

Boosting trauma resilience: The power of electronic mental health support - a randomized trial

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ABSTRACT

Post-traumatic stress disorder (PTSD) is a psychiatric condition triggered by experiencing or witnessing traumatic events, such as death, serious injury, or threats to oneself or others. Affecting 5–10 % of the population, PTSD is often underreported due to the reluctance of individuals to disclose personal traumatic experiences. This study explores the effectiveness of a digital (electronic mental health and psychosocial support) and psychologist-led intervention in mitigating PTSD symptoms.

A randomized control trial was conducted, comparing the effects of human and digital intervention (conditions 1 and 2), and no intervention (control group) on PTSD symptoms induced by a traumatic film excerpt. Participants were randomly assigned to one of the three conditions. Emotional responses were measured using various scales, and flashbacks were recorded over a week following the intervention.

Results demonstrated that both human and digital interventions significantly reduced negative emotions and flashbacks compared to the control group. The psychologist-led intervention was the most effective, followed by the digital intervention. This study highlights the potential of digital intervention to provide accessible, anonymous, and effective support for trauma victims, suggesting a promising avenue for future mental health interventions.

1. Introduction

Post-traumatic stress disorder (PTSD) is “a psychiatric disorder that can result from experiencing or viewing a traumatic event involving death, serious injury, or threat to self or others” (Holmes et al., 2009). Symptoms may include recurrent memories, traumatic nightmares, dissociative reactions, flashbacks, psychological distress at reminders of the trauma, and marked physiological reactivity to these reminders (American Psychiatric Association, 2022).

PTSD affects 5 to 10 % of the population over their lifetime (Greene et al., 2016). Unfortunately, this estimate does not account for undiagnosed cases. The reluctance of individuals to disclose personal traumatic experiences remains one of the major challenges related to PTSD. According to (Alhusen et al., 2015) only 4.1 % of undergraduate women assaulted in college reported the assault to law enforcement. This is also the case in the workplace, where only between 5 % and 30 % of the victims file a formal complaint for sexual harassment (McDonald, 2012). Lastly, a study on *Preventing and Responding to Gender-Based Violence* across 30 countries revealed that only 4 in 10 women who have

experienced sexual violence seek help at all, and only 6 % from authorities (The Swedish International Development Cooperation Agency, 2015).

Simultaneously, several studies show that anonymous online communication can increase disclosure (Andalibi et al., 2016; Richman et al., 1999; Rodríguez-Rodríguez & Heras-González, 2020; Weisband & Kiesler, 1996). Pickard et al. (2016) demonstrated that, in the case of eliciting sensitive information, participants prefer to disclose to a digital device. Moreover, studies have found that, extremely popular approaches like debriefing might be inefficient and might even worsen symptoms instead of preventing PTSD (Rose et al., 2002). Conversely, digital interventions interfering with visual memory consolidation or reconsolidation have been demonstrated to reduce the number of flashbacks induced in control participants (Holmes et al., 2009). Lastly, there is an increasing interest in digitalizing mental health support, particularly for restricted areas and traumatized cases. For these purposes, electronic mental health and psychosocial support (eMHPSS)—such as clinical video conferencing, self-help apps, and online counseling modules—emerge as “a beacon of hope” (Ahmed & Heun, 2024).

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These eMHPSS techniques can improve accessibility, reduce stigma, and can bring evidence-based best practices in mental health (Ahmed & Heun, 2024).

Despite this growing focus on eMHPSS, few studies have examined their effects on PTSD and its treatment (Fairburn & Patel, 2017; Horsch et al., 2017; Maples-Keller et al., 2017). This paper aims at filling this gap by conducting an experiment with an eMHPSS that has been designed to assist victims of traumatic experiences. In light of the above, our two research questions are the following:

1. Does the eMHPSS reduce the symptoms of induced PTSD (e.g., flashbacks)?
2. Is the effect of the eMHPSS similar or different from that of human intervention?

This paper first presents the experimental design, which comprises both pilot testing and a main experiment. It then outlines the methods used and the data collected. Finally, the results are highlighted and discussed.

1.1. Design of the experiment

The experiment is a randomized control trial, which uses descriptive statistics to compare emotions elicited by a film excerpt across three experimental conditions. We did not include covariates in the experiment because in a randomized control trial controlling for covariates is not typically necessary since the process of randomization itself achieves balance between groups on all variables, both known and unknown, that could potentially influence the outcome. Hence, covariates are likely to be equally distributed across the experimental groups.

Prior to the experiment, we conducted a pilot test in order to select the film excerpt for the experiment (see Section 2). For the experiment, healthy adults viewed the film excerpt selected thanks to the pilot test. Immediately after viewing, the participants were randomly allocated to one of the following conditions:

- Condition 1: Participants had an interview with a human psychologist;
- Condition 2: Participants had an interview via the eMHPSS, implemented on a tablet (digital intervention);
- Condition 3: Participants had no interview (control group).

In condition 1, the interview process was inspired by the Critical Incident Stress Debriefing also called Mitchell's model. This model is a specific, 7-phase, supportive crisis intervention process, which is "simply a supportive, crisis-focused discussion of a traumatic event" (Mitchell et al., 1997).

In condition 2, the participants were given a tablet with which they viewed a prerecorded interview featuring the same psychologist. The recorded interview followed the exact same procedure than in condition 1, except that the participants answered to the questions using the tablet. In both conditions, there was no time limit to answer each question. The eMHPSS was designed in order to provide the same interaction experience as the psychologist, but for the participants without being seen and heard by an actual human, hence enabling the anonymity and a nonjudgmental approach of the disclosure and facilitating its administration.

In condition 3, the participants had no physical or digital intervention.

For the three conditions, negative affect was measured with questionnaires filled before and after the film excerpt. The long-term effect of the film excerpt was evaluated by asking participants to write down their memories and flashbacks in an agenda during the week following the experiment. According to Holmes et al. (2009), flashbacks are "the hallmark symptom" of PTSD.

This experiment was conducted in compliance with the protocol, the

current version of the Declaration of Helsinki, the ICH-GCP the HRA, as well as other locally relevant legal and regulatory requirements.

Previous studies have shown that film viewing is among the best experimental method to elicit emotions in experimental laboratory (Arnaudova & Hagenaaars, 2017). Therefore, the Trauma Film paradigm method was used both in pilot testing and the experiment. The Trauma Film paradigm is a widely used experimental method, which was developed in the 1960s (Asselbergs et al., 2023; Holmes & Bourne, 2008). The method involves a film excerpt displaying a scene with stressful content, such as a road accident or an aggression (Holmes et al., 2009; Woodward & Beck, 2017). The film is used to "induce stress and approximate real-world responses to traumatic events" (Woodward & Beck, 2017). The paradigm consists of collecting pre-view and post-view measures from participants, and then monitoring the effects such as intrusive memories during the following days (Woodward & Beck, 2017). It is worth stressing that the trauma film paradigm does not induce PTSD in healthy participants.

