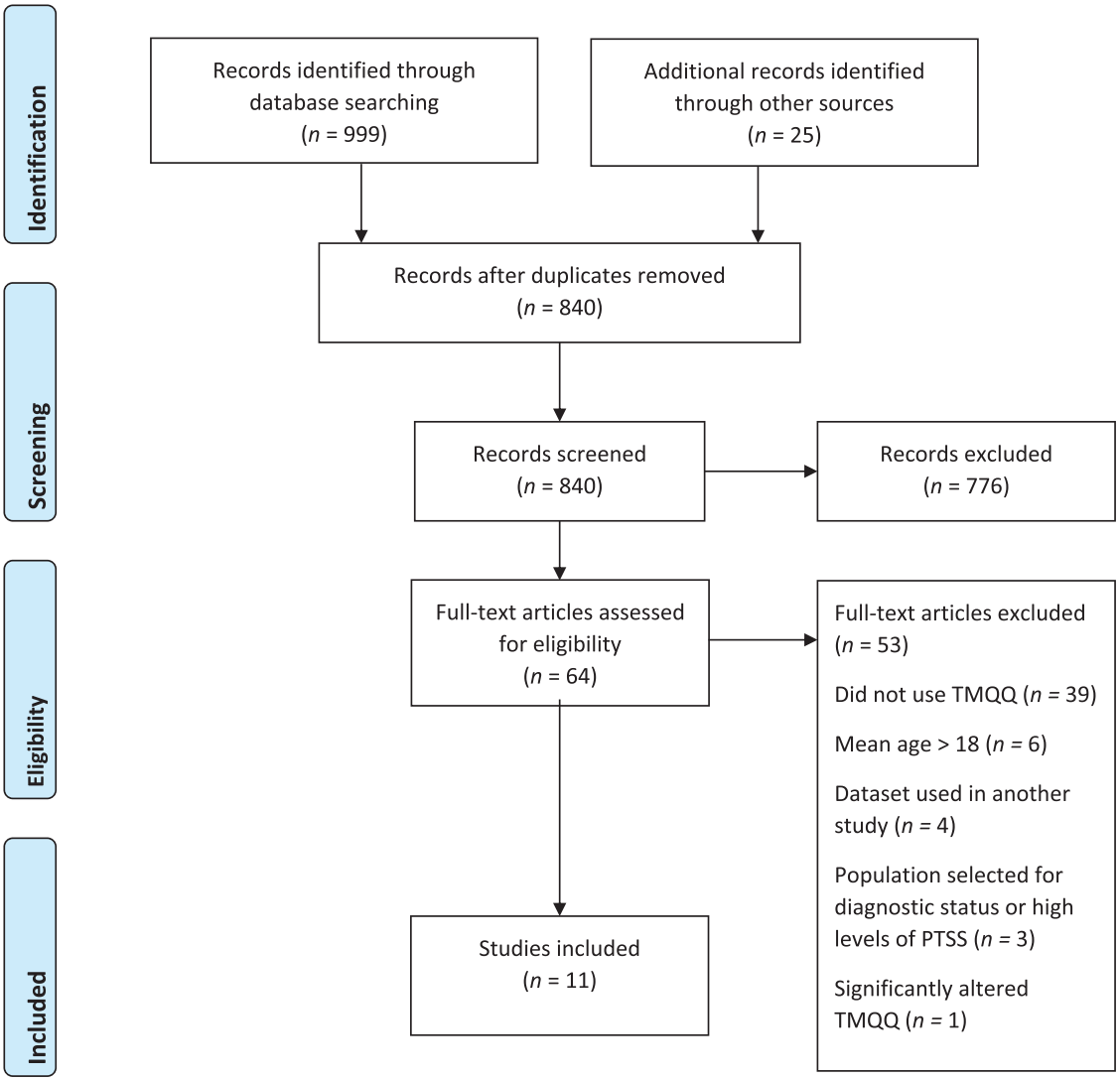

FIGURE 1 *PRISMA flow diagram*
Note: PTSS = posttraumatic stress symptoms; TMQQ = Trauma Memory Quality Questionnaire.

data (i.e., preceding the intervention) were available and participants were not selected solely based on diagnostic status. Studies were not excluded based on geographical location.

