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The Measurement of Functioning as an Outcome in Intervention Studies Targeting Intrusive Memories of Trauma: A Narrative Review

Emily M. Greenfield[1,2] · Oliver J. Mason[1] · Emily A. Holmes[3] · Kerry Young[4] · Michelle L. Moulds[5]

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Abstract

There has been a call for innovative, low-cost and simple treatments for people who have experienced trauma. The proposal that targeting intrusive memories could have the downstream effect of reducing other posttrauma symptoms or preventing their emergence has prompted the development of single-symptom interventions for intrusive memories, drawing on cognitive neuroscience models of memory consolidation and reconsolidation. To understand their full therapeutic impact, evaluations of the effectiveness of single-symptom interventions should include measures of broad outcomes (i.e. functioning), in addition to intrusion-related measures. This narrative review examined whether intervention studies targeting intrusive memories after real-world trauma measured functioning as an outcome, and if so, how.

General Audience Summary Posttraumatic stress disorder (PTSD) is a mental health disorder that an individual may experience following exposure to a traumatic event. Whilst effective treatments for PTSD exist, many people are unable to access them, e.g. refugees living in refugee camps. Therefore, a number of researchers have argued that new interventions which are simple, low-cost and easily accessed should be developed, to increase treatment access for people who may otherwise not receive psychological help. Researchers have started to develop interventions which target (i.e. aim to reduce) one specific symptom of a mental health disorder, with the goal of also improving other associated difficulties. In the case of trauma and posttraumatic stress, new treatments have been developed which target intrusive trauma memories. Intrusive memories are visual memories of traumatic events which repeatedly and involuntarily come to mind. They cause significant distress and can affect an individual's ability to do tasks in their daily life, such as work and socialise. To understand the ways in which new interventions may be beneficial, it is important that researchers examine whether the intervention has led to helpful changes (e.g. a reduction in the number of intrusive memories experienced), but also examine whether it reduces other mental health symptoms and improves functioning. This review of the literature looked at whether intervention studies targeting intrusive memories of trauma measured functioning as a treatment outcome, and if so, how it was measured. Twenty-five studies were included in the review, 17 of which included a measure of functioning. We found that functioning was not measured consistently. Moreover, when functioning was assessed, the measures used were not always appropriate. We recommend ways to assess functioning in future studies so that researchers will be able to better understand the impact that new interventions have on daily functioning.

Extended author information available on the last page of the article

Twenty-five studies were included, 17 of which included a measure of functioning. Functional outcomes were not consistently measured in a rigorous or informative way. We make recommendations to address these issues and propose ways in which functioning can be effectively assessed in future work.

Keywords Intrusive memory · Trauma · Single-symptom intervention · Cognitive neuroscience · Functioning · Measurement

Introduction

Posttraumatic stress disorder (PTSD) is a mental health disorder that an individual may experience following exposure to a traumatic event. Whilst effective evidence-based treatments for PTSD exist (National Institute for Clinical Excellence [NICE], 2018; Watkins et al., 2018), there are individual and systemic barriers to good outcomes in PTSD treatment—see Burback et al. (2024) for a review—with many people unable to access treatment. Refugees, for example, are up to 15 times more likely to have PTSD than the general Western adult population (Bogic et al., 2015). However, most refugee populations reside in locations such as warzones or refugee camps, where there is little mental health resource (Silove et al., 2017). Furthermore, people with subthreshold PTSD, who do not meet the full criteria for PTSD but still report significant PTSD symptoms and associated disability (Cukour et al., 2010; Klein et al., 2024), are often excluded from research and access to evidence-based interventions. There is evidence that rates of subthreshold PTSD are comparable, or higher, than rates of PTSD (e.g. Hruska et al., 2023; Rentmeesters & Hermans, 2023), and that symptoms can be longstanding (Cukour et al., 2010). Some researchers (e.g. Hoge & Chard, 2018; Holmes et al., 2018) have therefore argued for prioritising the development of low-cost and simple treatments, deliverable by lay mental health workers or accessed as a self-help resource, to increase access to treatment for individuals who may otherwise not receive an intervention.

To address these problems, there is a need for new ideas and active innovation (Holmes et al., 2018). There has been a call for 'an umbrella discipline of mental-health science that joins behavioural and neuroscience approaches to problems including improving psychological treatments' (Holmes et al., 2014; p.289). As cognitive science tends to examine specific processes in isolation under controlled conditions, researchers working under this 'umbrella' (e.g. Iyadurai et al., 2019; Singh et al., 2020) have suggested that it could be beneficial to identify a specific target symptom (e.g. a core clinical feature) and investigate ways to specifically modify that target symptom within a laboratory setting.

Within the field of trauma and posttraumatic stress, intrusive memories of trauma have been put forward as one such specific target symptom. Intrusive memories of trauma refer to the involuntarily reexperiencing of sensory impressions of the traumatic event(s) in a vivid and emotional way, predominantly through visual images, but also via other sensory modalities (Ehlers & Clark, 2000; Ehlers et al., 2004). The cognitive model of PTSD (Ehlers & Clark, 2000) suggests that

intrusive memories are a potential driver of the other symptom clusters. Furthermore, network analyses have demonstrated that intrusive memories are centrally associated with other PTSD symptoms (e.g. Borsboom, 2008; Bryant et al., 2017; Haag et al., 2017; Schlechter et al., 2022). This has prompted the proposal that 'clinically targeting an important core symptom, such as intrusive re-experiencing in PTSD… can produce downstream beneficial effects on other symptoms in a kind of therapeutic cascade' (McNally, 2012, p. 225). For example, concentration is often disrupted by intrusive memories (Holmes et al., 2017) and avoidance often relates to apprehension of experiencing intrusive memories (Bar-Haim et al., 2021). Thus, theoretically, reducing intrusive memories should lead to an improvement in concentration and a reduction in avoidance. McNally (2017) argued that '…successful early intervention targeting these symptoms would likely prevent the full syndrome of PTSD from emerging' in the first place (p.127). Additionally, approximately 10% of trauma-exposed individuals who would not meet diagnostic criteria for PTSD suffer from intrusive memories and reexperiencing symptoms (Bar-Haim et al., 2021), suggesting intrusive memories could be a good target for subthreshold PTSD.

Cognitive neuroscience models of memory consolidation and reconsolidation (Monfils & Holmes, 2018; Visser et al., 2018) have highlighted the potential of novel treatments for intrusive memories of trauma, whereby a memory is retrieved and altered (Wright et al., 2021). Following laboratory studies—see Iyadurai et al. (2019) and Asselbergs et al. (2023) for an overview—to test and refine the procedures that promote memory reactivation and subsequent reconsolidation of memory for traumatic events, research has recently been translated into clinical settings—see Iyadurai et al. (2019) and Wright et al. (2021) for an overview. It is therefore timely to consider the outcomes that need to be measured to assess the clinical utility of these findings for real-life trauma and real symptoms posttrauma.

In trials evaluating interventions which target intrusive memories, typically the key outcomes are intrusion-related, e.g. number of intrusions reported in a daily diary, ratings of intrusion-related distress, ratings of intrusion characteristics such as vividness. However, given that intrusive memories have been selected as a treatment target because of the potential for 'downstream effects', it is essential that outcome measures are not limited to intrusion-related indices, so that the full suite of potential clinical benefit of these interventions is understood. With any psychological therapy a key aim is to improve people's 'ability to live full and meaningful lives and improve their human experience' (Benfer & Litz, 2023, p.14), therefore many researchers (e.g. Kazdin, 1999; McKnight & Kashdan, 2009) assert that functioning is a crucial outcome to measure. However, functioning has only recently started to be included more routinely as an outcome measure in clinical research. In a meta-analysis investigating the effects of psychological therapies for PTSD, Cusack et al. (2016) concluded that too few articles reported on functional outcomes for them to be able to derive meaningful conclusions about the impact of interventions on functioning. Whilst improvements were seen in a recent updated meta-analysis (Bonfils et al., 2022), the authors note that variability in how functioning was defined and measured was problematic as it hindered comparisons across studies and contributed to uncertainty regarding the broader impact of interventions for PTSD.

Given that research evaluating the effectiveness of novel interventions specifically targeting intrusive memories of trauma is in its relative infancy, it is timely to review whether and how functional outcomes are measured in this literature, with a view to making recommendations to ensure their rigorous and meaningful assessment in future research. Whilst reviews evaluating functional outcomes for interventions targeting the full disorder of PTSD already exist (e.g. Benfer & Litz, 2023; Bonfils et al., 2022; Cusack et al., 2016), we see value in conducting a separate review for single-symptom approaches as there may be important nuances to consider when measuring functional outcomes following simple, targeted interventions.