2. Pilot testing

With pilot testing we determined which of four film excerpts would elicit the highest emotional response. Each film excerpt was rated by three different participants. 12 participants (7 females and 5 males, mean age 27.16 ± 6.6) were recruited and randomly assigned to view one single film excerpt.

The film excerpts were the following:

- The extinguisher scene from the French film *Irreversible* by Gaspar Noé (2003), which is a scene where a man has his face pounded in with a fire extinguisher, in an attack that continues until after he is apparently dead. It lasts 6 min and 30 s and was viewed by two females and one male.
- The rape scene from the French film *Irreversible* by Gaspar Noé (2003), in which the camera looks on unflinchingly as a woman is raped and beaten. It lasts 12 min and was viewed by one male and two females.
- The rape scene extracted from the 1988 American film *The Accused* by Jonathan Kaplan, in which the actress is brutally assaulted by three men in a bar while people watch and cheer them on. It lasts 9 min and 12 s and was viewed by two males and one female.
- The 2009 British road safety film *Texting while Driving* by P. Watkins-Hughes was viewed by two females and one male. This film is a United Kingdom public service announcement warning against the dangers of texting while driving. "Three teenage women are in a car arguing over a text message that the driver is attempting to send" (Strange & Takarangi, 2012). The driver, not paying attention, collides with another vehicle. The film lasts four minutes and 15 s and was used in previous studies (Strange & Takarangi, 2012; Takarangi, Segovia, et al., 2014; Takarangi, Strange, & Lindsay, 2014).

There was no evidence of boredom observed among the participants during the viewing of their assigned films. At the conclusion of the study, participants underwent a debriefing process to assess their well-being and to offer professional assistance if needed. No participants requested such assistance. Qualitative feedback indicated that the "Texting while Driving" film elicited a generally indifferent response from the viewers.

2.1. Data collection for the pilot testing

Immediately after viewing the film excerpt, participants were asked to rate their emotional state on an adapted version of the International Affective Picture System Evaluation Scale (IAPS). Participants also rated the film excerpt using a list of emotions. They rated the emotions of Fear, Helplessness, Horror, Anger and Disgust on a rating scale from 0 to 100, with 100 indicating the stronger intensity. Finally, they recorded their

flashbacks in a notebook during the whole week following the experiment.

2.1.1. The International Affective Picture System Evaluation Scale (IAPS)

IAPS is a self-assessment manikin scale which is an affective rating system developed at the University of Florida in order to offer standardized materials to researchers in the study of emotion and attention (Lang et al., 2008). In pilot testing, we adapted the IAPS to evaluate people's reaction after viewing a traumatic film. Our version included three self-assessment manikin scales with a 9-point scale, such that 9 represents a high rating on each scale and 1 represents a low rating on each scale.

In the activation scale, figures representing an emotional state were ranged from 9, if the participant felt excited, agitated, nervous, stimulated, or activated to 1, if he felt relaxed, calm, lethargic, sleepy, or unstimulated. Intermediate levels were represented between these two extremes.

The dominance scale described to which extent participants felt in control rather than controlled by the event. As can be seen in Fig. 1, the dominance scale ranged from a small fig. (1 = dominated) to a large fig. (9 = control). The participant could select any of the five figures or between any two figures.

For the trauma scale, participants expressed to which extent they found the film excerpt traumatizing. The scale ranged from 1 (not at all) to 9 (extremely), with no figure. Intermediate levels were represented between these two extremes.

2.1.2. The experience movie rating

The procedure to measure the distress experienced by the participants during the film was similar to the one used by Woodward and Beck (2017). Participants were asked to rate on a scale from 0 (not at all) to 100 (completely) to which extent they experienced: fear, helplessness, horror, anger, and disgust.

2.1.3. Flashbacks

During the seven days following the viewing of the film excerpt, participants were asked to fill out an agenda reporting the number of flashbacks they experienced. Participants were asked to keep their agenda with them all the time (night and day) and to fill it out if they had flashbacks. The agenda consisted of a compact paper diary, measuring 4 cm in width (approximately 1.57 in.) and 8 cm in length (approximately 3.15 in.), with one page allocated per day. **At the outset of the agenda, a precise definition of a flashback was provided: "an intrusive memory of the film excerpt, which may manifest as mental images, sounds, or thoughts".**

On day 7, participants came back to the laboratory to submit their agenda. Entries in the agenda were discussed with an experimenter to confirm their intrusive nature. Lastly, the experimenter also verified that the participants did not experience strong trauma experience during that week. No participant **indicated a need to consult psychological service.**

2.2. Results for the pilot test

2.2.1. IAPS results

The rape scene of the film *Irreversible* posted the highest score for traumatism and for activation. Results showed that the rape scene from *Irreversible* provoked more IAPS activation ($M = 7.00$; $SD = 0.00$) and IAPS traumatism ($M = 7.33$; $SD = 0.58$) compared to:

- the extinguisher scene (respectively $M = 6.00$; $SD = 1.73$; $M = 5.67$; $SD = 2.31$);
- the rape scene from *The Accused* (respectively $M = 6.33$; $SD = 0.58$; $M = 5.33$; $SD = 1.15$)
- Texting while Driving (respectively $M = 5.33$; $SD = 1.53$; $M = 4.33$; $SD = 2.51$).

Furthermore, the rape scene from *Irreversible* was associated with the lowest feelings of dominance ($M = 2.33$; $SD = 1.53$), which indicates that the person felt more influenced, intimidated, submissive, directed, and embarrassed when watching this film compared to the extinguisher scene ($M = 5.0$; $SD = 2.0$); the rape scene from *The Accused* ($M = 5.0$; $SD = 2.65$), and *Texting while Driving* ($M = 7.33$; $SD = 1.15$).

2.2.2. The experience movie rating

In Fig. 2, the Experience Movie Rating scale showed that the emotion of disgust was the highest for the rape scene from *Irreversible*, followed by horror, helplessness, anger, and fear. Furthermore, all five emotions were the highest for this film excerpt.

2.2.3. Flashbacks

The number of flashbacks for the rape scene from *Irreversible* was the highest with 27 flashbacks. It was followed by *Texting while Driving* with 22 flashbacks. Surprisingly, the rape scene from *The Accused* gathered only 9 flashbacks. Lastly, the extinguisher scene gathered 4 flashbacks. Therefore, the rape scene from *Irreversible* was chosen for the experiment. Interestingly, other studies have chosen the same scene for their experiments (Lass-Hennemann et al., 2014; Weidmann et al., 2009).