Screening method

The study selection and inclusion and exclusion processes are outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021) flow diagram (Figure 1). The first author screened all titles and abstracts. Relevant full-text studies were reviewed for eligibility against inclusion and exclusion criteria by the first author, and this process was repeated by the third author. When disagreements occurred, these two authors discussed discrepancies until a consensus was reached.

Data extraction

The Pearson correlation coefficient was used as the effect size estimate and was extracted for analyses. When this was not explicitly reported, means and standard deviations of TMQQ and PTSS measure scores were used to calculate Cohen's *d*, which was subsequently converted to Pearson's *r* (Aaron et al., 1998). If the data were reported in such a way that it was not possible to calculate Pearson's *r* (e.g., if the data were 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 (see Table 2) and pooled using a random-effects meta-analysis to assess the measure's overall internal consistency.

As the intensity of PTSS within the acute period (i.e., 2–4 weeks posttrauma) is liable to change over time, we initially intended that the main analysis would focus on studies pertaining to the postacute period during which PTSD can be diagnosed and symptoms are typically more stable (i.e., more than 1-month posttrauma), with a secondary analysis planned for the acute period. However, a relatively small number of relevant studies exploring the postacute period were identified, and most studies reported data pertaining to the acute phase; some prospective longitudinal studies reported data for both the acute and postacute phases. Therefore, we decided that the main analysis would include data from both the acute and postacute phases to maximize the number of studies that could be included. Rules were devised such that effect sizes for the association between TMQQ scores and postacute PTSS were prioritized for inclusion. Data were extracted and labeled according to the following rules: Rule A pertained to prospective data (i.e., TMQQ administered more than 1-month posttrauma and the strength of its association with later PTSS), Rule B related to acute prospective data (i.e., TMQQ administered within 1-month posttrauma and the strength of its association with later PTSS), Rule C dealt with cross-sectional data (i.e., TMQQ administered more than 1-month posttrauma and the strength of its association with concurrent PTSS), and Rule D pertained to acute cross-sectional data (i.e., TMQQ administered within 1-month posttrauma 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 prioritized hierarchically such that effect sizes that met the specifications for Rule A superseded effect sizes that met the specifications for Rule B, and so forth. The main analysis included data pertaining to all four rules. Descriptive data were also extracted, including participant demographic information. The third author repeated data extraction was repeated for all studies. When disagreements occurred and for cases in which data could not be readily extracted and required further calculation, discussions with the senior author were initiated for verification.

Subgroup and sensitivity analyses

Subgroup analyses were conducted to examine whether results differed between data collected in the acute and postacute phases as well as between data that were 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 Supplementary Materials): Rules A and B for prospective analyses, Rules B and D for acute analyses, Rules C and D for cross-sectional analyses, and Rule D for acute cross-sectional analysis.

Given the relatively small number of included studies, 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, and studies that used the same PTSS measure (i.e., Child PTSD Symptom Scale [CPSS; Foa et al., 2001] or 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 six items, with only the most relevant items selected to ensure the efficiency of the quality rating process (see Supplementary Materials for the full quality rating tool). For example, questions regarding the validity of measures were not necessary, as this was already specified in the inclusion criteria. The tool assessed the appropriateness of recruitment and sampling, analysis of nonresponse bias, sample-size justification, and drop-out rates in prospective studies.

