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A single case series using visuospatial task interference to reduce the number of visual intrusive memories of trauma with refugees

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Abstract

The current worldwide so-called "refugee crisis" has led to an unprecedented increase in migration globally. Because of stigma and language barriers, mental health care for refugees is limited. There is a need for novel, scalable psychological interventions. We investigated whether a brief behavioural intervention involving a memory reminder cue and Tetris gameplay on a smartphone reduces intrusive memories in refugees using a single case ($N = 4$) ABAB withdrawal design. The baseline phase (A) included a no-intervention week; the intervention phase (B) included an in-person session with the researchers, comprised of the behavioural intervention followed by self-guided use in daily life the following week. All participants reported a decrease in intrusive memories after the intervention, as well as functional improvements (e.g., in concentration). Importantly, participants rated the intervention as feasible and acceptable. As one in-person session was effective in persistent intrusion reduction, ABAB proved not to be the optimal design as intrusions did not rebound in the withdrawal phase. Findings are promising and highlight the need for further evaluation of novel interventions for mental health problems in refugees.

KEYWORDS

behaviour therapy, intrusive memories, psychological trauma, refugees, single case design, smartphone

1 | INTRODUCTION

Global displacement rates are the highest ever recorded, and we face a mental health crisis (Abbott, 2016; United Nations High Commissioner for Refugees, 2018). In addition to fleeing war in their homeland, refugees face stressors including the journey itself and living in foreign countries (Salami, Salma, & Hegadoren, 2019). Their

posttraumatic stress disorder (PTSD) and depression rates are high (Leiler, Bjärtå, Ekdahl, & Wasteson, 2019; Tinghög et al., 2017).

Intrusive memories of trauma are a core symptom of PTSD (American Psychiatric Association, 2013). These memories typically comprise visual images and are recurrent, involuntary, distressing and interfere with functioning (Iyadurai et al., 2019). Refugees in Sweden reported significant numbers of intrusions per week ($M = 12.65$, $SD = 9.71$), with impact on concentration reported as one of their most disturbing effects (Holmes et al., 2017).

This study was prospectively registered in the Clinical Trials Registry, number NCT03760601.

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Simple, accessible and scalable mental health care interventions are needed (Kazdin & Rabbitt, 2013) particularly for refugees (Morina et al., 2018), who often have limited access to mental health treatment due to barriers such as stigma and language (Salami et al., 2019). In terms of language, first of all, psychological therapies such as cognitive behaviour therapy have a dominant focus on patients' cognitions in the form of verbal (rather than visual) thoughts. Second, communication between patient and therapist typically relies on verbal language. Both require language translation. Task-based interventions, which are less verbally focussed and more visual/action based, provide an alternative way of at least, in part, targeting visual cognition and reducing language barriers. Clinical guidelines suggest it may be beneficial to target single symptoms related to PTSD (National Institute for Health and Care Excellence NICE, 2018). Given the prevalence of intrusive memories in refugees, targeting intrusions (see Iyadurai et al., 2019) could also potentially produce downstream benefits on other symptoms (McNally, 2012).

A novel behavioural approach to reduce the number of intrusive memories has recently been developed: it includes a brief memory reminder procedure then a visuospatial interference task. Details differ according to whether it is delivered soon or after a longer time interval posttrauma (e.g., Iyadurai et al., 2018; Kessler et al., 2018). The theoretical rationale for the intervention is drawn from cognitive neuroscience models of memory reconsolidation (Monfils & Holmes, 2018; Visser, Lau-Zhu, Henson, & Holmes, 2018). According to such accounts, reactivating long-term memories can open a (transient) window of time in which such memories are labile and malleable, within the limits of certain boundary conditions (Besnard, Caboche, & Laroche, 2012). This period of malleability provides an opportunity for memories to be altered. The administration of an interfering visuospatial task while a trauma memory is labile is one strategy that has been hypothesized to reduce intrusive memories. Visuospatial tasks occupy working memory and compete for working memory resources with visual imagery-based memories (Baddeley & Andrade, 2000; Kavanagh, Freese, Andrade, & May, 2001), such as intrusive memories. Tetris gameplay employs visuospatial working memory resources (Lau-Zhu, Henson, & Holmes, 2019; Lau-Zhu, Holmes, Butterfield, & Holmes, 2017). Therefore, completing a demanding visuospatial task such as Tetris gameplay during trauma memory reconsolidation (following a reminder cue to reactivate the memory) has been hypothesized to interfere with the restabilization of the visual aspects of those memories and reduce the frequency of subsequent intrusive memories (James et al., 2015).

The intervention is comprised of a simple memory reminder cue (trauma hotspots), followed by Tetris gameplay for which there are specific instructions to engage in the task using 'mental rotation'. The emphasis on mental rotation is key to ensure that the visuospatial demand of Tetris gameplay is maximised, as greater visuospatial demand has been associated with fewer subsequent intrusive memories (e.g., complex visuospatial tapping is more effective than single key tapping; Holmes, Brewin, & Hennessy, 2004). Furthermore, the effect of the intervention in reducing intrusions is thought to reflect modality-specific interference rather than merely distraction.

Key Practitioner Message

- Despite experiencing significant trauma and consequent intrusive memories, refugees typically have little access to mental health support.
- Novel, scalable and simple interventions are needed.
- We propose the value of targeting a single symptom—intrusive memories of trauma.
- Our case series confirmed that a brief behavioural intervention (involving a memory reminder, mental rotation plus Tetris gameplay) reduced intrusions and improved functioning of people who are refugees.

Laboratory studies show that not all distracting tasks reduce intrusive memories; for example, a verbal 'Pub Quiz' computer game increased intrusive memories relative to no task (Bourne, Frascaquillo, Roth, & Holmes, 2010). On the other hand, distracting may at times temporarily reduce distress in the moment.

Using an experimental trauma analogue (film footage) in laboratory settings, similar intervention procedures have been shown to be effective relative to control conditions (e.g., verbal game/no task) for both recent and older intrusive memories of experimental trauma (Deeprase, Zhang, DeJong, Dalgleish, & Holmes, 2012; Holmes, James, Coode-Bate, & Deeprase, 2009; Holmes, James, Kilford, & Deeprase, 2010; James et al., 2015; Kessler et al., 2020). Further, early stage research indicates effectiveness when translated to clinical settings to target memories of recent trauma (Horsch et al., 2017; Iyadurai et al., 2018) and older trauma memories in inpatients with complex PTSD (Kessler et al., 2018). Kessler et al. (2018) found that intrusions targeted by the intervention reduced in frequency 64% from baseline to postintervention, whereas nontargeted intrusions reduced by 11%. Holmes et al. (2017) reported that refugees rated the intervention approach (delivered by smartphone) as feasible, acceptable and enjoyable. These previous findings support both the use of the intervention to reduce intrusive memories of older trauma in inpatients with complex PTSD (Kessler et al., 2018) and with refugees the perceived acceptability of the intervention approach alongside feasibility of completing the intrusion diary (primary outcome measure) (Holmes et al., 2017). However, the possibility that the intervention effectively reduces older intrusive memories in refugee participants has not been tested to date.

Single case designs can help bridge experimental findings to real-world clinical application (Kazdin, 2013). A single case ABAB withdrawal design alternates between a baseline (A) phase and an intervention (B) phase. The baseline sheds light on current behaviour/symptoms while also predicting the pattern in the immediate future if no intervention were implemented. The intervention phase describes the current level of behaviour/symptoms when the intervention is administered and predicts patterns of such if the phase

continued. The second A phase serves the function of restoring the conditions from baseline and testing the first prediction, and the second B phase tests the same prediction as the first intervention phase (Kazdin, 2019). The replicated AB sequence strengthens the evidence and elucidates causal effects (Morley, 2018).