3. The experiment

3.1. Participants

Participants were recruited through advertisements posted in two French-speaking universities in Switzerland. All procedures were reviewed and approved by the local Ethical Committee (number 2019-00217).

A total of 77 students were recruited. Four participants were excluded. Two participants did not meet the inclusion criteria and the other two experienced an audio problem during film viewing which prevented the use of their data.

As showed in Table 1, a total of 73 participants (mean age 21.47; $SD = 3.19$) were randomly assigned to one of the three experimental conditions:

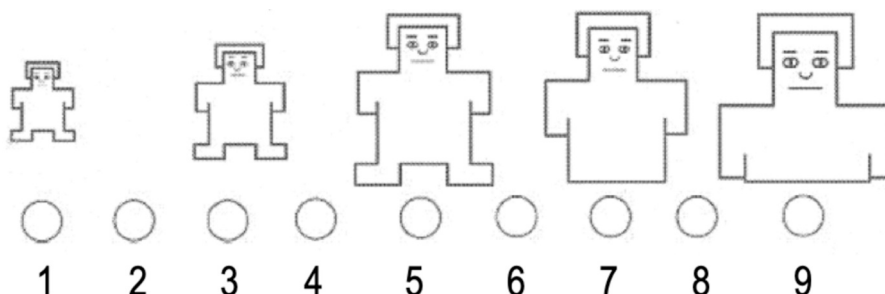


Fig. 1. IAPS Scale for dominance.

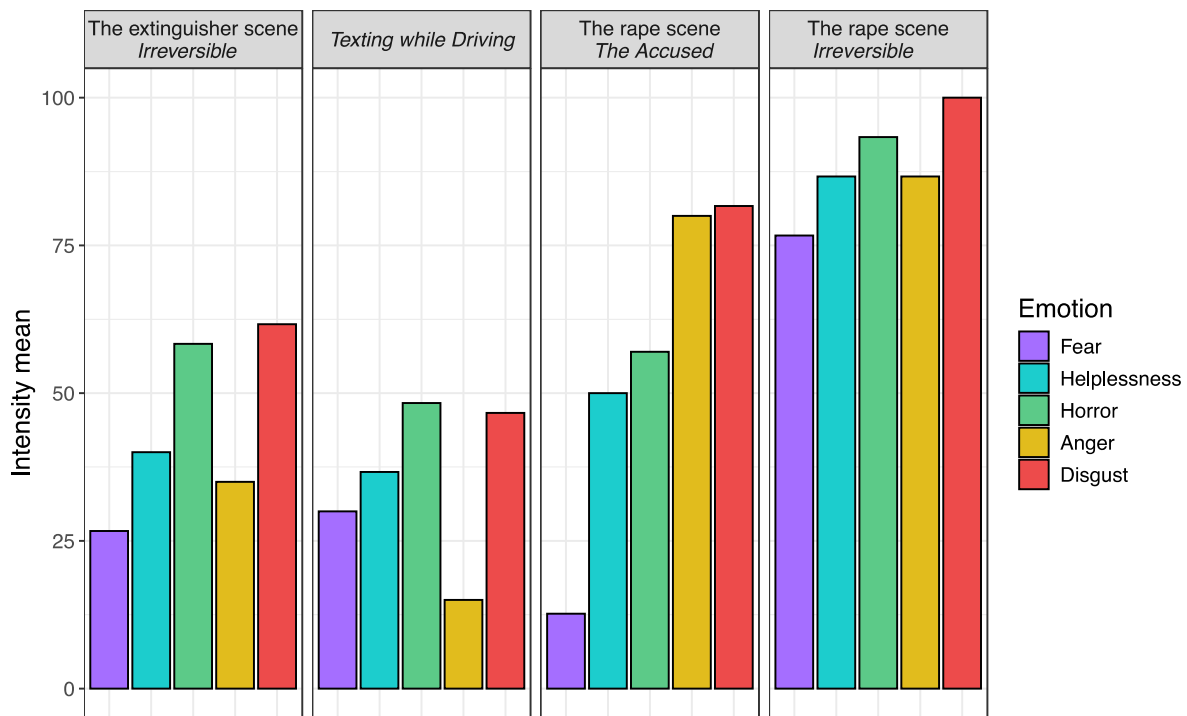


Fig. 2. Ratings of emotions associated with each film excerpt.

Table 1 Demographic table of the participants across all three conditions.

Experimental condition	Psychologist				eMPHSS				Control			
	Mean	SD	Count	Row N%	Mean	SD	Count	Row N%	Mean	SD	Count	Row N%
Age	21.78	3.13			21.25	2.80			21.42	3.66		
N° of males			11	48 %			12	50 %			17	65 %
N° of females			12	52 %			12	50 %			9	35 %

- 23 participants in condition 1 (intervention with a human psychologist);
- 24 participants, in condition 2 (digital intervention via the eMPHSS)
- 26 participants, in condition 3 (control group).

The result of a chi-squared test to assess the equality of the proportions of women in the three conditions is not significant ($\chi^2(2) = 1.851, p = 0.394$).

At the end of their involvement, they received 20 Swiss Francs per hour of participation.

3.2. Procedure and data collection

Three days prior to the commencement of the experiment, participants were provided with a comprehensive explanation of the experimental procedure. Consent forms were distributed via email, and potential participants were contacted to schedule an appointment. Potential participants underwent telephone screening to assess eligibility based on the following criteria:

- Aged between 18 and 35 years;
- Physically and mentally healthy, with no history of psychiatric disorders;
- Proficient in French, as the experiment was conducted in this language.

On the day of the experiment, participants provided written

informed consent, and completed the State-Trait Anxiety Inventory (STAI) questionnaire to ensure that potential participants did not suffer from high levels of anxiety before the experiment.

3.2.1. STAI

The STAI serves as an indicator of two types of anxiety, the state and trait anxiety, and measures the severity of the overall anxiety level. The STAI contains four-point Likert items. The number on the scale is positively correlated to the anxiety related to in the question. In the French adaptation of the STAI, participants evaluated a list of 20 items describing how they generally felt (Spielberger et al., 1993). Examples of items included “I am happy about myself”.

Participants whose STAI-TRAIT scores did not exceed two standard deviations (SD) from the mean anxiety level of the participant group were eligible to continue with the experiment. They were then informed that they were free to interrupt participation, even when the process had already begun. They were also assured that all results would be treated confidentially.

3.3. Prior to viewing the film excerpt

Before viewing the film excerpt, participants were asked to complete the Beck Depression Inventory (BDI) to assess levels of depression. This assessment was used to establish their emotional baseline.