Before turning to the review, we consider definitions of 'functioning'. Clinicians commonly use the term 'functioning' and routinely assess the impact of an individual's symptoms on their ability to 'function' (e.g. in occupational and social domains). Indeed, to reach diagnostic threshold for most psychological disorders in the DSM-5 (APA, 2013), symptoms need to cause clinically significant distress or impairment in social, occupational or other important areas of functioning. Nonetheless, there is no universally agreed upon definition of 'functioning'. Moreover, the terms 'functioning' and 'quality of life' are often used interchangeably (Endicott & Dorries, 2009; Ro & Clark, 2009). The International Classification of Functioning, Disability and Health (ICF) was developed to be a global framework of disability and functioning, applicable across cultures, and is now used worldwide, across a range of sectors (Leonardi et al., 2022). It states that functioning encompasses all 'body functions, activities and participation' (WHO, 2001; p.3). However, the authors (WHO, 2001) acknowledge that impairments in body functions overlap with symptoms of disease, and may be part of, or an expression of, a health condition, e.g. difficulty concentrating and sleeping, are classed as impairments in body functions (WHO, 2001), but are also DSM-5 symptoms of PTSD (APA, 2013).

Given that the term 'functioning' is used variously within the literature, it is important to outline how we conceptualised functioning in this review. To differentiate between symptoms and functional impairment, we conceptualised functioning as activities and participation (WHO, 2001), excluding body functions. 'Activity is the execution of a task or action by an individual. Participation is involvement in a life situation' (WHO, 2001; p.10). There are nine domains of activities and participation (WHO, 2001) including learning and applying knowledge, general tasks and demands, communication, mobility, self-care, domestic life, interpersonal interactions/relationships, community/social/civic life (e.g. recreation and leisure, and religion and spirituality) and major life areas (e.g. education and employment).

The primary aim of our review was to examine the measurement of functioning as an outcome in studies evaluating interventions targeting intrusive memories of trauma. Specifically, we examined whether studies included measures of functioning—defined as activities and participation (WHO, 2001)—and if so, what measure/s were employed. We aimed to take a critical stance on current measurement approaches, and, if indicated, propose ways in which researchers could address shortcomings and challenges regarding the assessment of functional gains in future work. In the event that our review identified intervention studies in which researchers administered a measure of functioning, our secondary aim was to note whether the interventions resulted in improvements in functioning.

Method

We conducted a narrative review with a methodical approach. Published studies and clinical trial registrations (CTRs) were reviewed. Whilst CTRs describe planned or ongoing studies and thus alone cannot provide information about the impact of interventions on functioning, they can provide helpful information about the measurement of functioning in current and ongoing studies. As such, they address the central aim of this review and were deemed important to include, particularly as this literature is in its infancy. The search process for each is described below and summarised in a flowchart (Fig. 1).

Psychology Cross Search was used to search databases for published literature. It enables a simultaneous search of PsychINFO, PsychARTICLES, Psychology and Behavioural Sciences Collection and MEDLINE. The search was initially conducted in February 2021 and updated in January 2023. Search terms of ('traum*' OR 'PTSD') AND ('intrusive memor*' OR 'involuntary memor*' OR 'intrusive imag*') AND ('intervention' OR 'treatment' OR 'therapy'), with limits 'Scholarly (Peer Reviewed)' and 'English Language', resulted in 304 published journal articles following the removal of duplicates. Titles, abstracts and full-text articles were screened by the first author. Uncertainties regarding inclusion were discussed with the fifth author and a final decision made collaboratively. If a clear decision could not be made by the first and fifth author, the study's corresponding author was contacted to clarify the methodology in order to confirm inclusion or exclusion. References of included articles were also reviewed.

Articles were included if they reported a study: (a) conducted with human participants, (b) which evaluated an intervention specifically targeting intrusive memories of trauma (i.e. not a broader PTSD treatment), if intrusive memories were (c) of a

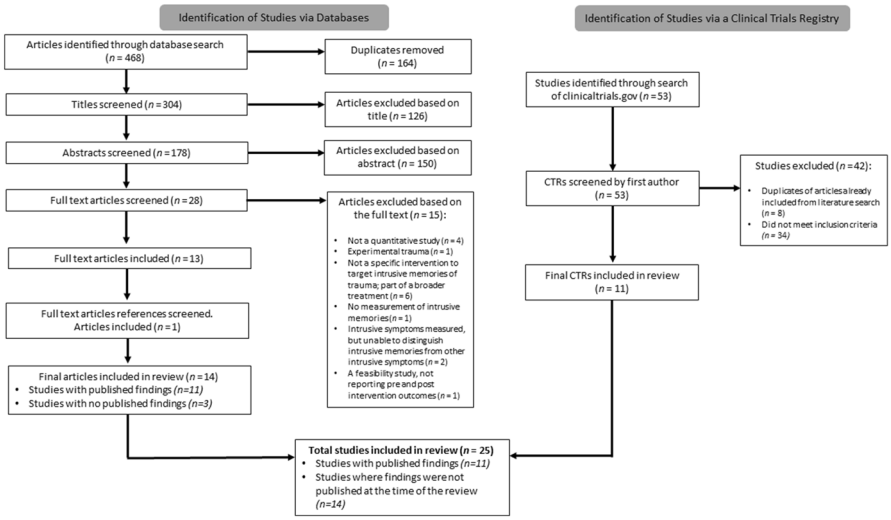

Fig. 1 Flow diagram of search strategy. Note: Adapted from PRISMA flow diagram (Page et al., 2021) to fit the study

real-life traumatic event as defined by DSM-5 (APA, 2013) (as opposed to analogue trauma studied in an experimental context, e.g. trauma-film paradigm; Holmes & Bourne, 2008; James et al., 2016), (d) quantitatively measured pre- and post-intervention, or across two conditions for comparison, and were reported separately from other PTSD symptoms (i.e. not only as part of a PTSD re-experiencing symptom cluster score) and the article (e) described the planned methodology (i.e. protocol papers or terminated studies). Fourteen articles were eligible for inclusion.

A search of clinicaltrials.gov registry was initially conducted in February 2021 and updated in February 2023. The search terms and limits of the search for published articles were adapted to fit within the constraints of the website's search function, i.e. as the search fields did not recognise the asterisk search function, full words were searched in the 'other terms' search box, with study type filtered as 'interventional': (trauma OR PTSD) AND (intrusive memory OR intrusive memories OR involuntary memory OR involuntary memories OR intrusive image) AND (intervention OR treatment OR therapy). This resulted in 53 CTRs. Screening for inclusion was conducted using the same process as for published articles. Eleven CTRs were eligible for inclusion.

In sum, 25 intervention studies were included in this review, categorised as studies with published findings ($n = 11$) or studies for which the findings were not published at the time of the review (i.e. CTRs, protocol paper, terminated study; $n = 14$). It was not deemed necessary nor viable to critically appraise the quality of included studies using a critical appraisal tool as (i) it was not the aim of the review to evaluate treatment outcome results and (ii) less than half (i.e. 44%) of the included studies had findings published at the time the review was conducted.

Findings

In this section, we answer the two review questions sequentially (for an overview of the measurement of functional outcomes in each study, see Tables 1 (studies with published findings) and 2 (studies for which findings were not published at the time of the review)). We also provide a brief overview of each study's design, sample and the intervention being evaluated in Tables 1 and 2. Across the 25 studies, three different interventions were evaluated: (1) a cognitive task procedure including a brief memory reminder cue, prior to engaging in a visuospatial interference task, the computer game Tetris, with specific instructions for 'mental rotation' (i.e. an imagery-competing task procedure), (2) Visual kinaesthetic dissociation, (3) Imagery rescripting.

Do Intervention Studies Targeting Intrusive Memories of Trauma Include a Measure of Functioning as an Outcome?