Following on from Holmes et al. (2017), an initial pilot case series (Olofsdotter Lauri, 2018) investigated the feasibility and acceptability of the behavioural intervention with refugees and explored the value of a single case series for outcome evaluation (Clinical Trials Registry NCT: 03525158). An experimental ABAB design was attempted which included a baseline phase (A)—no-intervention week; intervention week (B)—including an in-person session in which participants brought their intrusive memory to mind, played Tetris for 20 min, and engaged in self-guided use over the following week. One participant dropped out after baseline (A) phase, two completed an AB design without replication, and one participant successfully completing the ABAB design with replication. Accordingly, lessons learned included first, adjusting recruitment strategies to focus on language classes (rather than mental health supported housing). Second, strengthening training procedures and supervision of staff to better support retention of participants throughout all ABAB phases. Fourth we added emphasis to mental rotation in the intervention instructions, and fifth, to exploring functional outcomes. Finally, unlike previously, our research team now included someone who could speak the same language as participants (Farsi/Arabic).

Our primary aim in the current case series was to evaluate the use of the brief behavioural intervention to reduce the number of intrusive memories of trauma in a refugee sample. Secondary aims were to investigate feasibility and acceptability of, and adherence to, the intervention and its impact on functioning. We hypothesized that participants would report a reduction in number of intrusive memories—that is, fewer during the intervention phase than the preceding baseline phase. Alongside reduced intrusions, we predicted functional improvements (e.g., concentration).

2 | METHOD

2.1 | Participants

Participants ($N = 5$, two female) aged from 18 to 50 years ($M = 29.4$, $SD = 11.55$) were recruited from the Swedish language classes available to all refugees in Sweden (Swedish for Immigrants, SFI; $n = 4$ and a specialist psychiatry service; $n = 1$). Inclusion criteria were refugee or asylum seeker, aged 18, current intrusive memories of trauma, able to speak or read study materials in either Swedish, English, Arabic or Farsi, able to attend five to six meetings with a researcher and access to a smartphone. Exclusion criteria were psychotic symptoms or other severe mental illness that would affect study participation or require additional monitoring.

Eleven individuals were assessed for eligibility. Six were excluded for not meeting inclusion criteria (i.e., no intrusive memories, $n = 1$; not a refugee or asylum seeker, $n = 1$; symptoms of severe mental illness; $n = 1$) or declining to participate (no time, stigmatization and reason unknown, $n = 3$).

Four participants completed the ABAB design, and their data are included in the study (Figure 1). One participant completed an AB design then discontinued due to lack of time. This participant is not included in the analysis due to incomplete data for the primary outcome from the intervention phase (B1). To protect anonymity, participants are referred to as P1, P2, P3 and P4, gender has been omitted, and demographic information (see Table 1) is deidentified. Participants had experienced a range of traumatic events. These included repeatedly witnessing traumatic scenes in their war-torn homeland, scenes of human suffering during their flight to safety, being exposed to death-threat and personal trauma that was not war related. All participants reported having experienced multiple traumas but did not necessarily experience intrusive memories of all these events. That is, some participants experienced intrusions of only one of their traumas.

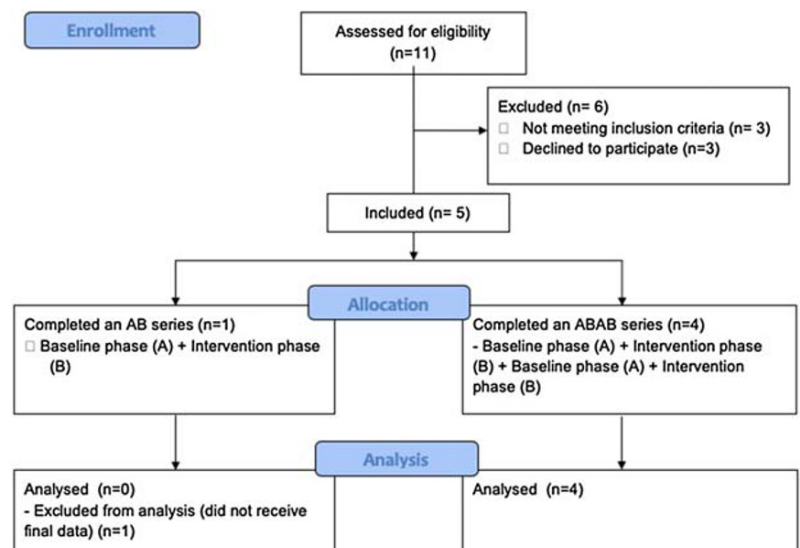


FIGURE 1 Flow diagram. Note. Adapted from CONSORT Flow Diagram to fit the study [Colour figure can be viewed at wileyonlinelibrary.com]

Note. Adapted from CONSORT Flow Diagram to fit the study.

TABLE 1 Demographic characteristics

| Variable | | | | |
|--------------------|------------------------------|------------------------------|----------------------------|------------------------------|
| Age | 26 | 50 | 33 | 20 |
| Gender | Male | Male | Female | Male |
| Country of origin | Iran | Afghanistan | Afghanistan | Yemen |
| Native language | Farsi | Farsi Dari | Farsi Dari | Arabic |
| Education in years | 9 | 2 | 5 | 13 |
| Current occupation | Unemployed, studying Swedish | Unemployed, studying Swedish | Unemployed, parental leave | Unemployed, studying Swedish |
| Years in Sweden | 3.50 | 3.25 | 3.25 | 4 |

Note: Participants' numbers have been omitted to preserve anonymity.

2.2 | Design

We employed a single case ABAB withdrawal design, attempting to adhere to current guidelines (Kratochwill et al., 2013; Tate et al., 2016). The A phase was a nonintervention phase, during which participants monitored their number of intrusive memories over a week. The B phase consisted of an intervention week, which included an in-person session (memory reminder procedure plus visuospatial task, i.e., Tetris gameplay using mental rotation), and subsequent engagement in self-guided use during the week. Participants continued to monitor their number of intrusions during the B phase. The study was nonblinded and nonrandomized. The primary outcome measure was number of intrusive memories, assessed in a daily diary over the course of the baseline and intervention weeks. Secondary outcome measures assessed feasibility and acceptability of the intervention and ratings of general and intrusion-specific functioning (e.g., concentration and sleep). See Figure 2 for an overview of meetings and measures.

2.3 | Materials and methods

2.3.1 | 'Hotspots' form

The 'hotspots' form was used to record participants' brief descriptions of their intrusive memories, and was completed with the researcher sitting next to them. Either the participant or the researcher wrote on the sheet. The heading on the 'hotspots' form sheet (1 A4) read: 'Put your flashbacks/intrusive memories into words'. It also contained these instructions: 'Please, briefly put the worst parts of your trauma that recur in your flashbacks/intrusive memories into words. Only a few words (symbols, numbers) are necessary, e.g., "a bomb exploding", "sitting in a boat"'. This text was followed by six numbered empty lines. Instructions and lines together covered approximately half the page. The remaining half was blank. Participants were given verbal instructions along with the form, following a written protocol, including these instructions: 'Can you briefly put the worst parts of your trauma that emerge as flashbacks/intrusive memories into words. You do not need to think about them in detail, just briefly describe the images that pop up', and if needed: 'Can I help—which images usually

pop up in your head now? Are there any images or details from the trauma that pop up? I just need a few describing words for each image'; or 'It's all right, you don't have to tell us anything in detail, as long as you can differentiate the memories'.