3.3.1. Beck depression inventory

The Beck Depression Inventory (Beck et al., 1961) is a 21-item scale,

which measures attitudes and symptoms associated with depression. The items can describe an emotion such as sadness, a feeling such as guilt, or a loss of interest or energy. After considering each of them, participants selected among four statements, which best described how they had felt over the past two weeks (including the day of the experiment). The statements were rated from 0 to 3 and described an emotional state. For instance, statements related to sadness, included sentences such as “I do not feel sad” or “I am so sad and unhappy that I can’t stand it”. If participants found that several statements described their feelings equally well, they had to select the one with the highest score. To assess the reliability of our measurements we performed a Cronbach test and obtained an alpha of 0.78, which signals good reliability.

3.3.2. PANAS

Participants were also asked to complete the Positive and Negative Affect Schedule (PANAS) to evaluate their positive and negative affect. PANAS is a self-report questionnaire designed to measure positive and negative affect developed in 1988 (Watson et al., 1988). It consists of 20 items, with 10 items assessing positive affect (e.g., excited, inspired) and 10 items assessing negative effects (e.g., upset, afraid). In the experiment we used the French version (Gaudreau et al., 2006) of the PANAS. Participants read each item and gauged how they felt at the present moment, on a scale from 1 being “not at all” to 5 being “extremely”. The PANAS 1 was used as a baseline measurement to compare results obtained with PANAS 2 (after viewing the film excerpt) and PANAS 3 (after the intervention).

After completing the Beck Depression Inventory and the PANAS, participants viewed the rape scene from *Irreversible* on a TV screen (Panasonic TX-L47E5E, diagonal screen size: 119 cm) placed in front of them at a distance of two meters and a half. They were left alone while viewing, but they were informed that they could call the experimenter, who was in an adjacent room, if needed.

3.4. After viewing the film

Immediately after the viewing, participants were presented with the following questionnaires: the IAPS and the Experience Movie Rating, which were described in the pilot test. They also completed the STAI-STATE 1. For the STAI-STATE 1, Cronbach’s alpha was 0.87. As mentioned before, PANAS 2 was taken to compare it with the PANAS 1 and the PANAS 3. Cronbach’s alpha for the PANAS 2 was 0.89.

3.4.1. The three conditions

Participants were then assigned to one of the three conditions. In condition 1, participants engaged in an interview with a clinical psychologist to discuss their experiences related to the film excerpt. The interview was divided into seven phases. (*Introduction Phase, Fact Phase, Thought Phase, Reaction Phase, Symptom Phase, Teaching Phase, Re-entry Phase*) in which a list of predefined questions inspired by Mitchell’s model were asked to the participants (Mitchell et al., 1997). On average, the interview lasted 20 min, but as mentioned before there was no time limit to answer each question.

In condition 2, participants were interviewed via the eMHPSS with no time limit for the responses. The eMHPSS consisted of an interactive, touchscreen interface featuring 13 screens that the participants navigated in sequence.

The first screen served to introduce the digital intervention and the final one marked the conclusion and expressed gratitude to the participants for their involvement. The other 11 screens presented participants with a prerecorded interview excerpt of the same psychologist than in condition 1. After watching each excerpt, participants answered anonymously the questions posed by the psychologist using both the tablet’s touchscreen and an external keyboard.

As shown in Fig. 3, responses could be submitted by typing in a text box or selecting one or more emoji from a panel displaying eight emoji

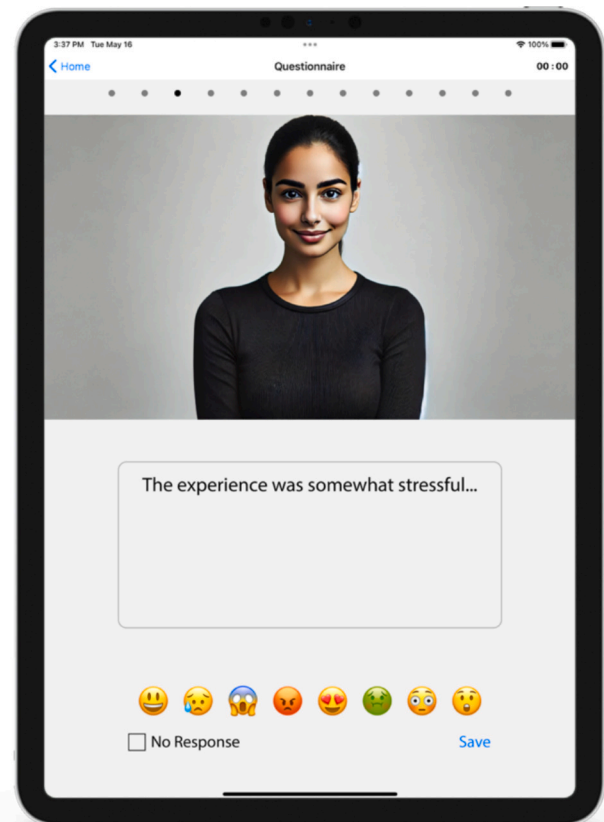


Fig. 3. The electronic mental health and psychosocial support tool.

reactions. Participants could also press on a quick reply button to specify that they did not have an answer to the question at hand.

Emoji have been recognized to be valuable affordances in computer-mediated communication (Huang et al., 2008). In our interface, we displayed eight emoji corresponding to the eight basic emotions defined by Plutchik (1997). To aid participants in identifying and expressing these emotions, the list for selecting emoji was always visible on the screen. Once the digital procedure was over, a file containing a participant’s responses was saved locally on the tablet and later extracted for analysis.

Participants in condition 1 and 2 were subjected to STAI-STATE 2 and PANAS 3. Cronbach’s was 0.88 after the intervention for STAI-STATE 2 and Cronbach’s alpha was 0.91 for PANAS 3, which indicates good reliability. For the control group (condition 3) there was no intervention after the viewing, therefore no measures were taken.

3.4.2. Flashbacks

During the seven days following the viewing of the film excerpt, participants were asked to fill out an agenda reporting the number of flashbacks they experienced. The procedure was the exact same procedure as the one described in the pilot testing phase. On day 7, participants came back to the laboratory to discuss entries in the agenda with the experimenter. The experimenter also verified that the participants did not experience strong trauma experience during that week. No participant indicated a need to consult psychological service. Table 2 summarizes the procedure.

3.5. Statistical analysis

Data analyses were conducted using IBM SPSS version 29.0 (IBM Corp. Released 2022. IBM SPSS Statistics for Windows, Version 29.0. Armonk, NY: IBM Corp.) and R (A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna,

Table 2
Experimental procedure and data collection.