A study was classified as having included a measure of functioning if at least one measure (i) known to be, or labelled, an index of functioning was included in the measures section of the article (including the supplementary materials, if secondary

Table 1 Summary of studies with published findings and their measurement of functioning

Article details	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed	Findings in answer to the question: Do interventions specifically targeting intrusive memories of trauma lead to improved functioning?
Deforges et al. (2022)	A single group pre-post-design	Women ($N=18$) who gave birth to a live baby ≥ 6 weeks and reported childbirth-related intrusive memories	1 session of childbirth-related reminder cues, 10-min time gap + visuospatial task (Tetris gameplay)	X	X	-
Horsch et al. (2017)	Randomised Controlled Trial (RCT)	Women who had an emergency caesarean section (ECS) ≤ 6 h. Intervention group ($n=29$), control group ($n=27$)	Intervention group: Visuospatial task (computer game Tetris) for 15 min Control group: usual care	X	X	-
Hossack and Bentall (1996)	Multiple baseline design	Men ($N=5$) with PTSD (4 victims of the UK Hillsborough football stadium disaster, 1 survivor of a helicopter crash)	2 sessions of relaxation training and 2 sessions of visual kinaesthetic dissociation	X	X	At baseline, 4 participants were unable to work; at study end, 3 participants showed improvement in academic and occupational functioning, 1 had improved social functioning; one continued to be impaired

Table 1 (continued)

Article details	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed	Findings in answer to the question: Do interventions specifically targeting intrusive memories of trauma lead to improved functioning?
Kanstrup et al. (2021a)	A single-case ABAB withdrawal design	Refugees living in Sweden ($N=4$) experiencing intrusive memories of trauma	2 intervention meetings (B1, B2) including a brief memory reminder cue, 10-min time gap + Tetris gameplay for ≥ 20 min using 'mental rotation'	World Health Organisation Disability Assessment Schedule 2.0 (WHODAS 2.0), 12 item version—self-rated (Üstün et al., 2010) *Five time points (at the start of each new phase and study end)*	Open-ended question: 'How do intrusive memories interfere with your ability to settle into this country and learn new skills, e.g. a new language?' Rating question: 'When you played Tetris, did it help you not think about your problems so that you could focus on for example your work or school or maintaining a friendship?' from 0 (not helpful) to 10 (very helpful) *Meetings 1, 3 and 5*	3 participants' functioning improved pre- to post-intervention, with reduced WHODAS scores (major improvement for 2, minimal for 1). One participant's functioning deteriorated (WHODAS scores increased). Open-ended responses suggested improvements in learning and applying knowledge for all participants (e.g. improved planning of future work). 2 participants noted functional improvements despite intrusions persisting. Responses on the rating question suggested that playing Tetris helped all participants not think about their problems and focus on other things, (e.g. work, friendship)
Kanstrup et al. (2021b)	Exploratory open-label pilot RCT	Adults who experienced a traumatic event resulting in them being admitted to an emergency department. Intervention group ($n=20$), control group ($n=19$)	Intervention: Memory reminder + visuospatial interference task for 20 min (Tetris, with mental rotation) Control: listen to a podcast for 20 min	Work and Social Adjustment Scale – self-rated (WSAS; Mundt et al., 2002) *1 week, and 1, 3 and 6 months*	X	A comparison of the mean scores for both groups suggested no difference in functional outcomes. However, there was no statistical analysis of the data, nor description of the data in the text

Table 1 (continued)

Article details	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed	Findings in answer to the question: Do interventions specifically targeting intrusive memories of trauma lead to improved functioning?
Kessler et al. (2018)	Single case series A within-subjects multiple baseline AB design	Patients with longstanding complex PTSD ($N=20$) in inpatient treatment	Weekly sessions (5–10 weeks), of a memory reminder for a specific intrusion + 25-min Tetris gameplay	X	X	-
Iyadurai et al. (2018)	RCT	Patients who presented to a UK emergency department ≤ 6 h of a motor vehicle accident. Intervention group ($n=37$), control group ($n=34$)	Intervention: reminder cue for the trauma + Tetris gameplay Control: written activity log	X	X	-
Looney et al. (2020)	Single-case design	Adults with PTSD ($N=7$) experiencing intrusive memories and doing trauma-focused CBT with an ImRs component in a routine clinical setting	Imagery rescripting for 1 intrusive image. Maximum 3 sessions	X	X	-

Table 1 (continued)

Article details	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed	Findings in answer to the question: Do interventions specifically targeting intrusive memories of trauma lead to improved functioning?
Singh et al. (2021)	Mixed methods exploratory pilot study	Swedish nurses ($N=3$) who worked clinically in a hospital in the COVID-19 pandemic, who experienced intrusive memories from traumatic events at work	1 meeting to teach use of the digital intervention (brief memory reminder + visuospatial interference task); self-guided intervention use was promoted (option for researcher support in week 1)	X	Rating question: 'During the previous month how much did your intrusive memories of the traumatic event affect your functioning (social, occupational or other important areas, e.g. relationships with other people, work, parenting, schoolwork, housework, volunteer work etc.)?' 11-point scale from 0 not at all to 10 extremely 2 items measuring total number and number of full workdays on sick leave because of reason for seeking health care Free text response questions related to work situation. At baseline, what type of health care they work with right now. At follow-up, whether their work situation changed and how *Baseline, 1 week and 1 month*	'From baseline to 1 month post-intervention, 2 participants reported that the impact of intrusive memories on functioning decreased (from 5 [P1] or 2 [P3] out of 10 at baseline to 0 at 1 month), and it remained low for P2 (1 out of 10 at baseline and 1 month).' (Singh et al., 2021; p.10) No participants reported taking sick leave at any of the measured time points No participants reported a change to their work situation

Table 1 (continued)

Article details	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed	Findings in answer to the question: Do interventions specifically targeting intrusive memories of trauma lead to improved functioning?
Thorarinsdottir et al. (2021)	Single-case study	A woman from Iceland experiencing intrusive memories to a traumatic event in childhood ($N=1$)	6 intervention sessions of a brief memory reminder (of a specific memory to target) + Tetris gameplay for 25 min using mental rotation	Sheehan Disability Scale (SDS) – self-rated (Sheehan, 1983) *Baseline, last intervention session, and 1- and 3-month follow-up*	Open-ended question: 'How have the intrusive memories affected your ability to function in your daily life in the past week?' Rating question: 'Have the intrusive memories affected your ability to function in your daily life?' 11-point scale, higher score = greater impact on functioning *Baseline, last intervention session, and 1- and 3-month follow-up*	SDS score did not change from pre- to post-treatment, reduced at 1-month follow-up and was 0 at 3 months. The score on the rating question reduced at each timepoint from baseline and was 0 at follow-up. Participant's open-ended response at baseline: 'I don't sleep very well, and that leads to fatigue which interferes with my daily functioning.' (Thorarinsdottir et al., 2021; p11); response at later stages did not reference functioning

Table 1 (continued)

Article details	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed	Findings in answer to the question: Do interventions specifically targeting intrusive memories of trauma lead to improved functioning?
Thorarinsdottir et al. (2022)	A single case series using a repeated AB design	Women in Iceland ($N=3$) who had ≥ 1 intrusive trauma memory that occurred ≥ three times per week for 4 weeks	Up to 6 sessions of a cognitive task (memory reminder cue + 25 min of Tetris gameplay using mental rotation)	SDS – self-rated (Sheehan, 1983) *Baseline, last intervention session and 1-month follow-up*	Rating question: 'Have the intrusive memories affected your ability to function in your daily life?' 11-point scale, higher score = greater impact on functioning Open-ended question: 'Have the intrusive memories affected your ability to function in your daily life in the past week? If yes, how?' *Baseline, last intervention session and 1-month follow-up*	SDS scores reduced for 2 participants from baseline to post-intervention to 1 month but increased again for 1 at 3 months. Scores on the rating question showed improvement over the intervention and follow-up periods. For the open-ended question, one participant described the impact on interpersonal relationships. Most responses described the impact of intrusive memories emotionally, rather than functionally

Table 2 Summary of studies for which findings were not published at the time of the review and their measurement of functioning

Article or CTR	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed
NCT 03525158 PI: Holmes Status: Completed SD: 06/2017 CD: 02/2018	Single-case AB design with or without optional replication (ABAB)	Refugees and asylum seekers ($N=4$) aged 16 to 25 years, experiencing intrusive trauma memories	1 session of a cognitive task (memory cue, 10-min time gap and ca. 20 min of Tetris game play)	X	Open-ended question 'How do intrusive memories interfere with your ability to settle into this country and learn new skills, such as a new language?' *Baseline, week 1 and intervention week 1*
NCT 04186962 PI: Chalder & McCormack Status: Completed SD: 03/2019 CD: 04/2020	RCT	Parent of a child in a paediatric intensive care unit ($N=19$)	Intervention group: a memory reactivation cue + computer game Tetris Control group: usual care	X	X
NCT 04342416 PI: Björnsson Status: Completed SD: 09/2020 CD: 09/2021	A single-case series using a within subject multiple baseline AB design	Women in Iceland ($N=10$) who had ≥ 1 intrusive trauma memory that occurred ≥ 3 times per week	Max. 6 intervention sessions of a cognitive task (memory cue + 25 min of Tetris gameplay with mental rotation)	SDS-self-rated (Sheehan, 1983) *Baseline, post-intervention and 1-month follow-up*	Open-ended question: 'Have the intrusive memories affected your ability to function in your daily life in the past week? If yes, how?' Rating question: 'Have the intrusive memories affected your ability to function in your daily life?' 11-point scale, higher score = greater impact on functioning *Baseline, post-intervention and 1-month follow-up*
NCT 04394156 PI: Greenfield Status: Terminated SD: 07/2020 CD: 04/2021	Multiple baseline case series design (AB)	Refugees and asylum seekers with PTSD ($N=6$), seeking treatment at an NHS service	Ca. 5 sessions of a memory reminder cue, 10-min time gap and ca. 20-min Tetris	WHODAS 2.0 12 item version—rater unspecified (Üstün et al., 2010) *Baseline and 2 weeks post-intervention*	Measure developed by the NHS Service: The Social and Occupational Tally (SOAT). Asks how many hours the person spent doing activities in the past 2 weeks, e.g. domestic chores, exercise, cultural activities. Higher score = better outcome *Baseline, 2 weeks post-intervention and 2 months post-intervention*