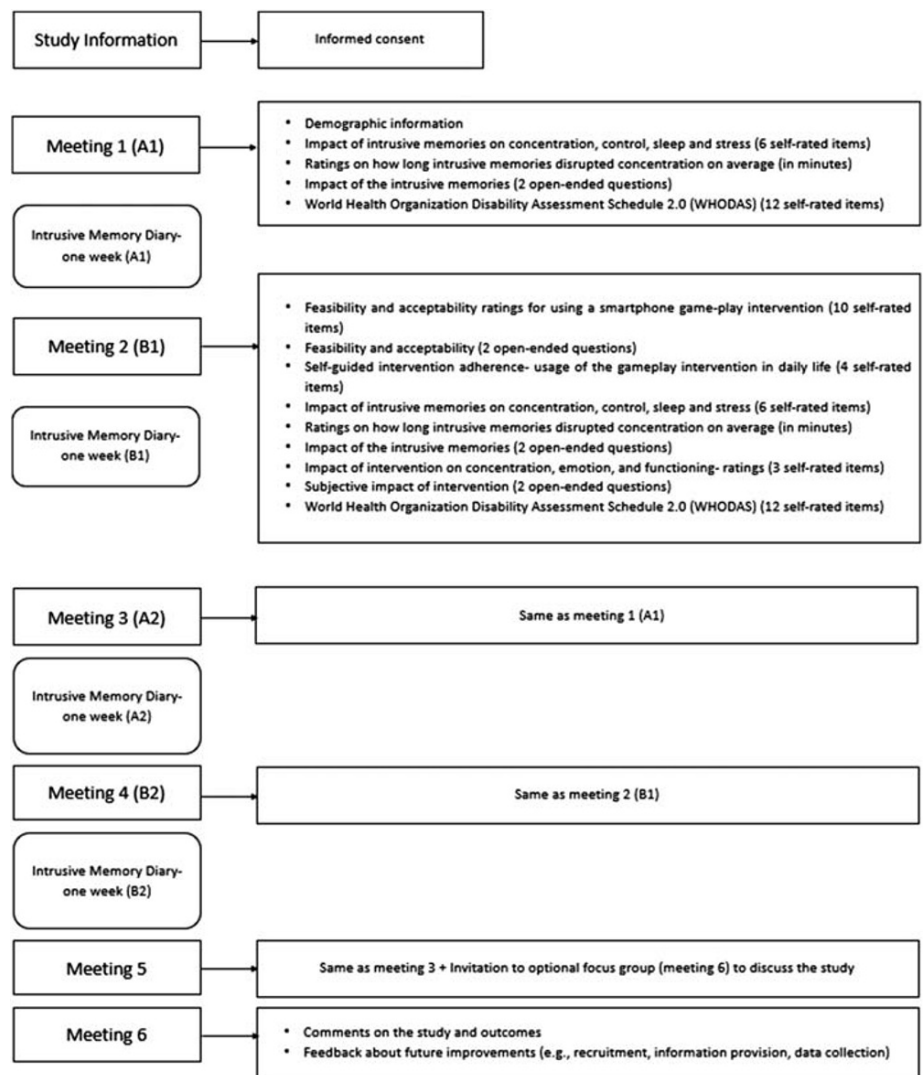
If necessary, participants were reminded by the researcher to keep their description brief, were given prompts to focus on visual trauma images (e.g., 'what do you see') and encouraged to use creative ways of naming the intrusive memory, like 'give it a title, like a title of a TV-series episode'. Participants' hotspots consisted of mean = 5.5 words, with a range from 1 to 16 words. The completed hotspots forms were used together with the participants' weekly intrusive memory diary as a basis for discussion between the participant and researcher, for example, to understand which intrusions had been more or less frequent during the week, or if any new intrusions had appeared since the last meeting. There was no requirement to talk about the trauma in detail, and whenever it seemed as if the participant was about to do this, they were gently reminded to focus on the task of briefly naming their intrusive memories. The hotspots form was also used when completing the 'trauma memory reminder cue' as part of the intervention.

2.3.2 | Intrusive memory diary

Participants were given a pen-and-paper diary to record their intrusive memories. The diary used here has been employed in previous work (e.g., Iyadurai et al., 2018; Kessler et al., 2018; Holmes et al., 2017—see page 101 for an example).

The diary consisted of an A4 paper sheet folded in half to a pamphlet. The front page included participant number, an image of Tetris shapes, the words 'intrusive memories diary' and lines for start and end date. On the pages inside the pamphlet, the left page of diaries for baseline and intervention weeks included the instruction: 'If you experience any intrusive memories/flashbacks during the upcoming week, please mark it in this diary'. This was followed by a definition of intrusive memories: 'Intrusive memories/flashbacks are imagery based intrusive memories from a traumatic event that pop up in your consciousness without warning. They often pop up as visual images that you can see in your mind's eye, for example as a picture or a film'. It also included a small example of how a diary could look when filled in,

FIGURE 2 Overview of study meetings and measures



that is, showing boxes with ticks or zeros. The intervention diary included the information that playing Tetris after an intrusive memory could be helpful, along with an instruction to play Tetris after experiencing an intrusive memory. The page to the right included tick boxes for 8 days. Each day was divided into four time periods, that is, morning (7 am–12 pm), afternoon (12 pm–5 pm), evening (5 pm–10 pm) and night (10 pm–7 am), giving 32 data points, on which participants were able to report as many intrusions as they had experienced during each such time slot, respectively. The days were labelled in session starting with the present weekday (e.g., Day 1: Tuesday). Following the example picture, participants ticked the box for the specific time slot in which they experienced an intrusion or wrote zero if they did not experience an intrusion. The diary also included a compliance rating below the tick boxes, asking participants to estimate at the end of the week how many of their intrusive memories they thought they recorded in the diary (0 = none of them to 10 = all of them). The back page of the pamphlet included a thank you note and contact details of the researchers in the event that participants had any queries. Along with the information written on the diary, participants were also given detailed verbal instructions by the researchers regarding how to fill in

the diary and information about distinguishing intrusive memories from other experiences such as engaging in rumination and actively recalling memories. Participants were advised to keep the diary accessible (e.g., in their bag), set specific daily times for completion, and received daily reminders. They completed each diary for up to 8 full days, for baseline (A1) and intervention (B1) and following weeks (A2 and B2). Participants were not asked to provide any information about the content of their intrusions in the diary (this was discussed in meetings with researchers).

2.3.3 | Tetris app

The computer game Tetris was downloaded on their smartphone as a freely available app from Appstore/Google play store (EA Mobile Montreal Team, 2018). Participants used their own smartphones (i.e., Iphone or Android). They had the option of borrowing a study phone for the gameplay task, but all participants used their own phones. Tetris is a visuospatially demanding game that requires the player to move seven differently shaped blocks which fall from the

top of the screen into horizontal lines. The game was set to 'Marathon mode', 'ghost piece' off. The touch screen function was used to move the blocks (drag to left/right and down to increase speed) and rotate them (double-click). Participants were asked to always focus on planning in their mind's eye where they would place the next blocks seen on the right side of the screen ('mental rotation').