Days	Procedure	Conditions 1&2	Control condition
Minus 3	Sending of information and consent form	x	x
0	Consent verification	x	x
	STAI-TRAIT		
	Immediate analysis for exclusion criteria		
	BDI	x	x
	PANAS 1		
	Film viewing	x	x
	IAPS	x	x
	Experience Movie Rating		
	STAI-STATE 1		
	PANAS 2		
	Intervention	x	
	STAI-STATE 2	x	
	PANAS 3		
	Flashbacks instructions for all participants	x	x
1-7	Flashback Reporting	x	x
7	Brief debriefing interview	x	x

Austria. To assess the equivalence of the three experimental groups prior to and after viewing the film, one-way ANOVAs were conducted on measures of anxiety, depression, and positive and negative affect. To test our research hypotheses, we subsequently conducted a mixed ANOVA to compare STAI and PANAS levels, incorporating a between-subjects factor (experimental condition) and a within-subjects factor (time of measurement). Finally, flashbacks were analyzed using a nonparametric longitudinal analysis.

4. Results

4.1. Prior to viewing the film excerpt

Pre-experiment questionnaires assessing anxiety (STAI), depression (Beck Depression Inventory), and positive and negative affect (PANAS) were analyzed. Participants across the three conditions did not exhibit significant differences in their baseline levels of anxiety ($F(2, 70) = 1.84$, $p = 0.167$), depression ($F(2, 70) = 1.50$, $p = 0.230$), positive affect ($F(2, 70) = 0.861$, $p = 0.427$), and negative affect ($F(2, 70) = 0.838$, $p = 0.437$).

4.2. After viewing the film excerpt

4.2.1. IAPS

The emotional state most strongly elicited by the film excerpt, as assessed by the IAPS questionnaire, was activation ($M = 7.26$, $SD = 1.55$). This was significantly higher than the levels of traumatism ($M = 6.10$, $SD = 2.24$) and dominance ($M = 3.71$, $SD = 2.18$). The emotional state did not significantly differ across the assigned experimental conditions.

4.2.2. The experience movie rating

The experience movie rating questionnaire revealed that all participants were emotionally impacted by the film. Disgust emerged as the most strongly associated emotion ($M = 87.40$, $SD = 23.10$), followed by anger ($M = 82.52$, $SD = 23.30$), helplessness ($M = 77.75$, $SD = 24.34$), and horror ($M = 76.25$, $SD = 25.15$). Fear was the least associated emotion ($M = 48.18$, $SD = 31.55$). Importantly, the ratings of negative emotions did not significantly differ across the three experimental conditions.

4.2.3. STAI-STATE 1

The level of state anxiety did not significantly differ among participants prior to their assignment to the different conditions;

psychologist ($M = 48.13$, $SD = 10.14$), eMHPSS ($M = 52.88$, $SD = 12.35$), and control condition ($M = 54.12$, $SD = 11.54$), $F(70,2) = 1.83$, $p = 0.167$.

All PANAS results are analyzed collectively in the PANAS subsection.

4.3. After the intervention with the psychologist or via eMHPSS

4.3.1. STAI-STATE 2

To examine whether anxiety levels varied as a function of the assigned condition, a mixed ANOVA was conducted with the experimental condition (psychologist, eMHPSS) as the between-participants variable, and the time of measurement (T0 = baseline; T1 = after viewing the film excerpt; T2 = after the intervention) as the within-participants variable, to analyze levels of negative affect.

The results depicted on the left side of Fig. 4 indicate that there was no significant difference in anxiety levels between participants assigned to the psychologist condition and those assigned to the eMHPSS condition ($F(1, 46) = 1.49$, $p = 0.228$). The results also reveal a significant main effect of the time of measurement ($F(1, 46) = 74.36$, $p < 0.001$), indicating that anxiety levels were significantly higher immediately after viewing the film excerpt ($M = 50.46$, $SD = 11.56$) compared to after the intervention ($M = 42.91$, $SD = 10.96$). Results after both the film viewing and the intervention were consistent, with the eMHPSS condition exhibiting higher levels than the psychologist condition at both time points.

4.3.2. PANAS

We examined negative affect at three points: baseline, after viewing the film excerpt, and following the intervention conditions. A mixed ANOVA was conducted with the experimental condition (psychologist, eMHPSS) as the between-participants variable, and the time of measurement (T0 = baseline; T1 = after viewing the film excerpt; T2 = after the intervention) as the within-participants variable, to analyze the levels of negative affect.

The results (Fig. 5) indicate a significant effect of the experimental conditions, $F(1, 46) = 4.12$, $p = 0.048$. Results in green indicate that negative affect was slightly higher in the eMHPSS condition ($M = 22.56$, $SD = 7.24$) compared to the psychologist condition ($M = 19.65$, $SD = 5.55$).

There was a significant main effect of the time of measurement, $F(2, 73) = 58.61$, $p < 0.001$. As shown in burgundy in Fig. 5, the highest level of negative affect was observed after film viewing ($M = 25.89$, $SD = 8.06$), which was significantly greater than the level of negative affect experienced after the intervention ($M = 21.47$, $SD = 8.07$). Both measurements also indicated higher values than the baseline level of negative affect, which was assessed before viewing the film excerpt ($M = 16.38$, $SD = 5.19$). Lastly, results showed no interaction of time of measurement by experimental condition ($F(2, 73) = 2.860$, $p = 0.239$).

4.4. Flashbacks during the week after

Fig. 6 illustrates the proportion of individuals experiencing at least one flashback during the week following the viewing of the film excerpt across three experimental conditions: control, eMHPSS, and psychologist. The data indicate that the control group had the highest proportion of individuals with flashbacks, followed by the eMHPSS group, and the psychologist group had the lowest proportion. This trend suggests that the intervention with the psychologist was most effective in reducing the occurrence of flashbacks, while the eMHPSS condition also provided some benefit compared to the control.

Fig. 7 depicts the number of flashbacks experienced by all participants over the course of seven days following the viewing of the film excerpt. The data show that participants in the control group experienced the highest number of flashbacks throughout the week, with a noticeable peak in the initial days. The eMHPSS group reported fewer flashbacks compared to the control group, indicating some effectiveness