Table 2 (continued)

Article or CTR	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed
NCT 04394832 PI: Greenfield Status: Terminated SD: 02/2020 CD: 05/2020	Multiple baseline case series design (AB)	Refugees and asylum seekers with PTSD ($N=4$), seeking treatment at an NHS service	Ca. 5 sessions of a memory reminder cue, 10-min time gap and ca. 20-min Tetris	WHODAS 2.0 12 item version—rater unspecified (Üstün et al., 2010) *Baseline and 2 weeks post-intervention*	Measure developed by the NHS Service: The Social and Occupational Tally (SOAT). Asks how many hours the person spent doing activities in the past two weeks, e.g. domestic chores, exercise, cultural activities. Higher score = better outcome *Baseline and 2 weeks post-intervention*
NCT 04709822 PI: Björnsson Status: Completed SD: 01/2021 CD: 09/2021	A single case series using a within-subjects multiple baseline AB design	Women in Iceland ($N=12$) who had ≥ 2 intrusive trauma memories over the previous week	2–6 remote sessions of a simple cognitive task (memory cue + 25 min of Tetris gameplay with mental rotation)	WHODAS 2.0 12 item version—self-rated (Üstün et al., 2010) Sheehan Disability Scale – self-rated (SDS; Sheehan, 1983) *Baseline, week 1, and 1 and 3-month follow-ups*	Open-ended question: 'Have the intrusive memories affected your ability to function in your daily life in the past week? If yes, how?' Rating question: 'Have the intrusive memories affected your ability to function in your daily life?' 11-point scale, higher score = greater impact on functioning Two items measuring total number and number of full workdays of sick leave the participant has taken over the past four weeks *Baseline, week 1 and, 1- and 3-month follow-ups*
NCT 04769999 PI: Steel Status: Completed SD: 06/2020 CD: 10/2020	Case series	NHS hospital and pre-hospital clinical staff ($N=14$) experiencing problematic intrusive memories	Brief memory reminder cue + Tetris gameplay for 25 min using mental rotation. Option for subsequent booster sessions	X	Rating question: 'How much have your intrusive memories affected your ability to function in your daily life?' 11-point scale from 0 ('not at all') to 10 ('a great deal'). Higher scores = greater impact/difficulties Open-ended question: 'Have your intrusive memories affected your ability to function in your daily life in the past week?' *1 week pre-intervention, and 4 weeks post-intervention*

Table 2 (continued)

Article or CTR	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed
NCT 04992390 PI: Holmes Status: Completed SD: 08/2021 CD: 06/2022	Randomised optimisation trial	Adults in a clinical role in an NHS Intensive Care Unit ($N=106$) in the COVID-19 pandemic, who experienced intrusive memories from traumatic events at work	Immediate Intervention: Session of memory cue + digital imagery-competing task, with mental rotation instructions. Optional self-administered or guided sessions Delayed intervention: Usual care for 4 weeks, then the intervention	WHODAS 2.0 – 12-item version – self-rated (Üstün et al., 2010) *Baseline and 4 and 8 weeks*	An item looking at sickness absence. Total number of sick days in the last 4 weeks 2 items looking at participants' weekly work pattern: (i) number of days working, (ii) number of nights worked (both with responses from 0 to 7) *Baseline, and 4 and 8 weeks*
NCT 05089058 PI: Björnsson & Holmes Status: Completed SD: 11/2021 CD: 11/2022	Pilot, Parallel Groups, RCT	Women in Iceland ($N=13$) experiencing intrusive memories of a traumatic event	Experimental: Digitally delivered imagery-competing task (memory cue + imagery-competing computer game with mental rotation instructions) Placebo: Brief, digitally delivered relaxation task intervention	Sheehan Disability Scale (SDS) – self-rated (Sheehan, 1983) WHODAS 2.0 – 12-item version – self-rated (Üstün et al., 2010) *Baseline, week 1, and 1-, 3- and 6-month follow-ups*	Rating question, 'Have the intrusive memories affected your ability to function in your daily life?' using an 11-point scale; higher score = greater impact on functioning Open-ended question 'How have the intrusive memories affected your ability to function in your daily life in the past week?') *Baseline, week 1, and 1, 3- and 6-month follow-ups* At baseline – Open-ended questions: 'Are there any specific activities that you would like to do, but avoid because they are linked to your intrusive memories?' and 'What change in your intrusive memories would make a meaningful difference in your life?' At follow-ups – Open-ended question: 'Since starting the study, are there any specific activities that you used to avoid (due to your intrusive memories), but now do more often?'

Table 2 (continued)

Article or CTR	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed
NCT 05381155 PI: Horsch Status: Recruiting SD: 07/2022 ACD: 12/2024	Single-blind waitlist RCT	Women (Est. enrolment $N=120$) who report childbirth-related intrusive trauma memories, who gave birth ≥ 6 weeks	Immediate Treatment: Single-session behavioural intervention (brief evocation of childbirth memory + Tetris) Waitlist: Receive intervention on day 30	X	X
NCT 05616676 PI: Holmes Status: Recruiting ASD: 12/2022 ACD: 09/2023	Parallel Groups, RCT	NHS staff (Est. enrolment $N=150$) who experienced intrusive memories from traumatic events related to clinical work during the COVID-19 pandemic	Group 1: 24-week access to a digital imagery-competing task (Memory cue + computer game play with mental rotation) Group 2: 24-week access to a brief digital music-listening task Group 3: treatment as usual	WHODAS 2.0 – 12-item version – self-rated (Üstün et al., 2010) *Baseline, and 4, 12 and 24 weeks*	Self-reported number of sick days taken from work in the last 4 weeks *Baseline, 4 weeks, 12 weeks and 24 weeks*
Kanstrup et al. (2021c)	*RCT* *Terminated Study. No data analysed*	Adults who had experienced or witnessed a traumatic event resulting in admission to the emergency department	Intervention group: memory cue + the computer game Tetris with mental rotation instructions Control group: podcast for a similar time	WHODAS 2.0—version and rater unspecified (Üstün et al., 2010) *1 week and 1-, 3- and 6-month follow-up*	One bespoke self-rated question on the impact of daily functioning associated with intrusive memories. Rated on an 11-point scale from 0 (none), 5 (some), 10 (extreme/much). Higher scores = greater functional impairment *1 week and 1-, 3- and 6-month follow-up*
Sandoz et al. (2019)	Double-blind multicentre RCT	Women who had an emergency caesarean section (Estimated enrolment $N=144$)	Intervention: brief behavioural procedure including playing Tetris Control group: written activity log	Mother-to-Infant Bonding Scale – self-rated (MIBS; Taylor et al., 2005) *1-week, 6-week and 6-month follow-up* Emotional Availability Scale – clinician rated (EAS; Biringen, 2008) *6-month follow-up*	X

Table 2 (continued)

Article or CTR	Design	Sample	Treatment conditions	Validated measure(s) of functioning and timepoint(s) completed	Unvalidated measure(s) of functioning and timepoint(s) completed
Singh et al. (2022)	A parallel groups, two-arm RCT	Healthcare staff (Est. enrolment *N* = 164) who experience intrusive memories of work-related traumatic event(s) during the COVID-19 pandemic	Digitalized self-administered materials (e.g. video instructions) and guided (remote) support from a researcher Intervention: memory reminder cue + Tetris with mental rotation instructions + Booster sessions Control group: podcast for a similar time	WHODAS 2.0 – 12-item version – self-rated (Üstün et al., 2010) *6 months*	2 items (Iyadurai et al., 2019) on the impact intrusive memories have on occupational functioning or daily functioning in other areas of life (e.g. social, housework, parenting). 11-point scale (0 'no impact' to 10 'extreme impact') + free text response Two items measuring the total number and the number of full workdays on sick leave because of reason for seeking healthcare. Higher numbers = more sick leave Free text response related to work situation. Day 1, type of health care they work with right now. Follow-up, whether their work situation changed and if yes, how *Baseline, 1 week and 1, 3 and 6 months* Week 5, 2 open-ended questions, (1) example of how a specific intrusive memory has had a negative impact on functioning; (2) how a specific intrusive memory reducing has had a positive impact on functioning

Description of codes/abbreviations: X = no measure used; *PI*, principal investigator; *SD*, study start date (mm/yyyy); *CD*, study completion date (mm/yyyy); *ACD*, study anticipated completion date (mm/yyyy)

outcomes were described and reported there) or CTR, or (ii) which arguably indexed functioning, defined as activities and participation (WHO, 2001), was included, despite the measure not being developed specifically as a measure of functioning, and the authors not labelling it as such. In order for a measure to be eligible for inclusion, it needed to be a complete measure of functioning (i.e. not just one item related to functioning, amongst other unrelated items), unless it was clear data for the functioning question(s) would be presented separate to the total score. For example, the Psychological Outcomes Profile (PSYCHLOPS; Ashworth et al., 2004) asks the respondent to indicate problems that trouble them the most and what is difficult for them to do because of them: Thus, whilst a question within this measure is relevant to functioning (i.e. what is difficult for the person to do), other questions are unrelated to functioning, and as the data is usually presented as a total score, the measure has not been included.