2.3.4 | Ratings of impact of intrusive memories on concentration, control, sleep and stress

Participants rated concentration difficulties (owing to intrusive memories, and in general), sense of control over intrusions, sleep disturbance and stress levels due to intrusive memories on a 6-item measure, from 0 (*not at all*) to 10 (*very*). Participants also estimated how long intrusions disrupted concentration on average (6-point scale where 1 = <1 min, 2 = up to 1–5 min, 3 = 5–10 min, 4 = 10–30 min, 5 = 30–60 min and 6 = > 60 min), and answered two open-ended questions: *How do intrusive memories interfere with your concentration?* and *How do intrusive memories interfere with your ability to settle in to this country and learn new skills, e.g., a new language?*

2.3.5 | Ratings of impact of intervention on concentration, emotion and functioning

Participants rated the impact of the intervention on their concentration, emotion and functioning using three 11-point scales (0 = *not helpful*, 10 = *very helpful*).

2.3.6 | Subjective impact of intervention

The subjective impact of the intervention was assessed using two open-ended questions: *How would you describe the impact of this intervention in the short/long term?*

2.3.7 | The WHODAS 2.0

Participants rated their functioning in six life domains (cognition, movement, personal care, relations, daily activities and participation) using the World Health Organization Disability Assessment Schedule (WHODAS) 20.0: twelve items ranging from 1 = *none* to 5 = *extreme or cannot do*; World Health Organization, 2010).

2.3.8 | Feasibility and acceptability

Ratings of feasibility and acceptability of the intervention were obtained using 10 bespoke self-rated items (0 = *not at all* to 10 = *very*) and two open-ended questions: *How did you feel about playing Tetris after you had an intrusive memory?* and *Why?*; also *How much would*

you prefer an intervention that is delivered by a computer/smartphone compared to seeing a doctor/psychologist in person? and *Why?*

2.3.9 | Ratings of adherence to intervention in daily life

Ratings of adherence was assessed with four items: *Did you play Tetris in the last week since the last meeting?* (Yes/No). *If yes, how many days did you play Tetris in the last week since we first practiced the game together?* *How long did you spend playing Tetris at a time?* (<10 min to >30 min). *How often did you manage to play Tetris after you experienced an intrusive memory?* (11-point scale, 0 = *not at all* to 10 = *every time*).

2.3.10 | Open-ended questions in focus group meeting with researchers

The semistructured interview for the focus group meeting included questions such as: *Please describe your experiences from study participation and doing the intervention, both from a short and long term perspective;* *If we wanted to reach more participants in the future how could we do this and how should we inform them about the study?;* *What are your thoughts about targeting only one symptom (intrusions) as in this study versus other treatment options?;* *Do you have any feedback on data collection, study procedures, or any suggestions for improvement?* Prompts were used as needed, verbatim notes taken and clarification sought as necessary.

2.4 | Procedure

Meetings followed a written protocol and were held in community locations (language school, libraries and cafés) rather than mental health settings. One of the research assistants spoke Farsi, Arabic, English and Swedish. Before Meeting 1 (baseline phase A1), researchers explained the study in detail. Participants provided their written and informed consent before proceeding. See Figure 2 for an overview of meetings and measures.

2.4.1 | Baseline (A) and intervention (B) meetings

Each participant had five in-person weekly meetings with at least two researchers present. Meetings ranged from 40 to 90 min (depending on degree of translation required, time spent calling supervisor, etc). Meetings 1 and 3 involved preparation for baseline phases (A1 and A2); Meetings 2 and 4 were preparation for the intervention phases (B1 and B2); and Meeting 5 was a concluding meeting. During meetings, ratings of intrusions from previous weeks were shared.

In Meeting 1, **A1**, researchers explained the concept of intrusive memories, differentiating intrusive memories from actively thinking about the trauma. Participants provided information about the frequency

and impact of their intrusions, then completed the 'hotspots' form (see Section 2.3). Next, participants were given instructions on how to complete the diary over the following week and asked how they would like to be reminded about it (SMS or phone call).

In Meeting 2, **B1**, researchers collected the diary and discussed anything that needed clarification (e.g., days with particularly high/low number of intrusions and which intrusion was most frequent/distressing). Participants next completed the intervention: (1) brief trauma memory reminder cue (using the 'hotspot' form) (2) 10-min time gap, and (3) Tetris gameplay for at least 20 min using 'mental rotation'. Participants rated current distress three times per session: prior to and after memory reminder and after gameplay (0 = *no distress* to 10 = *maximum level of distress*: subjective units of distress, SUDs; Wolpe, 1969) to check engagement with the memory reminder and index changes in distress following the intervention.

Step 1: Trauma memory reminder cue

Participants completed the 'hotspots' form to bring the memory to mind and provided SUDs ratings before and after completing this form. Participants focused on one of their intrusions per session. The researchers suggested focusing on their most frequent intrusion before engaging in next steps including Tetris gameplay using mental rotation instructions; however, participants ultimately made the decision as to which memory they brought to mind (some preferred to target their most distressing intrusion, which was not always the most frequent).

Step 2: 10-min gap: Game download and mental rotation instructions

Participants spent approximately 10 min downloading Tetris onto their phone and receiving instructions for gameplay, given the hypothesis that a 10-min time gap is required to make an older memory malleable (James et al., 2015; Visser et al., 2018). To maximize visuospatial interference, researchers emphasized the importance of 'mental rotation' while explaining Tetris. Specifically, participants were instructed to imagine where and how each block about to appear in the game could be rotated to fit in the line below and to focus on upcoming blocks, that is, 'plan' the game. Participants then completed a practice round to demonstrate understanding.

Step 3: Tetris gameplay (20 min)

Participants played Tetris uninterrupted, restarting if the game was over before 20 min. Researchers remained in the room, encouraging participants to engage in the game, focus, remember to use 'mental rotation' and plan responses ahead.

Participants then rated SUDs for the third time. They were asked to complete the daily diary for 1 week. When possible, they were asked to play Tetris for 20 min after experiencing an intrusive memory.

Meeting 3 (**A2**) followed the same procedure as Meeting 1, but researchers also collected participants' diaries and asked questions about the content (e.g., which intrusion was most frequent) as well as their experience of Tetris. Participants were instructed to continue to monitor their intrusions in the diary but refrain from using the intervention over the following week.

The procedure of Meeting 4 (**B2**) (second intervention meeting) was the same as Meeting 2 (B1).

Meeting 5 followed the same format as Meeting 3. Participants were invited to an optional focus group meeting to discuss the study (Meeting 6).

Meeting 6 (optional). Participants were invited to comment on the study and their outcomes, and provide feedback about future improvements (e.g., recruitment, information provision and data collection).

2.5 | Training to deliver the intervention

Research assistants who delivered the intervention had no prior experience conducting research or clinical work with traumatized participants. To ensure procedural fidelity and appropriate delivery of intervention, research assistants completed detailed training prior to recruitment. Research assistants completed a total of 2.5 days of training procedures, which included roleplay with experienced researchers/clinical psychologists and practicing delivering the protocol until adequate performance was reached. Training also included role-playing potential challenging situations, for example, participants becoming significantly distressed, and attention to tracking incoming data (e.g., checking diaries were returned). The research assistants received clinical supervision in relation to sessions (e.g., adherence to protocol; how to help participants complete the brief trauma memory reminder cue without inducing distress) and continuous monitoring of incoming data (e.g., discussing patterns in primary and secondary outcomes). This supervision and monitoring was brief, flexibly adapted pending needs and delivered either in person or remotely. Details about the delivery of the intervention and our training, monitoring and supervision procedures can be requested from the corresponding author.