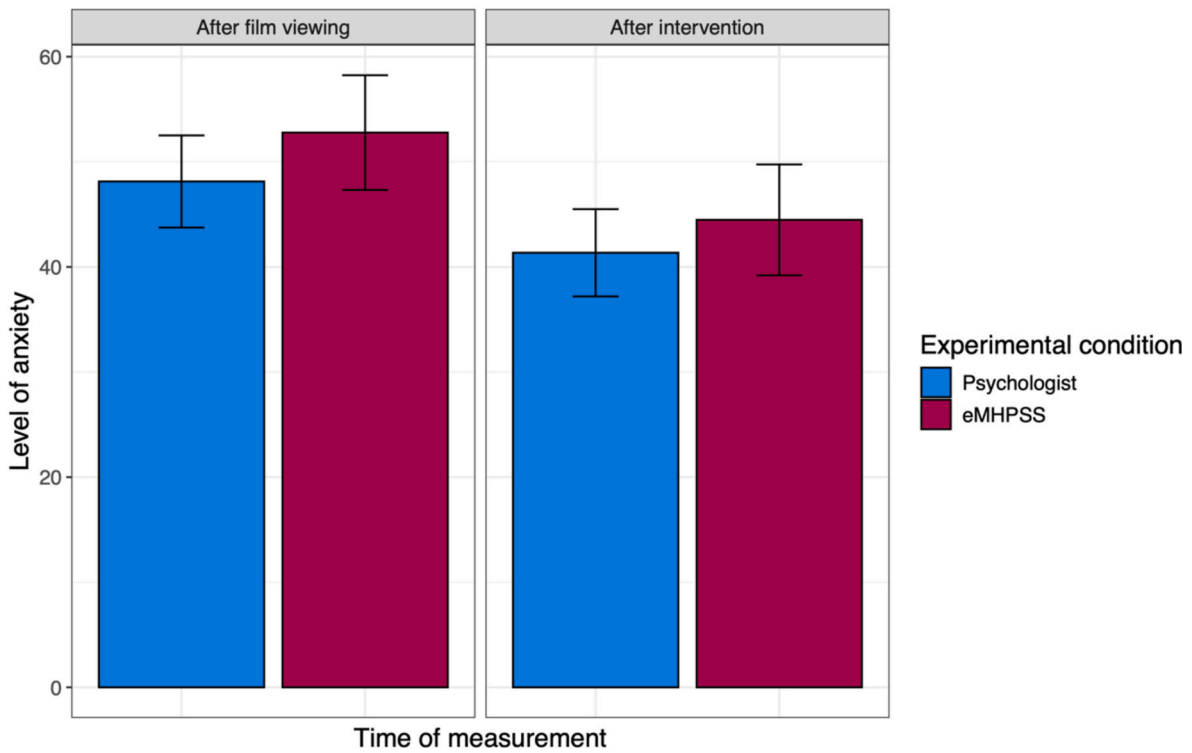


Fig. 4. Effect of time of measurement and experimental condition on the level of anxiety. Bars represent 95 % confidence intervals.

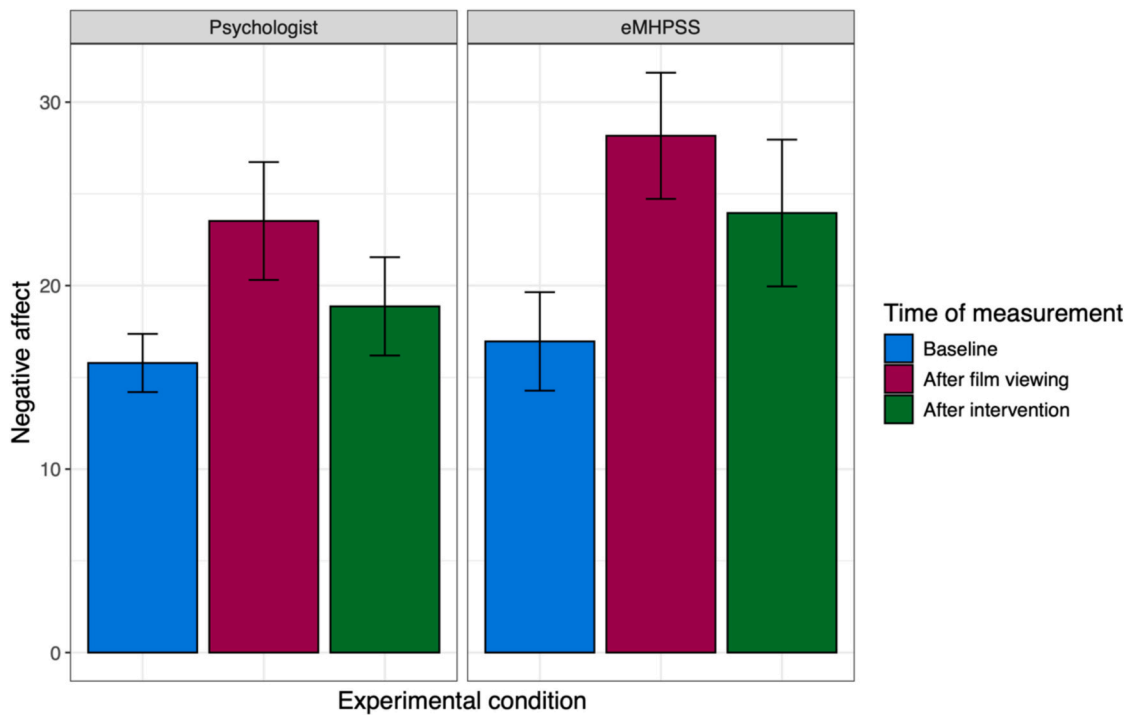


Fig. 5. Negative affect by condition and time measurement. Mean levels of negative affect with 95 % confidence intervals measured by PANAS questionnaires in the two experimental groups, before the movie (baseline in blue), after the movie (in burgundy), and after the intervention, human or digital (in green). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

of the electronic mental health support system in reducing flashbacks. The psychologist group had the lowest number of flashbacks, suggesting that the intervention with the psychologist was the most effective in mitigating the occurrence of flashbacks over the week.

Due to the skewed distribution of flashback occurrences, with a higher frequency observed in the initial days, we utilized nonparametric statistical methods. Specifically, we conducted Nonparametric Tests for the F1-LD-F1 design (Noguchi et al., 2012), which is analogous to the