Five of the 11 studies with published findings included a measure of functioning (Kanstrup et al., 2021a, b; Singh et al., 2021; Thorarinsdottir et al., 2021, 2022). One study that did not include a measure of functioning, did, however, report some qualitative information related to functioning (Hossack & Bentall, 1996). Twelve of the 14 studies with unpublished findings (NCT03525158; NCT04342416; NCT04394156; NCT04394832; NCT04709822; NCT04769999; NCT04992390; NCT05089058; NCT05616676; Kanstrup et al., 2021c; Sandoz et al., 2019; Singh et al., 2022) specified a measure of functioning.

How is Functioning Measured?

We classified instruments used to measure functioning as either: (1) known to be validated or (2) unvalidated or validity unknown. In published articles (Kanstrup et al., 2021a, b; Sandoz et al., 2019; Singh et al., 2021, 2022; Thorarinsdottir et al., 2021, 2022), it was usually clear when a measure was validated or unvalidated: validated measures had citation(s) of studies reporting their psychometric properties. One study (Kanstrup et al., 2021c) did not provide information about the secondary outcome measures in the article, referring the reader instead to their CTR, which did not provide a reference for the validated measure of functioning used. Whilst some CTRs included citation(s) for validated measures and acknowledged when a measure was 'bespoke' (NCT04394156; NCT04394832; NCT04769999), most did not consistently (NCT03525158; NCT04342416; NCT04709822; NCT04992390; NCT05089058; NCT05616676). When a measure was known to be validated (e.g. The Sheehan Disability Scale, SDS; Sheehan, 1983), it was classified as such. All other measures were categorised as 'unvalidated or validity unknown'. Most of these measures consisted of single questions, so were likely unvalidated and bespoke (i.e. developed for the purpose of that study).

Validated Measures of Functioning

Of the five studies with published findings that included a measure of functioning, four used a validated measure (Kanstrup et al., 2021a, b; Thorarinsdottir et al., 2021,

2022), and of the 12 studies with unpublished findings that included a measure of functioning, 10 employed validated measures (NCT04342416; NCT04394156; NCT04394832; NCT04709822; NCT04992390; NCT05089058; NCT05616676; Kanstrup et al., 2021c; Sandoz et al., 2019; Singh et al., 2022).

Two types of functioning measures were administered: those measuring functioning broadly across multiple domains and those capturing specific domains of functioning. Three different broad measures of functioning were used: the World Health Organisation Disability Assessment Schedule 2.0 (WHODAS 2.0; Üstün et al., 2010), the SDS (Sheehan, 1983) and the Work and Social Adjustment Scale (WSAS; Mundt et al., 2002). Two domain-specific measures were used: the Mother-to-Infant-Bonding Scale (MIBS; Taylor et al., 2005) and the Emotional Availability Scale (EAS; Biringen, 2008).

The WHODAS 2.0 (Üstün et al., 2010) was the most commonly used measure of functioning, included in nine studies (NCT04394156; NCT04394832; NCT04709822; NCT04992390; NCT05089058; NCT05616676; Kanstrup et al., 2021a, c; Singh et al., 2022). The WHODAS 2.0 was developed to reflect the ICF model of disability (WHO, 2001) and assesses limitations on activity and restrictions on participation, irrespective of medical diagnosis. Although there are nine domains within the ICF's model of activity and participation (WHO, 2001), on the WHODAS 2.0, these are condensed into six domains: cognition, mobility, self-care, getting along, life activities and participation. There are multiple versions of the WHODAS 2.0, differing in length (e.g. 12, 12 + 24 or 36 items), and mode of administration (e.g. self-report or proxy, i.e. family, friend or carer). The 36-item version generates scores for six domains of functioning, as well as an overall functioning score. Whilst the 12-item version only generates an overall functioning score. The 12 + 24 version enables the researcher to screen for problematic domains of functioning to inform which domains of functioning to ask further questions about. Each version includes additional questions about how many days the person was unable to carry out, or had to cut back, their usual activities. The 12-item version was used in 8 studies (NCT04394156; NCT04394832; NCT04709822; NCT04992390; NCT05089058; NCT05616676; Kanstrup et al., 2021a; Singh et al., 2022), whilst in one study (Kanstrup et al., 2021c) the version used was not specified. The self-report version was used in 6 studies (NCT04709822; NCT04992390; NCT05089058; NCT05616676; Kanstrup et al., 2021a; Singh et al., 2022). Whilst in 3 studies (NCT04394156; NCT04394832; Kanstrup et al., 2021c), the version used was not stated, it was assumed (based on the wider study description) that the self-report version had been administered.

The SDS (Sheehan, 1983), used in five studies (NCT04342416; NCT04709822; NCT05089058; Thorarinsdottir et al., 2021, 2022), includes three self-rated items. Individuals rate how much, on a scale from 0 (not at all) to 10 (extremely), their symptoms have disrupted their work/school, social life/leisure activities and family life/home responsibilities. The three items can be summed into a single score of functional impairment from 0 (unimpaired) to 30 (highly impaired). There are two additional questions, which ask (i) on how many days in the last week the person missed school, work or were unable to carry out their normal daily responsibilities, and (ii) on how many days in the last week the person felt so impaired by their

symptoms, that even though they went to school, work or had other daily responsibilities, their productivity was reduced. In the 5 studies using the SDS, the scale was modified to assess impairment associated with intrusive memories.

The WSAS (Mundt et al., 2002) was used in one study (Kanstrup et al., 2021b). It includes 5 self-rated items. Individuals rate how much, on a scale from 0 (not at all) to 8 (very severely), their problem has impaired their ability to work, home management, social leisure activities, private leisure activities and ability to form and maintain close relationships. The five items can be summed into a single score of functional impairment from 0 to 40, with higher scores indicating more functional impairment.

Two validated measures were used to index functioning in the specific domain of interpersonal interactions and relationships. The Mother-to-Infant-Bonding Scale (MIBS; Taylor et al., 2005), employed by Sandoz et al. (2019), has eight self-rated items assessing the feelings of a mother towards her new baby. The emotional availability scale (EAS; Biringen, 2008), used by Sandoz et al. (2019), is a clinician-rated instrument which assesses (through observation of a free-play session) whether the mother and child share an emotionally healthy relationship.

To summarise, most validated instruments used in the reviewed studies measured functioning broadly, across multiple domains. Measures were brief, with self-report items having between three and 12 items. Whilst the WHODAS 2.0 assessed a wide range of activity and participation domains (WHO, 2001), the SCS and WSAS assessed four: domestic life, interpersonal interactions and relationships, major life areas and community, social and civic life. Only one study (Sandoz et al., 2019) included validated instruments indexing functioning in a specific domain. The majority of measures were self-report, whilst just one measure (EAS; Biringen, 2008) was clinician-rated.

Measures of Functioning Which are Unvalidated or Their Validity is Unknown

Measures which are known, or assumed, to be unvalidated were also utilised to assess functioning (for simplicity, referred to as unvalidated measures). Of the five studies with published findings that included a measure of functioning, in four an unvalidated measure was used (Kanstrup et al., 2021a; Singh et al., 2021; Thorarinsdottir et al., 2021, 2022); of the 12 studies with unpublished findings that included a measure of functioning, an unvalidated measure was used in 11 of them (NCT03525158; NCT04342416; NCT04394156; NCT04394832; NCT04709822; NCT04769999; NCT04992390; NCT05089058; NCT05616676; Kanstrup et al., 2021c; Singh et al., 2022). Unvalidated measures were used in combination with a validated measure of functioning in the majority of studies (only three studies did not, i.e. NCT03525158; NCT04769999; Singh et al., 2021). As per our classification of validated measures of functioning, we also categorised unvalidated measures into those that measured functioning broadly (across multiple domains) and those which captured specific domains of functioning.