2.6 | Data reduction and descriptive analyses

Descriptive analysis was performed with Microsoft Excel Version 16.24 and IBM SPSS Version 25. We conducted visual inspection of primary outcome data. Visual inspection is the mainstay of single case methodology; it allows one to see a clear pattern in the data compared with other statistical techniques that only test one parameter at a time (Morley, 2018). The visual inspection graphs were made using a website for single case data analysis (Methodology of Educational Sciences Research Group, 2019). Ratings on secondary outcomes are reported descriptively for each case.

2.7 | Procedural changes

First, in the original protocol, participants provided the first SUDs rating after collecting/reviewing the diary; this was changed to before collecting/reviewing the diary instead. Second, we noted that participants found it difficult to complete the WHODAS for the past 30 days

once they commenced the intervention. Thus, we altered the time-frame to 'the past week' from Meeting 2 onwards.

2.8 | Ethical approval

The study was approved by the Regional Research Ethics Committee, Stockholm (EPN dnr. 2017/978-31, Amendments 2017/1678-32, 2017/2361-32, 2018/2149-32 and 2019-01329) and registered with the Clinical Trials Registry, Number NCT03760601, prior to recruitment. All participants provided their written and informed consent. Participants were not compensated for taking part. Data were handled confidentially and according to GDPR.

3 | RESULTS

3.1 | Primary outcome: Number of intrusive memories

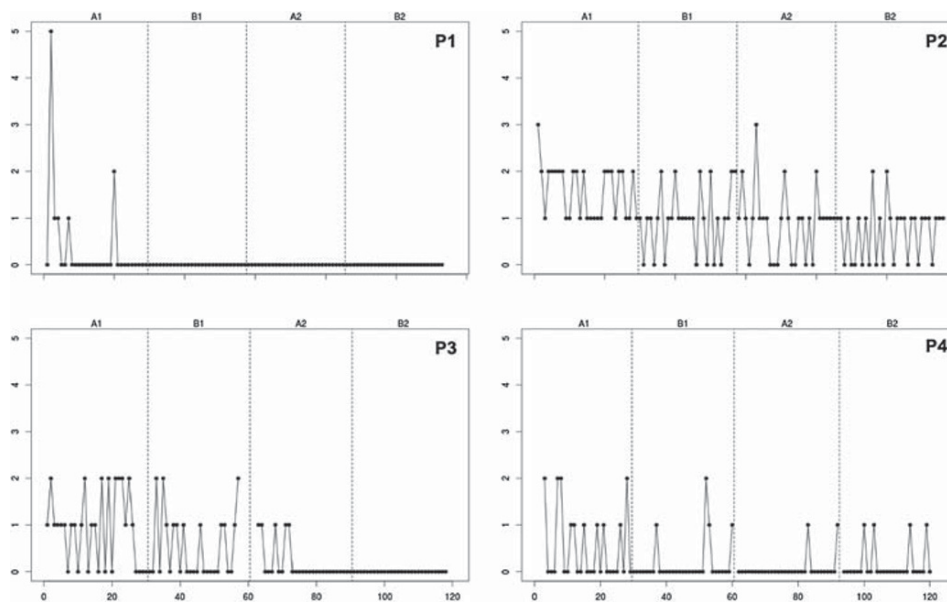
Figure 3 shows the number of intrusive memories per time period for each participant during the baseline and intervention phases. See Table 2 for additional details on intrusions, including diary compliance ratings, which were high. During the intervention, participants provided SUDs ratings before and after naming the hotspots and after playing Tetris. On four (of five) occasions, participants' distress increased after naming their hotspots, indicating successful emotional

memory activation. It is noteworthy that distress only reached ceiling once (i.e., 10) and that all participants completed each aspect of the intervention. All participants' levels of distress decreased or remained at zero after gameplay.

Visual inspection of graphs (Kazdin, 2019; Morley, 2018) suggests a general decrease in frequency of intrusions after implementing the intervention. P1 showed a clear decrease from baseline to intervention, from several a week to zero. This participant reported frequent intrusive memories after recruitment, reflected in the peak at the beginning of the week (Figure 3). P1 reported typically experiencing a minimum of five intrusions per week, sometimes more if triggered (e.g., by watching news). The hotspot targeted during the intervention was their strongest and most frequent. It is visually striking that after one intervention, intrusions were reduced to zero and did not rebound in the following phases (A2 and B2).

P2 reported a decrease in intrusion occurrence from baseline to intervention (Figure 3). Frequency did not increase during the second baseline phase but rather continued to decrease during both the following baseline and intervention week. During the first baseline phase, P2 did not experience any intrusion-free time periods but then experienced 8/29 intrusion-free time periods during B1, 8/28 during A2 and 11/31 during B2.

P3 showed a rather unstable baseline and intervention phase, but like P2, intrusion-free time periods increased compared with baseline phase. P3 experienced 9/29 intrusion-free time periods during A1 and 16/27 during B1 (Figure 3).



Note. Number of intrusive memories per time period (four periods per day – morning, evening, afternoon and night) (x-axis) during baseline week 1 (A1), intervention phase week 1 (B1), baseline phase week 2 (A2) and intervention week 2 (B2) (y-axis) for Participant 1, Participant 2, Participant 3 and Participant 4.

FIGURE 3 Graph for visual inspection of primary outcome data (Number of intrusive memories): Participant 1, Participant 2, Participant 3 and Participant 4. *Note.* Number of intrusive memories per time period (four periods per day—morning, evening, afternoon and night) (x axis) during baseline Week 1 (A1), intervention phase Week 1 (B1), baseline phase Week 2 (A2) and intervention Week 2 (B2) (y axis) for Participants 1–4

TABLE 2 Total number of intrusions during whole week, as well as the mean number (and standard deviation) of intrusive memories per day for each participant during the baseline (A) phases and intervention (B) phases, and mean diary adherence ratings during the study

| Participant | A1 | | B1 | | A2 | | B2 | | Mean diary adherence rating ^a |
|-------------|------------|-------------------|------------|-------------------|------------|-------------------|------------|-------------------|--|
| | Week total | Mean (SD) per day | Week total | Mean (SD) per day | Week total | Mean (SD) per day | Week total | Mean (SD) per day | |
| P1 | 10 | 1.38 (2.02) | 0 | 0.00 (0.00) | 0 | 0.00 (0.00) | 0 | 0.00 (0.00) | 9.5 |
| P2 | 46 | 6.34 (1.14) | 27 | 3.86 (1.39) | 25 | 3.57 (1.47) | 22 | 2.84 (1.18) | 9.75 |
| P3 | 28 | 3.73 (1.57) | 14 | 2.07 (1.40) | 5 | 0.71 (0.78) | 0 | 0.00 (0.00) | 7.75 |
| P4 | 14 | 2.07 (1.51) | 5 | 0.65 (0.91) | 2 | 0.26 (0.50) | 4 | 0.59 (0.72) | 10.0 |

Note: A1, baseline Week 1; B1, intervention Week 1; A2, baseline Week 2; B2, intervention Week 2.

^aHow many of your flashbacks do you think you recorded in the diary, where 0 = none of them and 10 = all of them.

P4 also showed a decrease from baseline to intervention (Figure 3). However, intrusions rebounded during the second intervention phase (A2: two intrusions; B2: four intrusions). Notably, three of the four intrusions reported in the final week had not been targeted in the intervention sessions—that is, the intrusion targeted in B1 (reported to be the most frequent and distressing) only occurred once in A2 and not at all in subsequent weeks. Further, the intrusion targeted in B2, which was described as most distressing although not always frequent, was experienced only once in the final week.