Studies were given a rating of "high risk" or "low risk" for each question. Prospective studies were scored on a scale of 0–6, and cross-sectional studies on a scale of 0–5. Prospective studies were rated: high quality if they received a low-risk rating on at least five or six items, or at least four or five items for cross-sectional studies; medium quality if they received a low-risk rating on three or four items, or two or three items for cross-sectional studies; and low quality if they received a low-risk rating on zero, one, or two items, or zero or one items for cross-sectional studies. The second author repeated the quality rating process; when disagreements occurred, discussion with the first author was initiated. 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's *Z* transformation during analyses and were back-transformed to Pearson's *r* correlation coefficients for reporting and interpretation. Pearson's *r* was interpreted as a small (.1), medium (.3) or large (> .5) effect (Cohen, 1988). The heterogeneity of effect sizes was estimated using the *Q* statistic and prediction intervals, and the I^2 statistic was calculated to provide contextualization of the observed effects, aligned with recommendations from Borenstein et al. (2017). A "leave-one-out" analysis was conducted for the main analysis to identify any studies that potentially presented as outliers.

Publication bias

To estimate the risk of publication bias, funnel plots were generated, and Duval and Tweedie's (2000) trim-and-fill method 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. Summaries of study characteristics and measures are presented in Tables 1 and 2. Most studies assessed single-event trauma, including acute medical illness or injury ($k = 8$) and natural disasters ($k = 1$). Two studies assessed more chronic forms of trauma, including maltreatment and war exposure. All studies were rated against the quality assessment tool. Three were categorized as high quality, six as medium quality, and two as low quality; see Supplementary Materials for a breakdown of the proportion of studies rated as low– or high–risk of bias across the six items included in the quality rating tool. Four studies featured a cross-sectional design, and seven featured a prospective longitudinal design. Only one study repeated the TMQQ at follow-up (Bray et al., 2018). Table 2 specifies the PTSS measure used in each study.

Main analysis

The main analysis included one effect size from each of the 11 included studies. The analysis captured both cross-sectional and prospective data in the acute and postacute posttrauma phases. The overall sample size for the main analysis was 1,270.

As shown in Table 3, a large estimated effect size, $r = .52$, 95% confidence interval (CI) [.44, .58], 95% prediction interval (PI) [.31, .68], was observed for the association between self-reported trauma memory characteristics, as measured using the TMQQ, and PTSS (see the Supplementary Materials for a forest plot of the results). The leave-one-out analysis indicated that removing the study by McKinnon et al. (2008) reduced estimates of heterogeneity, with the *Q* statistic indicating that the studies shared a common effect size, $Q(9) = 11.11$, $p = .268$. This suggests that the effect size in this study was an outlier and accounted for a large proportion of the observed heterogeneity (see Supplementary Materials). A random-effects meta-analysis of Cronbach's alpha values produced a pooled estimate of .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 most included in the analysis, suggesting that the inclusion of these studies would generate a larger rather than smaller overall estimated effect size (see Supplementary Materials). A regression test of funnel plot asymmetry indicated no significant asymmetry indicative of publication bias, $p = .744$.

Subgroup analyses

As shown in Table 3, subgroup analysis of acute data and postacute prospective data yielded similar results to the main analysis and to each other. The *Q* statistic suggested that studies included in the acute analysis may not share a common effect size, $Q(8) = 23.71$, $p = .002$, whereas those in the postacute prospective analysis were shown to share a common effect size, $Q(4) = 8.57$, $p = .073$.

Subgroup analyses of cross-sectional and acute cross-sectional data yielded similar results to each other, with a large estimated effect size, $r = .62$, 95% CI [.53, .70], 95% PI [.30, .82], and $r = .63$, 95% CI [.52, .72], 95% PI [.27, .84], respectively. These estimated effect sizes were higher than those observed in the main, acute, and prospective analyses. The *Q* statistic indicated that studies included in both the cross-sectional and acute cross-sectional analyses may not share a common effect size, $p = < .001$.