Twelve studies included an unvalidated measure which assessed functioning broadly across multiple domains (NCT04342416; NCT04394156; NCT04394832; NCT04709822; NCT04769999; NCT05089058; Kanstrup et al., 2021a, c;

Singh et al., 2021, 2022; Thorarinsdottir et al., 2021, 2022). Ten of these studies included a self-report rating question. Six studies (NCT04342416; NCT04709822; NCT04769999; NCT05089058; Thorarinsdottir et al., 2021, 2022) included the rating question 'Have the intrusive memories affected your ability to function in your daily life?' using an 11-point scale, with higher scores indicating a greater impact on functioning. One study (Kanstrup et al., 2021c) did not specify the exact wording of question but noted that participants rated the impact of intrusions on daily functioning. Several studies defined what was meant by functioning within the rating question: Kanstrup et al. (2021a) asked 'When you played Tetris, did it help you not think about your problems so that you could focus on for example your work or school or maintaining a friendship?'; Singh et al. (2021) asked 'During the previous month how much did your intrusive memories of the traumatic event affect your functioning (social, occupational, or other important areas, e.g. relationships with other people, work, parenting, schoolwork, housework, volunteer work etc.)?'; and Singh et al. (2022) asked about the impact of intrusive memories on daily functioning in other areas of life (aside from occupational functioning), e.g. social, housework, parenting.

In seven studies participants had the opportunity to report on their functioning in an open-ended response. Six studies (NCT04342416; NCT04709822; NCT04769999; NCT05089058; Thorarinsdottir et al., 2021, 2022) included the open-ended question: 'Have the intrusive memories affected your ability to function in your daily life in the past week? If yes, how?'. Singh et al. (2022) provided participants with a free text response box in which to provide details. In addition, they asked participants for an example of how a specific intrusive memory had a negative impact on functioning, and if a specific intrusive memory had reduced, how this had a positive impact on functioning. Participants' engagement in activities was assessed in three studies. In one study (NCT05089058), participants were asked 'Are there any specific activities that you would like to do but avoid because they are linked to your intrusive memories?' and 'What change in your intrusive memories would make a meaningful difference in your life?' at baseline, and 'Since starting the study, are there any specific activities that you used to avoid (due to your intrusive memories), but now do more often?' in follow-up assessments. Two studies (NCT04394156; NCT04394832) included a measure developed by the NHS service conducting the research, The Social and Occupational Tally (SOAT), which asks how many hours the person spent doing various activities in the past two weeks (e.g. domestic chores, exercise, cultural activities), with a higher score indicating increased activity.

Seven of the studies included an unvalidated measure capturing specific domains of functioning. Primarily (i.e. in six studies), this approach was adopted when a particular subdomain of functioning was pertinent to the population of interest; e.g. occupational functioning when the sample were healthcare staff who experienced intrusive memories related to trauma at work, or ability to settle into the country and learn a new language when the sample were refugees. Of the five studies that included healthcare staff experiencing intrusive memories related to trauma experienced in the work context (NCT04769999; NCT04992390; NCT05616676; Singh et al., 2021, 2022), four (NCT04992390; NCT05616676; Singh et al., 2021,

2022) included measures related to occupational functioning. This included items asking about sick leave from work, and questions assessing changes to the participants work. For example, at baseline, Singh et al. (2021, 2022) asked participants what type of health care they worked with right now, then at follow-up they asked participants if their work situation had changed, and if yes, how. Participants were asked about their weekly work pattern at different timepoints in one study (NCT04992390). One study (Singh et al., 2022) included a bespoke rating question assessing the impact of intrusions on work-related functioning on an 11-point scale from 0 (none) to 10 (extreme/much), with higher scores indicating greater functional impairment. Only one study (NCT04709822) (which notably was not investigating work-related traumatic events) also included a measure related to occupational functioning, which consisted of two items asking about sick leave from work. Of the four studies with refugee participants (NCT03525158; NCT04394156; NCT04394832; Kanstrup et al., 2021a), two (NCT03525158; Kanstrup et al., 2021a) included the open-ended question: 'How do intrusive memories interfere with your ability to settle into this country and learn new skills, e.g. a new language?' This item specifically examined how intrusive memories impacted the refugees' ability to settle and integrate into their host country.

In sum, a variety of unvalidated questions were used to assess functioning across studies. Some questions asked about functioning broadly (e.g. ability to function in daily life) whilst others asked about specific domains of functioning (e.g. occupational functioning). Some questions were anchored specifically to intrusive memories (e.g. asking how intrusive memories impacted the person's ability to function), others anchored the question to the intervention (e.g. the impact of playing Tetris on functioning), and others did not anchor the question to any specific symptom or intervention. Questions varied in the type of response they elicited, including rating, open response and objective measures of performance (i.e. number of days off sick from work).

Do Interventions Specifically Targeting Intrusive Memories of Trauma Lead to Improved Functioning?

There is little data available to answer the secondary question of whether interventions specifically targeting intrusive memories of trauma lead to improved functioning. Only five studies with published findings included measures of functioning as outcomes (Kanstrup et al., 2021a, b; Singh et al., 2021; Thorarinsdottir et al., 2021, 2022). The findings of four of these studies (Kanstrup et al., 2021a; Singh et al., 2021; Thorarinsdottir et al., 2021, 2022) indicated that such interventions may lead to some improvements in functioning (see Table 1 for further information). However, as case studies/case series, these studies had small samples ($N=4$, $N=3$, $N=1$ and $N=3$, respectively) and all included unvalidated measures. Although all four studies presented scores from validated measures of functioning, none included statistical analyses of the data, but instead utilised descriptive approaches. It was difficult to draw any conclusions from the data presented by Kanstrup et al. (2021b), as no descriptive or statistical analyses related to their measurement of functioning

were provided. Despite not including functional outcomes, one study (Hossack & Bentall, 1996) included qualitative information about functioning, which suggested improved functioning for several participants following the intervention (4/5). However, this was a small sample ($N=5$), and the information about functioning was not obtained via an outcome measure.

In summary, as only five studies with published findings included functional outcomes (Kanstrup et al., 2021a, b; Singh et al., 2021; Thorarinsdottir et al., 2021, 2022), and all had methodological limitations which influenced the conclusions that could be drawn (e.g. sample size, data analysis approach), the question of whether interventions specifically targeting intrusive memories lead to improved functioning could not be answered definitively on the basis of current evidence.

Discussion

There has been a call for active innovation to develop low-cost and simple treatments to increase access to treatment for people who experience psychological distress following trauma. Network analyses of PTSD, and cognitive neuroscience models of memory consolidation and reconsolidation, have highlighted the potential of novel treatments specifically targeting intrusive memories. Following initial laboratory studies, research has recently been translated into clinical settings. Whilst this literature is in its relative infancy, it is timely to review whether and how functional outcomes have been measured in this literature to date, to ensure their rigorous and meaningful assessment in future research.

Our first aim was to examine whether studies evaluating interventions targeting intrusive memories of trauma included measures of functioning—and for those that did, to provide an overview and evaluation of the measurement approaches adopted. Although less than half of the studies with published findings included a measure of functioning, the majority of studies with unpublished findings (i.e. recently completed or ongoing studies) did. This suggests that researchers are shifting towards prioritising the measurement of functioning as an outcome in this area of research, mirroring the trend in the wider clinical literature with the inclusion of functional outcomes gaining traction in clinical trials of psychotherapy for PTSD (Bonfils et al., 2022). Our secondary aim was to note whether the interventions resulted in improvements in functioning. However, as only five studies with published findings included functional outcomes and all had methodological limitations which influenced the conclusions that could be drawn (e.g. sample size, data analysis approach), the question of whether interventions specifically targeting intrusive memories lead to improved functioning could not be answered definitively on the basis of current evidence.

A number of key issues emerged regarding the current status of measuring functioning in this area: (1) There is currently no consensus in the literature on how the term functioning is defined, which may lead to discrepancies in results across studies. (2) Functional outcomes are not consistently measured in a rigorous or informative way (e.g. use of measures which may not capture meaningful change, and use of unvalidated measures). (3) Many studies are not designed in a way which

enables researchers to answer questions about the impact of treatment on functional outcomes. These issues are important to address to ensure that future research has scope to provide a full understanding of the impact of interventions targeting intrusive memories. Each of these issues will now be discussed in turn, and ways that researchers can address them, in order to take the literature forward, will be proposed.