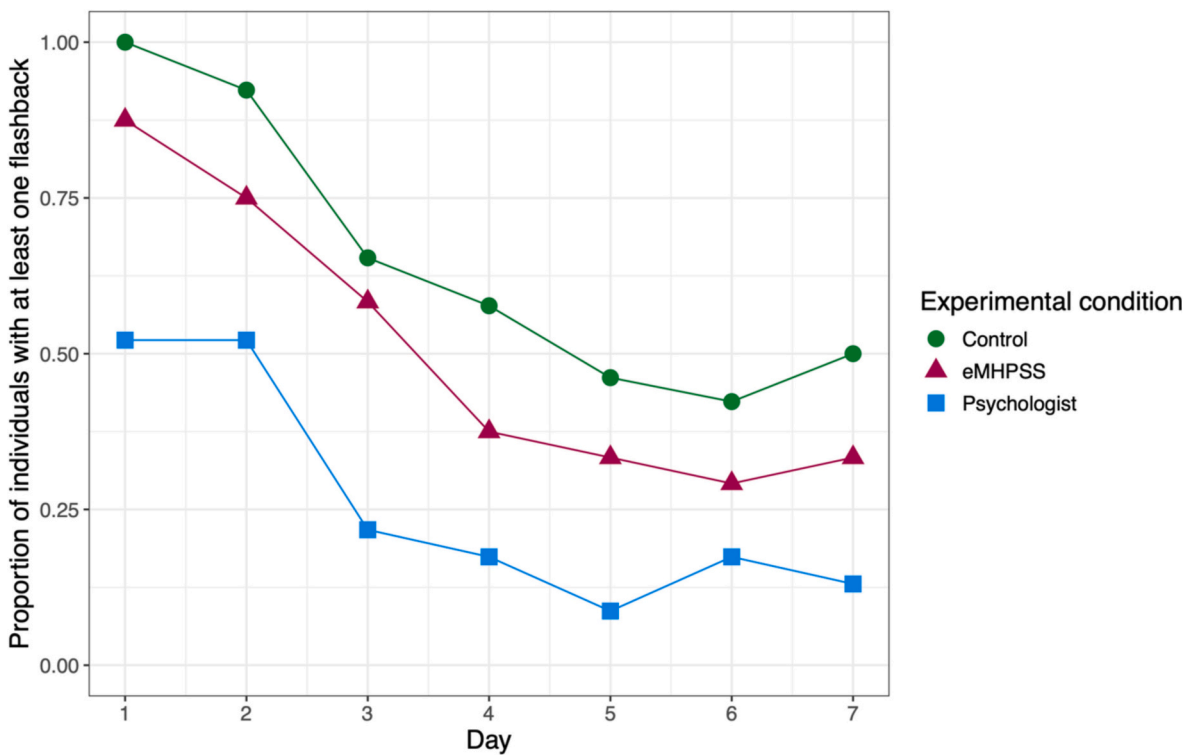


Fig. 6. Proportion of individuals having at least one flashback during the week following the viewing of the film excerpt in the three experimental conditions.

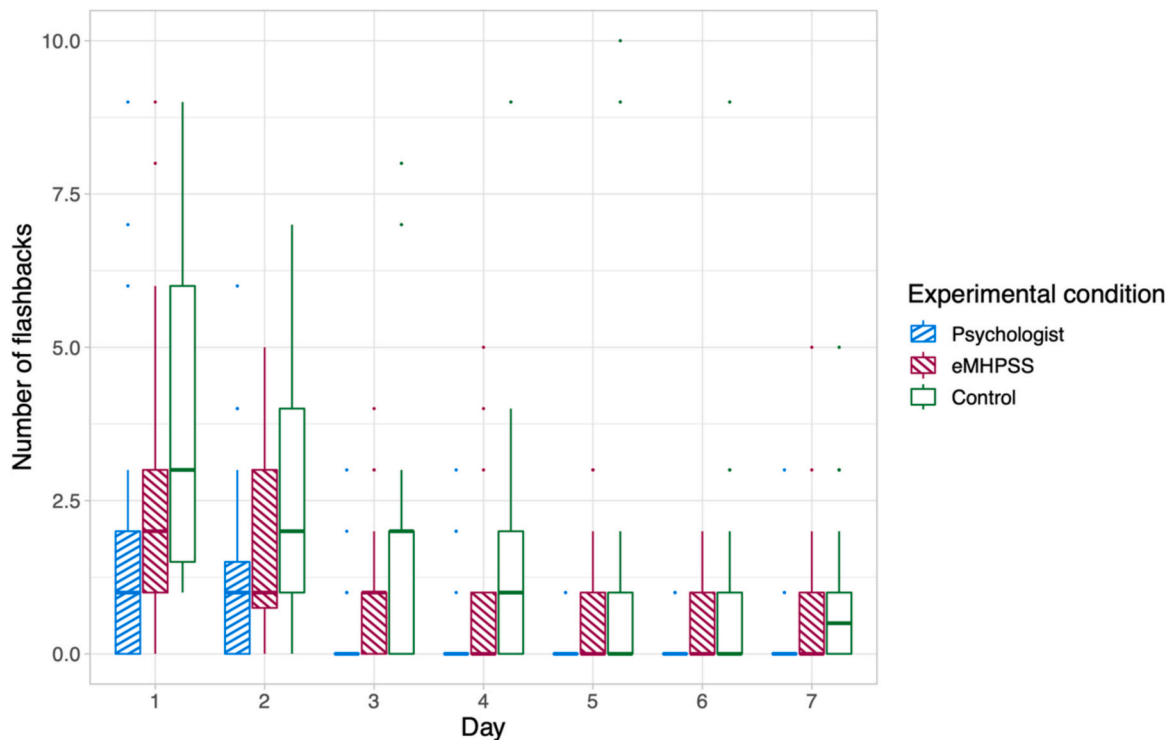


Fig. 7. Number of flashbacks during the week after watching the film excerpt in the three experimental conditions.

parametric mixed ANOVA model. The experimental condition (psychologist, eMHPSS, control) was treated as the between-participants variable, while the time of the week (ranging from 1 to 7 days post-film viewing) served as the repeated within-participants variable.

Results, which are shown in Fig. 7, reveal a main effect of time, with more flashbacks at the beginning of the week following the film excerpt

as compared to the end of the week, across all three conditions (*Wald test* = 176.76, $p < 0.001$), a main effect of the experimental condition, with the psychologist condition associated with the least flashbacks, followed by eMHPSS and control condition (*Wald test* = 18.41, $p < 0.001$), and no significant interaction between experimental conditions by time.

Our data includes some extreme values (Fig. 7), raising the question of whether these outliers impact our results. To address this, we conducted the non-parametric longitudinal analysis again, excluding the extreme values. The conclusions remained consistent, indicating the robustness of our findings.

Additionally, we calculated the median number of flashbacks for each condition and compared them across the three experimental groups. As illustrated in Table 3, during the first three days, participants in the control condition experienced the highest number of flashbacks, while those in the psychologist condition experienced the fewest. From Day 4 onwards, the eMHPSS condition demonstrated a similar effect on the number of flashbacks as the psychologist condition.

5. Discussion

The study aimed to assess the impact of different interventions—psychologist-led, digital, and no intervention—on severe negative reactions and traumatic experiences. Although exposure to the film excerpt did not result in an increase in fear, the film was primarily designed to evoke other negative emotions, such as anger, disgust, horror, and helplessness. The results indicate that both psychologist-led and digital interventions significantly reduced negative emotions, suggesting that both human and digital interventions enhance participants’ emotional well-being compared to the control condition. Although both interventions were equally effective in reducing anxiety levels, the digital intervention resulted in higher negative affect than the psychologist-led intervention, highlighting the superior efficacy of the psychologist-led intervention in alleviating negative emotional responses.