3.2 | Secondary outcomes

3.2.1 | Feasibility and acceptability

All participants rated the app as 'very easy' to download and Tetris as enjoyable and relatively easy (Table 3). Overall, participants felt that it would be easy to play Tetris, irrespective of their location, directly after an intrusive memory, and that playing distracted them from unpleasant thoughts and feelings. On average, participants rated Tetris as an acceptable way of reducing intrusive memories, indicated a preference for a digital intervention over attending a session with a health professional and indicated that they would recommend the game to a friend.

3.2.2 | Self-guided intervention adherence

Participants reported playing Tetris following the majority of their intrusive memories (i.e., $M = 7$, where 10 = 'every time') (Table 4).

3.2.3 | Impact of intrusive memories on concentration, control, sleep and stress

For all participants, across items, ratings decreased from Meeting 1 to Meeting 5—indicating that intrusive memories were perceived to have less impact on functioning over time. Ratings of control showed the opposite pattern, indicating an increased sense of control across the intervention (see Table 5).

3.2.4 | Impact of intrusive memories on concentration and ability to settle

In Meetings 1 and 3, P1 described how intrusions affected concentration in social situations (e.g., with friends) and their motivation and how intrusions made planning difficult. 'When I have the plan to do something, these intrusive memories make it hard to follow that plan' (P1). In Meeting 5, P1 commented that planning was easier. Regarding integration in a new country, in Meetings 1 and 3, P1 commented that intrusions affected integration and learning Swedish and their personality (now more introverted) and that experiencing intrusions took both time and energy. P1 reported in Meeting 5 that these aspects improved during the study.

In Meeting 1, P2 described difficulties focusing on work and studies due to intrusive memories. P2 described a positive change in Meeting 3 (A2), 'When I'm studying, these intrusive memories come to my mind and I play Tetris and I can study better', and a similar positive outcome in the final meeting, commenting that the intervention helped lift mood and that intrusive memories now only affected concentration 'sometimes'. Similarly, P2 described in Meeting 1 that intrusive memories affected integration by hindering planning for future work. In Meeting 3, P2 described improvements in this regard. In Meeting 5, P2 described increased motivation to learn Swedish and engage in more activities but noted that intrusions sometimes continued to be a problem.

In Meetings 1 and 3, P3 reported difficulties concentrating on daily tasks and important aspects of parenting as well as mood disturbances due to intrusions. P3 reported an absence of intrusions in the final meeting but reported having not engaged in many activities which required concentration over the past week—so that it was difficult to determine whether concentration had improved. Regarding integration, in Meetings 1 and 3 P3 described a major impact of intrusions on daily life, noting 'I couldn't learn Swedish because these intrusive memories are always around'. In the final meeting, P3 expressed motivation to engage in language classes again. We note that during the study, P3 struggled with complex family circumstances along with other psychological symptoms.

In Meeting 1, P4 reported that intrusions affected concentration 'a lot' and that 'you continue thinking about it, sometimes the whole day', which also affected mood. Similarly, in Meeting 3, intrusions were described as causing rumination, which prevented P4 from

TABLE 3 Ratings on feasibility and acceptability of the intervention from Meeting 2, Meeting 4 and Meeting 5 for each participant

| Items | Meeting | P1 | P2 | P3 | P4 |
|--|---------|----|----|----|----|
| Do you think that it would be good for you to have less intrusive memories of trauma every day? ^a | M2 | 10 | 10 | 10 | 10 |
| | M4 | 10 | 10 | 10 | 10 |
| | M5 | 10 | 10 | 10 | 10 |
| How easy did you find downloading the game Tetris? ^b | M2 | 10 | 10 | 10 | 10 |
| How easy did you find playing Tetris? ^c | M2 | 8 | 5 | 6 | 6 |
| | M4 | 9 | 8 | 3 | 6 |
| Did you enjoy playing Tetris? ^d | M2 | 10 | 10 | 10 | 10 |
| | M4 | 10 | 10 | 0 | 10 |
| Do you think it will be easy for you to play Tetris (independent of where you are) directly after you have experienced an intrusive memory? ^e | M2 | 7 | 10 | 4 | 9 |
| | M4 | 10 | 9 | 0 | 5 |
| Did you experience that Tetris distracted you from unpleasant thoughts/images/feelings? ^f | M2 | 7 | 10 | 8 | 8 |
| | M4 | 10 | 10 | 6 | 10 |
| Would you recommend Tetris to a friend? ^g | M2 | 10 | 10 | 8 | 5 |
| | M4 | 10 | 10 | 5 | 10 |
| Do you think that a computer game is an acceptable way to reduce the number of intrusive memories per day? ^h | M5 | 8 | 10 | 7 | 10 |
| Would you prefer an intervention via a computer/smartphone or meeting a doctor/psychologist face to face? ⁱ | M5 | 10 | 10 | 1 | 8 |
| How did it feel to play Tetris after you had an intrusive memory? ^j | M5 | 8 | 9 | 2 | 10 |

Note: M2, Meeting 2, beginning of B1; M4, Meeting 4, beginning of B2; M5, Meeting 5, end of B2.

^a0 (not good at all)–10 (very good).

^b0 (not at all easy)–10 (very easy).

^c0 (not at all easy)–10 (very easy).

^d0 (not at all)–10 (enjoyed it a lot).

^e0 (not easy)–10 (very easy).

^f0 (not at all)–10 (very much).

^g0 (absolutely not)–10 (absolutely).

^h0 (not at all acceptable)–10 (very acceptable).

ⁱ0 (prefer doctor/psychologist)–10 (prefer smartphone/computer).

^j0 (it felt bad)–10 (it felt good).

TABLE 4 Ratings of adherence to the intervention collected at Meeting 3 and Meeting 5 for each participant

| Items | Meeting | P1 | P2 | P3 | P4 |
|--|---------|-----|-----|-----|-----|
| Did you play Tetris in the last week since the last meeting? | M3 | Yes | Yes | Yes | Yes |
| | M5 | Yes | Yes | No | Yes |
| How many days have you played Tetris during the week since we practiced the game Tetris together? ^a | M3 | 7 | 7 | 4 | 7 |
| | M5 | 3 | 5 | 0 | 5 |
| How long did you spend playing Tetris at a time? ^b | M3 | 3 | 3 | 2 | 5 |
| | M5 | 3 | 3 | 1 | 3 |
| How often did you play Tetris after you experienced an intrusive memory? ^c | M3 | — | 9 | 5 | 5 |
| | M5 | — | 8 | — | 8 |

Note: M3, Meeting 3, beginning of A2; M5, Meeting 5, end of B2; —, question not relevant due to no intrusive memories.

^a0–7 days.

^b1 = <10 min, 2 = 10–15 min, 3 = 15–20 min, 4 = 20–25 min, 5 = 25–30 min, 6 = >30 min.