Sensitivity analyses

As shown in Table 3, a large estimated effect size was observed for all exclusionary sensitivity analyses. The

TABLE 1 Sample characteristics and study design for the included studies

Article	Trauma type	*N*	Age range (years)	*M* age (years)	% female	Country	Study design	Time since trauma	
								Baseline	Follow-up
Bray et al., 2018	Medial illness/injury	25	7–17	12.26[b]	33.9[b]	Australia	Prospective longitudinal	1 week	2 months
Dow et al., 2019	Medial illness/injury	70	6–17	11	44	Australia	Cross-sectional	3 weeks	
Hiller et al., 2019	Medial illness/injury	132	6–13	9.9	37.9	UK	Prospective longitudinal	2–6 weeks	7 months
Hiller et al., 2021	Maltreatment (abuse/neglect)	120	10–18	13.5	55	UK	Prospective longitudinal	12 months[d]	
McKinnon et al., 2008	Medial illness/injury	75	7–16	11	31	Australia	Cross-sectional	1–4 weeks	
McKinnon et al., 2017	Medial illness/injury	67	7–16	11.8	37	Australia	Prospective longitudinal	4 weeks	8–12 weeks
Meiser-Stedman et al., 2007[a]	Medial illness/injury	226	11–16	14	36.8	UK	Prospective longitudinal	2–4 weeks	3 months
Meiser-Stedman et al., 2019	Medial illness/injury	83	8–17	14.1	42.5	UK	Prospective longitudinal	2–4 weeks	2 months
Mordeno et al., 2018	Natural disaster	225	9–17	14.2	55.1	Philippines	Cross-sectional	< 1 month	
Peltonen et al., 2017	War exposure	197	10–12	11.4	49.4	Palestine/Israel	Prospective longitudinal[c]	11 months	
Salmond et al., 2011	Medial illness/injury	50	8–17	13.5	60	UK	Cross-sectional	2–4 weeks	

Note: UK = United Kingdom.

[a]Only Sample 2 used, Sample 1 was not exposed to a Criterion A traumatic event.

[b]Demographic data were split into two subgroups (high/low PTSS); the mean subgroup values are reported.

[c]Although this was a prospective longitudinal study, the Trauma Memory Quality Questionnaire was only administered 11 months posttrauma.

[d]Not possible to determine time since trauma at baseline due to chronic nature of trauma; follow-up was at 12 months.

TABLE 2 Measures, psychometric properties, and quality ratings for the included studies

Article	PTSS measure	Measure administration	Cronbach's α for TMQQ	Quality rating
Bray et al., 2018	Baseline: ASC-Kids Follow-up: CPSS	Self-report	.73	Medium
Dow et al., 2019	CRIES-13	Self-report	.64	High
Hiller et al., 2019	PTSD-RI	Self-report	.80	High
Hiller et al., 2021	CATS	Self-report	.88	Medium
McKinnon et al., 2008	ASC-Kids	Self-report	.75	Medium
McKinnon et al., 2017	Baseline: CASQ Follow-up: CPSS	Self-report	.63	Medium
Meiser-Stedman et al., 2007	RIES-C	Self-report	.82	Low
Meiser-Stedman et al., 2019	CPSS	Self-report	.72	High
Mordeno et al., 2018	ASDI	Interview	.81	Medium
Peltonen et al., 2017	CRIES-13	Self-report	.73	Low
Salmond et al., 2011	CPSS	Self-report	.68	Medium

Note: PTSS = posttraumatic stress symptoms; PTSD = posttraumatic stress disorder; ASC-Kids = Acute Stress Checklist for Children; ASDI = Acute Stress Disorder Interview; 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; PTSD-RI = PTSD Reaction Index; RIES-C = Children's Revised Impact of Events Scale; TMQQ = Trauma Memory Quality Questionnaire.