We Need a Universally Agreed Upon Definition of Functioning

Whilst the term 'functioning' is commonly used, no universally agreed upon definition exists (Endicott & Dorries, 2009; Ro & Clark, 2009). This is problematic, as studies may use the same term whilst measuring markedly different constructs. Whilst all instruments labelled a measure of 'functioning' in reviewed studies were considered to fit the definition we adopted (i.e. activities and participation; WHO, 2001), often outcome criteria were not explicitly labelled. Indeed, several instruments were not labelled as a measure of functioning by the authors but met this definition, e.g. the EAS (Biringen, 2008) and MIBS (Taylor et al., 2005) were labelled as measures of mother–child interaction, which fits within the activity and participation domain of interpersonal interactions/relationships (WHO, 2001) so were classed as an index of functioning for the purpose of our review. Furthermore, many studies included outcome measures which were not eligible for inclusion as a measure of functioning in this review, as they measured what was deemed to be a related but different construct. For example, whilst sickness absence was included as a measure of occupational functioning, outcome measures assessing satisfaction with, or the emotional impact of, work (e.g. the Scale of Work Engagement and Burnout, SWEBO; Hultell & Gustavsson, 2010) were not.

Conversely, some published studies (Kanstrup et al., 2021a, b; Singh et al., 2021) conceptualised other measures (e.g. concentration) as functional outcomes in their discussion, although they were not labelled as a measure of functioning and did not fit the definition adopted in our review. Given that concentration is a symptom of PTSD, arguably these studies conflated symptom improvement and functional gains. However, we acknowledge that disentangling symptoms and functioning is difficult. Indeed, even validated measures of functioning have been criticised for conflating symptoms and functioning (Bovin et al., 2018; Üstün & Kennedy, 2009). For example, the WHODAS 2.0 includes a question about difficulty concentrating on tasks. Whilst concentration is classified as a psychological function (i.e. a symptom) in the ICF (WHO, 2001), focusing attention, i.e. 'intentionally focusing on specific stimuli' (WHO, 2001; p.130) is classified as activity and participation. This highlights how a lack of conceptual consistency has implications for the measurement of functioning. Whilst attempts have been made to develop measures of functioning which reduce conflation (e.g. Inventory of Psychosocial Functioning, IPF; Bovin et al., 2018), further work is needed.

In sum, variations in how a construct is both defined and subsequently measured may lead to discrepancies in results across studies (Coster, 2013). To synthesise the findings of studies evaluating interventions for intrusive memories and

understand whether they are effective in improving functioning, it first is imperative that researchers arrive at a consensus on a definition of functioning which is more independent of symptoms and other related constructs. Whilst the ICF (WHO, 2001) has attempted to do this, there are still gaps in the field that need to be addressed to improve the measurement of functioning (Leonardi et al., 2022; Madden & Bundy, 2019).

We Need to Better Measure Functioning

A second key issue to emerge is that researchers need to better measure functioning.

When Selecting an Outcome Measure Researchers Need to Consider More Than Whether the Measure is Validated

Whilst it is promising that most studies which included a measure of functioning utilised one which was validated and known to be responsive to change, the measures employed nonetheless had several shortcomings. For example, some instruments consisted of a list of pre-defined items, with set response options. It is possible that such instruments may have included items that were irrelevant for some participants, and also not included items that were highly relevant (Sales & Alves, 2016). For example, the SDS (Sheehan, 1983) and WSAS (Mundt et al., 2002) do not ask about all activity and participation domains (WHO, 2001), so may miss important aspects of functioning. Furthermore, the phrasing of items may be more relevant to individuals of certain cultures and ages, and thus be less sensitive to functional changes within other groups. For example, for the category of 'social leisure activities' on the WSAS, examples include 'parties, bars, clubs, dating, home entertaining' which may be less relevant to older individuals and those from a non-western culture, in which individuals may instead spend time engaging in community activities (Mgonja, 2020).

Also, all of the measures utilised give a 'total' score of functional impairment. Although this makes it easier to interpret the measure and compare across studies, changes may only be seen on a small sub-set of items, which may be overlooked when focusing on an overall score (Coster, 2013). Relatedly, as questions on the SDS (Sheehan, 1983) and WSAS (Mundt et al., 2002) ask about broad concepts (e.g. occupational functioning), smaller changes may be negligible (e.g. contribute to a 1-point difference). However, even small gains in functioning (e.g. having a shower) may be significant, and may be a first step toward larger functional gains (e.g. getting a job). It is important that researchers utilise instruments that are sensitive to small functional gains, given the brevity of interventions targeting intrusive memories, in order to gauge their functional impact. Furthermore, it is important that the follow-up period is sufficient for functional changes to emerge. It was therefore encouraging to see that most reviewed studies assessed functional outcomes at follow-up, with several studies including a follow-up 6 month post-intervention.

Several approaches could be employed to overcome these shortcomings. One potential way to capture personal, meaningful change is to use individualised

patient-generated measures. Whilst these tools have a standardised structure, the patient defines the specific content to be evaluated, i.e. issues of personal relevance, rather than pre-defined items (Sales & Alves, 2016). One example is the Psychological Outcomes Profile (PSYCHLOPS; Ashworth et al., 2004), which is well validated and highly sensitive to change (Ashworth et al., 2005). The measure asks the respondent to indicate problems that trouble them the most, and what task/s are difficult for them to do because of them. The individual can then rate, at different time points, how difficult it has been to do that task or activity. This measure, utilised by NCT04992390 and NCT05089058, was excluded from inclusion in this review, as it only includes one item related to functioning (amongst other unrelated items) and was thus not deemed to be a complete measure of functioning. However, if the data are analysed and presented in a way that enables researchers to comment on functioning (i.e. scores are presented for the functioning question, as well as a total score), this could be a useful inclusion in future work. In addition, several validated measures of functioning (e.g. IPF, Bovin et al., 2018; WHODAS 2.0 12 + 24 version, Üstün et al., 2010) have been developed whereby only questions or subscales relevant to the individual are asked, reducing the likelihood that change is obscured by irrelevant items. Furthermore, measures could be utilised whereby different levels of functioning are assessed to capture both small and large functional gains: One such example is the Daily Activity Report (DAR; Velligan et al., 2016), which scores activities within a domain (e.g. work or school) based on the type of activity completed, with lower scores reflecting more basic activities (e.g. job searching) and higher scores reflecting higher level activities (e.g. paid employment).

It could also be useful for researchers to consider whether particular subdomains of functioning are pertinent to the population of interest, and if so, select instruments to measure them specifically (Coster, 2013). Indeed, Frawley et al. (2023) found that measures targeting specific aspects of functioning (e.g. employment activity) yielded a more sensitive estimate of change than global measures of functioning. Some of the reviewed studies measured specific subdomains of functioning relevant to their population: (i) in the one study with mothers who had recently experienced a traumatic childbirth (Sandoz et al., 2019), validated measures assessing the mother–child interaction were included, (ii) in four studies with healthcare staff experiencing intrusive memories of work-related trauma (NCT04992390; NCT05616676; Singh et al., 2021, 2022) participants completed (unvalidated) measures related to occupational functioning (e.g. amount of sick leave from work), and in (iii) two studies with refugee participants (NCT03525158; Kanstrup et al., 2021a) participants answered a bespoke open-ended question assessing how intrusive memories impacted their ability to settle and integrate into the host country. Assessing functioning in relevant subdomains may enable researchers to meaningfully capture functional gains in the population of interest, particularly when samples have been exposed to the same type of trauma (e.g. traumatic childbirth, healthcare professionals, road traffic accident). However, we acknowledge that this approach may be less feasible in samples who have been exposed to a range of trauma types.

Another limitation of the measures utilised is that some items may be open to interpretation and hold various meanings for different individuals (Sales & Alves, 2016). For example, one item on the WSAS asks how much the person's 'ability to

work is impaired' (Mundt et al., 2002). This could be interpreted differently across respondents, depending upon their expectations of what they should be able to do/achieve at work. One approach to overcome this potential subjectivity would be to select an instrument that asks more concrete, specific questions. For instance, the IPF (Bovin et al., 2018) asks multiple questions within each domain of functioning (e.g. within the domain of education: 'I arrived on time for my classes', 'I turned in assignments late'). These items are likely to be less ambiguous than one broad question (e.g. 'The symptoms disrupted my schoolwork'; SDS, Sheehan, 1983). Measures including specific questions also provide more detailed data, so will thus have more scope to quantify functional gains across specific domains following treatments targeting intrusive memories. For example, the 36-item version of the WHODAS 2.0 (Üstün et al., 2010) yields scores for six individual domains of functioning, rather than just a total score.