^c0 (no times)–10 (every time)

TABLE 5 Ratings on impact of intrusive memories on concentration, control, sleep and stress from Meetings 1, 3, and 5 for each participant

| Items | Meeting | P1 | P2 | P3 | P4 |
|---|---------|----|----|----|----|
| Over the past week, how much did your intrusive memories disrupt your concentration? ^a | M1 | 3 | 6 | 10 | 9 |
| | M3 | 0 | 8 | 5 | 9 |
| | M5 | 0 | 4 | 0 | 9 |
| When you have an intrusive memory, how long does it disrupt your concentration on average? ^b | M1 | 3 | 4 | 4 | 5 |
| | M3 | 4 | 2 | 2 | 4 |
| | M5 | 3 | 2 | 3 | 2 |
| Over the past week, how much difficulties did you have concentrating in general? ^c | M1 | 6 | 10 | 8 | 8 |
| | M3 | 7 | 3 | 6 | 5 |
| | M5 | 2 | 1 | 5 | 5 |
| Over the past week, how much control over your intrusive memories did you experience? ^d | M1 | 8 | 5 | 0 | 5 |
| | M3 | 10 | 9 | 6 | 5 |
| | M5 | 10 | 9 | 8 | 5 |
| Over the past week, did your intrusive memories affect how stressed you felt? ^e | M1 | 10 | 7 | 9 | 10 |
| | M3 | 0 | 8 | 4 | 3 |
| | M5 | 0 | 1 | 0 | 8 |
| Over the past week, did your intrusive memories disturb your sleep, for example, difficult to fall asleep, difficult to maintain sleep, or restless sleep? ^f | M1 | 3 | — | 10 | 10 |
| | M3 | 0 | 2 | 4 | 3 |
| | M5 | 0 | 1 | 0 | 6 |
| Over the past week, have you had nightmares that disturbed your sleep? ^g | M1 | 0 | 6 | 9 | 7 |
| | M3 | 0 | 8 | 0 | 0 |
| | M5 | 0 | 4 | 0 | 0 |

Note: M1, Meeting 1, beginning of A1; M3, Meeting 3, beginning of A2; M5, Meeting 5, end of B2; —, missing data due to data not available.

^a0 (not at all disruptive)–10 (extremely disruptive).

^b1 = <1 min, 2 = 1–5 min, 3 = 5–10 min, 4 = 10–30 min, 5 = 30–60 min, 6 = >60 min.

^c0 (no concentration difficulties)–10 (extreme concentration difficulties).

^d0 (no control)–10 (full control).

^e0 (not at all)–10 (affected very much).

^f0 (not at all)–10 (disturbed very much).

^g0 (not had any nightmares)–10 (had a lot of nightmares).

engaging in everyday life and made them feel disconnected: 'you go away, you are not here'. In Meeting 5, P4 continued to describe negative effects of intrusions, but also that 'when you've played they can disappear'. P4 also reported their intrusions disturbed their capacity for integration, that is, 'they are always there affecting your goals and future', and caused sleep disturbance. In Meeting 3, P4 noted that intrusions still had an impact but also said 'but do you know what? The past week, I started to like to learn new words and reading and listening to the radio and TV. There has been a big difference'. In the final meeting, P4 again described some of their difficulties in moving forward and learning things due to traumatic memories.

3.2.5 | Impact of intervention on concentration, emotion and functioning

P1, P2 and P4 rated over 5 on all questions for both Meetings 3 and 5, suggesting that they found the intervention helpful in managing emotions, improving concentration and general functioning. P3 provided lower ratings relative to the remaining participants on the first

two items yet provided a notably higher rating (i.e., 9/10) of the capacity of the Tetris intervention to distract from problems during Meeting 3 (see Table 6).

3.2.6 | WHODAS

As per Table 7, P1 showed a minimal improvement from Meeting 1 to 5, while the scores of P2 and P4 reflect major improvements. By comparison, P3's ratings evidenced decreased functioning across the intervention. In the final meeting, P3 reported that their functioning was affected by current illness in the family.

3.3 | Subjective impact of the intervention

P1 noted in Meeting 3 that the gameplay intervention was helpful in the moment, disconnecting them from intrusions. In Meeting 5, P1 expressed that the intervention had helped reduce stress and resulted in them engaging in new social interactions (e.g., talking to new people and going to a crowded gym).

TABLE 6 Ratings of impact of intervention on concentration, emotion and functioning for each participant

| Items | Meeting | P1 | P2 | P3 | P4 |
|---|---------|----|----|----|----|
| When you played Tetris, did you experience that it helped you handle your emotions? ^a | M3 | 8 | 10 | 4 | 8 |
| | M5 | 10 | 10 | 7 | 9 |
| When you played Tetris, did it help you with your ability to concentrate? ^b | M3 | 8 | 10 | 4 | 6 |
| | M5 | 8 | 10 | 5 | 9 |
| 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? ^c | M3 | 6 | 10 | 9 | 8 |
| | M5 | 8 | 10 | 4 | 10 |

Note: M3, Meeting 3, beginning of A2; M5, Meeting 5, end of B2.

^a0 (not at all)–10 (very helpful).

^b0 (not at all)–10 (very helpful).

^c0 (not at all)–10 (very helpful).

TABLE 7 Total score of ratings on the World Health Organization Disability Assessment Schedule (WHODAS) 2.0 assessed at every meeting for each participant

| WHODAS | P1 | P2 | P3 | P4 |
|--------|----|----|-----------------|-----------------|
| M1 | 27 | 33 | 26 | 36 |
| M2 | 28 | 26 | 33 | 24 ^a |
| M3 | 27 | 23 | 37 ^a | 19 ^a |
| M4 | 25 | 19 | 30 ^a | 13 ^a |
| M5 | 24 | 16 | 33 ^a | 13 ^a |

Note. 12 questions assessing functional impairment, rated from 1–5 (1 = none, 2 = mild, 3 = moderate, 4 = severe, 5 = extreme or cannot do); highest possible score = 60.

^aRatings refer to the past 7 (rather than 30) days.

P2 described (Meeting 3) that having the plan to play Tetris after experiencing intrusive memories helped increase relaxation: 'When I played Tetris I was zoomed in on the game and it could help me concentrate and I felt I forgot about that memory. It was so helpful and it was very joyful. It was like my mind was getting busy with something else (Tetris) and I could instead think about this new interesting memory consisting of playing Tetris.'

In Meeting 3, P3 commented that playing felt good in the moment but at times it also increased nervousness. In addition, P3 noted that the intervention helped them not to think about intrusive memories.

P4 described positive effects on sleep and mood in Meeting 3 ('The first days, I played, then I noticed that I don't think about the bad things like I did before. I got good sleep, I used to not be able to sleep, could lie awake several hours thinking about problems, now I don't anymore. I sleep good') and Meeting 5 ('The difference is big, now you have something to do to not have to think about the bad (memories/thoughts). I became optimistic and now I see that things can be good in the future, it will become better').

3.4 | Focus group meeting with researchers

P1 and P2 met with researchers for a focus group meeting at 7–8 weeks follow-up after the final session and echoed the positive

effects reported in Meetings 3 and 5. For P1, intrusions had not resumed. P2 reported that intrusions were now almost completely gone and now being able to study without being disturbed by them ('My mind is not struggling with the memories'). These participants provided advice about recruitment for future studies, noting, for example, that it was important to communicate the intervention's capacity for positive outcomes. Their thoughts on targeting one symptom included 'It was one specific event in the past so this intervention is enough, if there are more problems at the moment or more complex problems you need another intervention'. They also noted that it was helpful not to have to meet with a doctor given that this requires language competency, time and money, suggesting we describe the study to prospective participants as 'no medicine, no doctor'. Participants were positive about digital data capture for the primary outcome, rather than a paper diary. They acknowledged the potential efficiency of options for future remote delivery but felt that refugees would prefer to meet the researcher in person for the first session. Notably, P2 reported having delivered the intervention approach to their friend who also had intrusive memories by photographing and sharing the study materials and explaining the intervention. P2 reported that their friend had completed study procedures and subsequently experienced a major reduction in intrusions.