TABLE 3 Results from the main, subgroup, and sensitivity analyses

Analysis	*k*	*N*	*r*	95% CI	95% PI	*Z*	*Q*	I^2 (%)
Main analysis	11	1270	.52	[.44, .58]	[.31, .68]	11.84***	24.61**	61.1
Subgroup analyses								
Prospective	5	628	.51	[.42, .59]	[.33, .66]	9.36***	8.57	52.0
Acute	9	953	.52	[.43, .61]	[.25, .71]	9.23***	23.71**	68.4
Cross-sectional	11	1270	.62	[.53, .70]	[.30, .82]	10.51***	52.79***	81.5
Acute cross-sectional	9	953	.63	[.52, .72]	[.27, .84]	8.85***	41.60***	82.9
Sensitivity analyses								
Excluding altered TMQQ	8	793	.54	[.44, .62]	[.27, .72]	8.98***	20.05**	66.1
Excluding LMIC populations	9	848	.53	[.43, .61]	[.27, .71]	9.42***	22.44**	64.8
Excluding low quality	9	990	.53	[.44, .61]	[.28, .71]	9.79***	22.53**	66.9
Excluding non–single-event trauma	9	953	.53	[.44, .61]	[.28, .71]	9.66***	22.45**	66.4
CRIES-13 only	3	350	.46	[.37, .54]	[.37, .54]	9.23***	-[a]	0.0
CPSS only	4	368	.53	[.41, .64]	[.33, .69]	7.43***	-[a]	40.4

Note: CI = confidence interval; CPSS = Child PTSD Symptom Scale; CRIES-13 = Children's Revised Impact of Event Scale; LMIC = low- and middle-income country; PI = prediction interval; TMQQ = Trauma Memory Quality Questionnaire.

[a] A *Q* statistic is not typically interpreted in analyses where $k < 5$.

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

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 association between self-reported trauma memory characteristics and PTSS. The estimated effect size for the CRIES-13 sensitivity analysis was slightly lower than observed in other analyses. For all sensitivity analyses except those pertaining to PTSS measures, the *Q* statistic suggested that the included studies may not share a common effect size. This indicates that the inclusion of studies that received a low quality rating, used an altered version of the TMQQ, were conducted in LMIC populations, investigated non–single-event trauma, and the inclusion of studies using a number of different PTSS measures, in the main analysis was unlikely to have substantially affected the observed estimated effect size. Total sample sizes for subgroup and sensitivity analyses are presented in Table 3.

DISCUSSION

The current review and meta-analysis aimed to examine the strength of the association between trauma memory characteristics, as measured using the TMQQ, and PTSS in youth populations. The main analysis indicated a large estimated effect size for the association between self-reported memory characteristics and PTSS. Congruent 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 because both cross-sectional analyses included acute cross-sectional data (i.e., associations between TMQQ administered in the acute phase and concurrent PTSS). For the overall cross-sectional analysis, effect sizes pertaining to the postacute administration of the TMQQ and concurrent PTSS could only be extracted from three studies. Therefore, the estimated effect size was 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, the opportunity for natural recovery is more limited, meaning 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 used in the included studies 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 association between trauma memory characteristics and PTSS. Although the observed results of the cross-sectional analyses differed slightly, they indicated a stronger rather than weaker association, which can instill confidence in the large estimated effect size observed 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. Similar results were also observed in the postacute prospective analysis, suggesting that the strength of the association 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 standardized interpretations of effect sizes may be too conservative, and that an r value 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 association between trauma memory characteristics, captured by the TMQQ, and both concurrent and future PTSS. To place these results in context of previously conducted meta-analyses investigating cognitive factors in PTSD, they are substantially larger than the small estimated effect size ($r = -.12$) for the association between social support and PTSD (Allen et al., 2021), similar to the large estimated effect size ($r = .63$) for the association between negative appraisals and PTSS (Mitchell et al., 2017), and smaller than the large estimated effect size ($r = .70$) for the association between cognitive avoidance and PTSS (Trickey et al., 2012). However, it is important to note 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. Additionally, the strong association between PTSS and trauma memory characteristics, such as dominant sensory features and a sense of nowness, as captured by the TMQQ, is also congruent with dual-representation theory, suggesting this is also relevant to understanding trauma memory characteristics in youth populations. The current findings indicate that trauma memory characteristics are prospectively associated with both acute and postacute PTSS, which may provide some tentative evidence that these memory characteristics could be relevant to both the development and maintenance of PTSS. However, although the results provide a clear indication that trauma memory characteristics are implicated in the phenomenology of posttraumatic stress reactions, it is not possible draw definitive conclusions on whether these memory characteristics are necessarily causative of PTSS.