Similarly, the terms used as response options (e.g. mild, moderate, severe difficulties) are also open to interpretation and could mean different things to different people. One option is to select an instrument with objective responses. For example, several of the reviewed studies (NCT04394156; NCT04394832; NCT04709822; NCT04992390; NCT05616676; Singh et al., 2021, 2022) included objective measures, e.g. asked about hours spent doing various activities (NCT04394156; NCT04394832), number of days and nights worked (NCT04992390) or days off work sick (NCT04709822; NCT04992390; NCT05616676; Singh et al., 2021, 2022); however, they were unvalidated. The WHODAS 2.0 (Üstün et al., 2010) and SDS (Sheehan, 1983), utilised in many studies (NCT04342416; NCT04394156; NCT04394832; NCT04709822; NCT04992390; NCT05089058; NCT05616676; Kanstrup et al., 2021a, c; Singh et al., 2022; Thorarinsdottir et al., 2021, 2022), also include additional questions with objective responses (not included in the total score), asking about the number of days lost and days less productive. However, in the reviewed studies with published findings, data for these questions were not published. Analysis of the responses to these questions could provide useful information in future studies. The inclusion of validated instruments which objectively measure functioning will also strengthen future studies. One such measure is the Time Use Survey, originally used by the Office for National Statistics (Lader et al., 2006), and since adapted for use in clinical research (e.g. Hodgekins et al., 2015) which asks how many times a person engaged in specific activities within the categories of work, education, voluntary work, housework and childcare, leisure and sports. Another way to counteract the subjectivity of self-report measures is to gain additional perspectives (e.g. from a family member, carer, professional). Most of the studies reviewed only assessed the participants' perspectives; only one (Sandoz et al., 2019) included a clinician-rated outcome. Gaining multiple perspectives on functioning could lead to greater insights into the nature and degree of any functional gains at post-intervention.

Researchers Should Avoid the Use of Quantitative, Unvalidated Measures

A major critique of the reviewed studies was the frequent use of unvalidated measures of functioning. Without established psychometric properties, researchers cannot be

sure that instruments are reliable, valid or responsive to change, which may make it difficult to draw conclusions from the data. Open-ended questions, on the other hand, can provide rich, idiographic, qualitative data. Whilst idiographic data can be collected through individualised patient-generated measures (e.g. PSYCHLOPS; Ashworth et al., 2004), these instruments are limited by collecting quantitative data, so do not capture the same amount of rich data as open-ended questions. Summarising responses to their open-ended question, Kanstrup et al. (2021a) provided specific examples of functional changes reported by each participant following the intervention, e.g. 'the past week, I started to like to learn new words and reading and listening to the radio and TV' (Kanstrup et al., 2021a; p.11). This brought to life the impact the intervention had on the individual's life. However, a limitation of qualitative responses is that they do not quantify the extent of any change. Accordingly, we recommend that open-ended questions are used in conjunction with validated, quantitative measures.

When open-ended questions are used to assess functioning as an outcome, their wording should be carefully considered. For example, Kanstrup et al. (2021a) acknowledged that they should have asked about functional gains rather than functional impairment in order to have better captured what participants were able to do after the intervention. Also, in some instances, participants appeared to answer open-ended questions regarding how intrusive memories affected their ability to function in their daily life by referring to changes that (according to the definition of functioning we adopted) would not be classed as functioning; e.g. describing the impact of intrusive memories on emotions rather than on functioning (e.g. P5 reported, 'I get very stressed and anxious; it takes a lot of energy to get out of the emotion…' (Thorarinsdottir et al., 2022, p.15). Just as within the literature there is no universally agreed definition of functioning (discussed earlier), participants may too have differing views on what the word 'functioning' means.

In sum, a limitation of many of the reviewed studies was that researchers employed unvalidated quantitative measures. However, open-ended questions have the potential, if phrased correctly, to provide rich, idiographic data and could be used alongside validated instruments to index functional outcomes.

Functional Outcomes Need to Be Considered Within a Wider Context

It is important to acknowledge that the wider context in which the person or sample is situated will have an impact upon how much change in functioning is possible. Even when an intervention has potential to lead to large changes, the environmental context may not enable this. The ICF (WHO, 2001) argue that functioning is the interaction between health conditions and contextual factors, e.g. social attitudes and legal and social structures. This is significant to reflect on, as many of the reviewed studies with unpublished findings (i.e. recently completed or ongoing studies) will have taken place during the COVID-19 pandemic, and thus, participants may have been limited in their ability to function not by symptoms, but by legislation in their country (e.g. national lockdowns). Accordingly, findings regarding functional outcomes may be difficult to interpret for studies conducted within the context of the pandemic, highlighting the importance of considering functional outcomes within the wider social context. Madden and Bundy (2019) argued that assessment of functioning should include

measurement of environmental factors. Furthermore, personal factors such as age or gender may also impact functioning, as there may be cultural differences in terms of what is expected, or allowed, of people (e.g. Fehrmann et al., 2019). For these reasons, it is important that measures of functioning are anchored to the target symptom.

We Need to Better Design Studies to Enable Conclusions About Functioning to be Drawn

Whilst the central aim of this review was to consider ways in which functioning is measured, a secondary aim was to note whether interventions specifically targeting intrusive memories of trauma lead to improved functioning. Only five studies with published findings included functional outcomes (Kanstrup et al., 2021a, 2021b; Singh et al., 2021; Thorarinsdottir et al., 2021, 2022), and these studies had other methodological limitations which influenced the conclusions that could be drawn. Therefore, it was not possible to answer this secondary question. To move the field forward, not only do functional outcomes need to be measured effectively, but studies need to be designed in a way which gives researchers scope to answer interesting questions about the impact of treatment on functional outcomes—e.g. do interventions specifically targeting intrusive memories of trauma lead to functional gains? are changes in functioning mediated by a reduction in symptoms? is there a lagged effect between symptom change and functional change?

Limitations of this Review

This literature is in its infancy, so only a small number of studies met the inclusion criteria—even when studies with unpublished findings (protocol papers, terminated studies and CTRs), in addition to papers with published outcomes, were included. Whilst studies with unpublished findings increased the number of studies, their format (particularly for CTRs) limited the level of detail provided about the study. Some information pertaining to the measures of functioning utilised, which would likely be included in a published article, was missing. For example, not all CTRs included citation(s) for validated measures, acknowledged when a measure was bespoke or specified which version of a measure was being used.

Alternative measures of functioning which address some of the shortcomings highlighted have been referenced throughout the discussion. However, we note that we did not conduct an exhaustive search for other measures. A useful direction for future research could be to conduct a comprehensive literature search for outcome measures of functioning.

Conclusions

Functional outcomes are potentially important indicators of the effectiveness of an intervention (Kazdin, 1999; McKnight & Kashdan, 2009). Therefore, when evaluating novel interventions and assessing the clinical utility of interventions

developed within the laboratory, it is important functional outcomes are included. We considered it timely to review the inclusion of measures of functional outcomes in studies in this area to date, with a view to aiding future work. Whilst less than half of studies with published findings included a measure of functioning, the majority of studies with unpublished findings (i.e. recently completed or ongoing studies) did, suggesting researchers are starting to prioritise the measurement of functioning as an outcome in clinical research. However, a number of challenges in the measurement of functional outcomes have been highlighted which need to be addressed to move the field forward.

Based on this review, we make the following recommendations: (1) Researchers need to arrive at a consensus on a definition of functioning, more independent of symptoms. (2) Researchers should avoid using unvalidated measures of functioning. (3) When selecting a measure, more than validity needs to be considered, i.e. whether the measure will capture change meaningful for the participant. Consequently, it could be useful to include idiographic measures, alongside more general, validated measures of functioning. (4) The period of follow-up needs to be sufficient to ensure that if 'larger' functional gains occur, they are captured. (5) Studies need to be designed in a way that gives researchers scope to answer questions about the impact of treatment on functional outcomes. Measuring functional outcomes in a rigorous and meaningful way will enable researchers to effectively evaluate the broader impact of novel interventions outside of the laboratory, following real-world trauma.

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Declarations

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Authors and Affiliations

Emily M. Greenfield[1,2] · Oliver J. Mason[1] · Emily A. Holmes[3] · Kerry Young[4] · Michelle L. Moulds[5]

✉ Emily M. Greenfield
emily.greenfield@sabp.nhs.uk

[1] School of Psychology, University of Surrey, Surrey, UK

[2] Surrey and Borders Partnership (SABP) NHS Foundation Trust, England, UK

[3] Department of Women's and Children's Health, Uppsala University, Uppsala, Sweden

[4] Central and North West London (CNWL) NHS Foundation Trust, England, UK

[5] School of Psychology, UNSW Sydney, Sydney, Australia