4 | DISCUSSION

We investigated the use of a brief behavioural intervention for reducing intrusive memories of trauma in refugees, which included a short memory reminder cue (hotspot sheet) followed by a time gap, mental rotation instructions and sustained Tetris gameplay. As predicted, participants reported a reduction in their number of intrusive memories post-intervention. The intervention was reported to be feasible and acceptable, and ratings of compliance indicated good adherence to both intervention and primary outcome measurements. Further, participants reported improvements across multiple domains, including concentration, control, sleep, stress, emotion and functioning. Results provide a preliminary indication that this simple intervention helped reduce the frequency of intrusive memories in trauma-exposed

refugees, even when delivered by undergraduates/research assistants who had received training but were not mental health professionals.

A notable observation (arising from discussion of the diary and not systematic assessment of the number of specific intrusions) was that the particular intrusive memory targeted in the intervention (e.g., image of bomb blast vs. boat) did indeed seem to be the intrusion with the lowest frequency in subsequent weeks—in accordance with Kessler et al. (2018). Future examinations of such patterns (e.g., as in Kessler et al. (2018) by marking each intrusion with a unique number or colour to track the trajectory of reductions of each memory) will shed light both on the specificity of the effect and the extent to which the intervention reduces other intrusions. Moreover, should the intervention prove to effectively reduce the frequency and distress associated with intrusions more generally (i.e., not just the target memory), it would be theoretically and clinically informative to understand factors that may be important, for example, the extent to which such nontargeted intrusions are thematically related to the memory targeted.

Participants' responses revealed functional gains they found important. Improvement was particularly evident for concentration, such that intrusive memories caused less disturbance to daily concentration over the intervention, evident in ratings as well as open-ended responses. These results are encouraging because impaired concentration was one of the most distressing impacts of intrusive memories reported by young refugees (Holmes et al., 2017). In addition, open-ended comments suggest that this improvement led to downstream effects on other functional domains, that is, academic, social and occupational functioning (e.g., comments by P2). Further, in addition to effects reported by participants on primary and secondary outcomes, the notion that they perceived the intervention to be a helpful distraction in the moment is yet another promising aspect worth exploring. Shifting focus has been recommended as a coping strategy to manage anxiety, for example, in the context of the COVID-19 pandemic (e.g., Public Health England & NHS, 2020). Future research should explore longer term effects to assess whether short-term distraction as a result of engaging in Tetris gameplay after experiencing intrusive memories is related to beneficial functional outcomes such as boosted well-being (Rankin, Walsh, & Sweeny, 2019), reduced worry, or a swift return to important activities (e.g., studying, as described by P2). Equally, it is also clinically important to determine whether such short-term distraction alternatively has any detrimental effects, for example, resulting in increased avoidance symptoms.

The behavioural intervention has several practical advantages. First, it does not need to be delivered by a mental health professional nor administered in a health care setting—this is important as refugees typically have limited access to existing evidence-based interventions for mental health delivered in traditional settings. Following training in how to use the intervention (as is good practice in clinical research) and with supervision, the intervention was delivered successfully by research assistants in community settings. That is, as it does not require discussion of trauma details nor a detailed 'therapy style' conversation it is amenable to delivery in public settings, such as a library. Together, these factors reduce both structural barriers to access, as

well as potential stigma, for example, associated with attending a psychiatric clinic. Second, Tetris—a language free component of the intervention—poses an advantage as language barriers present a significant impediment to accessing mental health services for refugees. Third, and critically, the intervention is low cost and could be delivered remotely at scale and thus has tremendous scope to overcome key barriers to the delivery of psychological support to many refugees (e.g., transport and cost). The advantage of potential remote delivery at scale is even more relevant due to the current COVID-19 situation in which simple, remotely delivered interventions to promote mental health are urgently needed (Holmes et al., 2020). Finally, unlike existing evidence-based trauma-focused interventions for PTSD, which necessitate prolonged focus on and engagement with the trauma memory (NICE, 2018), this novel intervention, which targets one specific symptom only (intrusive memories), has the significant advantage that recipients are not required to describe the trauma in detail, thus do not become significantly distressed (see also Kessler et al., 2018). Together, these advantages are worth exploring for their potential to facilitate uptake of the intervention and reduce typical rates of trauma treatment dropout in real-world settings (Najavits, 2015).

We acknowledge a number of limitations and avenues for future research. First, a single case ABAB design does not appear to be the optimal means for evaluating the intervention given that intrusions did not rebound in the withdrawal phase—contrary to predictions, the intervention had prolonged effects after just one session. We note that for P4, who reported an increase in intrusive memories in the final week, the majority of these were intrusions that had not been targeted in the intervention. It is possible more broadly that intrusion reduction effects last for a limited time and the duration of effects should be further investigated. Future studies would benefit from using an alternative single case methodology, for example, a multiple-baseline design, as per Kessler et al. (2018), which would also facilitate the possibility of exploring and targeting one intrusive memory at a time. Future single-case research should also seek to establish quantitatively whether an effect has occurred for each individual participant using a prespecified statistics plan, for example, using methods suggested by Maric, de Haan, Hogendoorn, Wolters, and Huizenga (2015). Further, a study design using a control group, such as a case series with a separate AAAA-condition or a pilot RCT, would address alternative explanations concerning the decline of intrusions (e.g., effects of monitoring alone, natural variations in intrusion frequency, a natural decline in intrusion frequency over time or placebo effects of the intervention).

Second, although a case series is appropriate for investigating the feasibility of new interventions, it precludes examining long-term effects. The inclusion of follow-up assessments in future case series' is needed to establish the longevity of treatment effects. Our focus group was promising in this regard. Third, we used several bespoke measures. Although the majority had been tested in pilot work (e.g., Olofsdotter Lauri, 2018), they nonetheless require validation. Relatedly, we made procedural changes during the case series. For example, while the WHODAS indexes functioning over the past 30 days, we modified this measure mid-study to instruct participants

to anchor responses to the past week (7 days). Although this improved our capacity to determine the specific timeframe of participants' functional gains, both validation of this approach and further improvements to functional assessment are now needed.

Third, we acknowledge that some of the acceptability/feasibility items may have been inadvertently worded in such a way that they made assumptions (e.g., that participants preferred digital interventions over those delivered in person), which may have shaped participants' responding. The precise wording of these items will need refinement in future work.

Future studies could explore whether the intervention and evaluation can be carried out via remote methods (e.g., videocall and internet). One participant delivered the intervention to a friend—raising the possibility that peer-to-peer delivery may be feasible and worth studying. Finally, future investigations should more thoroughly index functional outcomes (e.g., in addition to measuring reduced impairment, also indexing functional gains—i.e., what participants are able to do following their intrusions' cessation), as well as examine changes in key intrusion-related variables beyond frequency (e.g., appraisals; Newby & Moulds, 2010).

We need novel psychological interventions that can be delivered at scale and adapted for global use (Holmes et al., 2018; Kazdin & Rabbitt, 2013). Nowhere is this more apparent than in mental health interventions for refugees. Our findings provide encouragement for targeting one key symptom to reduce psychological distress after trauma working in this group. Reductions in intrusive memory frequency were coupled with functional improvements. The novel behavioural intervention may open up a promising way forward in addressing one mental health problem—intrusive memories of past trauma—faced by many refugees.

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