When considering trauma memory characteristics in youth, it is important to consider the unique psychosocial and developmental considerations of this population. Previous researchers have highlighted that difficulty recalling trauma memories in children may reflect an immaturity of language development rather than fragmentation and a lack of integration of trauma memories (Salmon & Bryant, 2002). However, as the TMQQ encompasses sensory characteristics and a sense of nowness, in addition to difficulty with verbal recall, the current results tentatively suggest that specific trauma memory characteristics, similar to those observed in adults (Crespo & Fernandez-Lansac, 2016; Richard & Perrott, 2006), are related to PTSS

in youth. Additionally, previous research has highlighted that adults play an important role in children's responses to trauma (Alisic et al., 2017; Salmon & Bryant, 2002), which could plausibly influence the conceptualization of trauma memories. It would be beneficial for future researchers to consider further how these psychosocial, developmental, and cognitive factors interact in youth PTSD.

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 a valid argument given the strong empirical support for the role of negative appraisals in posttrauma reactions (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 that operate in isolation. It is plausible that a perceived higher intensity of sensory content, sense of nowness, and difficulty verbally accessing memories could be appraised as more threatening than trauma memories which are not perceived to have these characteristics. The association between self-reported trauma memory characteristics and PTSS observed in the current meta-analysis could, therefore, potentially represent an association between perceptions of trauma memories and PTSS, whereby perceived higher levels of intensity surrounding certain trauma memory characteristics are 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 have indicated that improvements in negative appraisals and trauma memory characteristics are correlated with symptom reduction (Kangaslampi & Peltonen, 2019). However, other research has shown that changes in negative appraisals during treatment mediate symptom reduction whereas changes in trauma memory characteristics do 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 researchers could also consider using network analysis to explore associations between multiple cognitive factors and specific symptom clusters, such as reexperiencing symptoms, simultaneously. This would help clarify the associations between cognitive factors themselves as well as those between cognitive factors and symptom clusters, which would, in turn, benefit the exploration of cognitive theory in more detail and identification of relevant mechanisms of action for psychological interventions.

Some limitations of the current review merit consideration. The limited number of studies included in the main analysis mean that it was not possible to conduct moderator analyses. Although the results for the subgroup and sensitivity analyses suggest it was unlikely that individual study characteristics influenced the results of the main analysis, it is important to note that the sample size was more limited for these analyses. Due to limited prospective data, most of the extracted effect sizes pertained to the association between trauma memory characteristics and PTSS within the acute phase. Understanding relevant cognitive factors in the postacute phase is important given that psychological interventions are not recommended until symptoms have stabilized and a diagnosis of PTSD can be made, (i.e., in the postacute 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 2–3 months posttrauma, and research has shown that organic reductions in PTSS may continue to for up to 6 months posttrauma (Hiller et al., 2016). Therefore, it could be beneficial for future research to employ prospective designs to replicate the preliminary results indicating that the association between trauma memory characteristics and PTSS remain strong in the postacute phase and investigate whether the strength of this association is maintained over a longer period of time. Furthermore, as the TMQQ is currently only validated for use as a composite score, we were unable to investigate phenomenological characteristics of trauma memories separately in the current review. Future research may consider alternative methodology, such as network analysis or individual participant data meta-analysis, to explore this in more detail. A broader limitation within the field of trauma memory in youth is the paucity of studies in non-Western populations and overrepresentation of single-event trauma exposure, specifically acute medical illness or injury, thus limiting the generalizability of the findings. It is 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 association between self-reported trauma memory characteristics and PTSS in youth, suggesting that this represents an important cognitive factor in the phenomenology of posttraumatic stress reactions. 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.

OPEN PRACTICES STATEMENT

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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Richard Meiser-Stedman is an author and coauthor on a number of the included studies and coauthored the Trauma Memory Quality Questionnaire. The other authors have no conflicts of interest to declare.

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