Regarding flashbacks, the results indicate a main effect of time, with a higher frequency of flashbacks observed at the beginning of the week following the viewing of the film excerpt compared to the end of the week across all three conditions. This pattern aligns with findings from other studies (Asselbergs et al., 2023), which reported a greater incidence of flashbacks in the initial days post-intervention, followed by a gradual decline over time.

Additionally, there was a main effect of the experimental condition, with the psychologist-led intervention resulting in the fewest flashbacks, followed by the eMHPSS condition, and the control condition. Lastly, no significant interaction effect between condition and time was observed.

Flashbacks are a critical measure of PTSD-like symptoms, as they constitute a core symptom of PTSD. The most pertinent findings of our study pertain to the number of flashbacks, which were significantly reduced in both experimental conditions (psychologist-led and

Table 3

Median and interquartile intervals of the number of flashbacks following the film excerpt over seven days in the three experimental conditions.

	Psychologist	Digital mediation	Control	
Day 1	1.00 [0.00, 2.00]	2.00 [1.00, 3.00]	4.00 [2.00, 6.75]	$\chi^2(2) = 15.308, p < 0.001$
Day 2	1.00 [0.00, 1.50]	1.00 [0.75, 3.00]	2.00 [1.25, 4.00]	$\chi^2(2) = 10.595, p = 0.005$
Day 3	0.00 [0.00, 0.00]	1.00 [0.00, 1.00]	2.00 [0.00, suppl2.75]	$\chi^2(2) = 13.241, p = 0.001$
Day 4	0.00 [0.00, 0.00]	0.00 [0.00, 1.00]	1.00 [0.00, 2.00]	$\chi^2(2) = 7.931, p = 0.019$
Day 5	0.00 [0.00, 0.00]	0.00 [0.00, 1.00]	0.00 [0.00, 1.00]	$\chi^2(2) = 8.143, p = 0.017$
Day 6	0.00 [0.00, 0.00]	0.00 [0.00, 1.00]	0.00 [0.00, 1.00]	$\chi^2(2) = 4.914, p = 0.086$
Day 7	0.00 [0.00, 0.00]	0.00 [0.00, 1.00]	0.50 [0.00, 1.00]	$\chi^2(2) = 7.490, p = 0.024$

Note: On each day, medians were compared using a Kruskal-Wallis rank sum test.

eMHPSS). Our results demonstrate that both interventions were effective in decreasing flashbacks during the week following the trauma-like experience. The psychologist-led intervention was the most effective, followed by the digital intervention. However, the digital intervention was still beneficial in reducing participants’ negative feelings and anxiety and the total number of flashbacks, compared to the control group.

As mentioned in the introduction, previous studies have investigated various procedures, such as playing the Tetris game immediately after the film or following memory reconsolidation (Holmes et al., 2009). Playing Tetris could potentially disrupt the visual memory consolidation of a trauma, considering that traumatic experiences often involve visual elements, whether the individual is directly experiencing or witnessing the traumatic event.

Interestingly, while Tetris was previously considered effective due to its interference with visual memory, recent observations suggest that visual interference is not the sole method for achieving negative memory interference. Other tasks, such as taking a quiz, have also been found to be effective (Kessler et al., 2020). Our study corroborates this finding, as the two proposed interventions did not interfere with visual processing. Moreover, participants were asked to report their feelings about the film through an interview inspired by the Critical Incident Stress Debriefing (Mitchell et al., 1997).

The observed reduction in negative emotions following both human and eMHPSS interventions, compared to the control, suggests that these interventions may mitigate flashbacks by facilitating emotional regulation. Both intervention groups experienced less negative affect post-intervention compared to the control group. Although some previous studies have found that debriefing could exacerbate symptoms like flashbacks through verbal memory consolidation (Holmes & Bourne, 2008), our findings demonstrate that it is not always the case. Emotional disclosure through human or digital interviews can alleviate symptoms such as flashbacks via self-disclosure. Self-disclosure or the communication of one’s feelings and thoughts to others (Jourard, 1971) plays a crucial role in coping with stress and traumatic events (Frattaroli, 2006). For instance, Pennebaker’s emotional disclosure paradigm has been shown to effectively reduce the impact of traumatic events on physical and mental health (Pennebaker & Beall, 1986) and to decrease negative affect in victims of sexual assault immediately after written disclosure, although not at a one-month follow-up (Kearns et al., 2010).

6. Limitations and future work

This study has a number of limitations that reduce the extent to which our findings can be fully generalized to PTSD. In this section, we highlight a few of these limitations and propose how they could be addressed in future work. First, it is important to note that due to ethical considerations, the trauma induced by our intervention is—by design—milder than the trauma arising from situations that usually lead to PTSD. To address this, future studies could validate the proposed eMHPSS in real-world settings. Second, while the effects of PTSD can be long-lasting, our study period is relatively short, spanning only one week and restricting our ability to observe the longer-term effects of our intervention. This limitation could be addressed by integrating longitudinal measurements into the study design. Finally, we did not record physiological measures, such as skin conductance data, which could provide an objective measure of emotional response. Including these physiological measures in future studies could offer a more comprehensive understanding of participants’ emotional states, rather than relying solely on self-reports.

7. Conclusion

Detecting and treating PTSD presents several challenges. Firstly, previous studies have highlighted the lack of technological tools that facilitate rapid intervention following trauma exposure (Holmes et al., 2009). Secondly, human intervention by psychologists or psychiatrists is

costly in terms of both time and resources. Given the critical importance of timely intervention to prevent or mitigate the impact of traumatic experiences (Giummarra et al., 2018), there is a pressing need for alternative approaches that can provide support to victims at any time and at a lower cost.

This study presents promising results regarding the effectiveness of eMHPSS in reducing symptoms following trauma-like experiences. Future research should focus on developing digital interfaces that emulate human interaction while maintaining anonymity and a nonjudgmental approach at the core of the interaction.

CRedit authorship contribution statement

Isabelle Vonèche-Cardia: Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. **Caroline Bendahan:** Supervision, Resources, Project administration, Methodology. **Marina Fiori:** Writing – original draft, Visualization, Methodology, Formal analysis. **Jean-Philippe Antonietti:** Writing – review & editing, Visualization, Methodology, Formal analysis. **Juan Carlos Farah:** Writing – review & editing, Visualization, Software. **Denis Gillet:** Supervision, Software, Resources, Project administration, Methodology, Funding acquisition, Conceptualization. **Delphine Preissmann:** Writing – original draft, Funding acquisition, Conceptualization.

Declaration of competing interest

None.

Acknowledgments

This work was funded by the EPFL-UNIL Collaborative Research on Science and Society Program.

Data availability

Data will be made available on request.

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