A novel virtual reality paradigm

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A novel virtual reality paradigm: Predictors for stress-related intrusions and avoidance behavior

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ABSTRACT

Background and objectives: Most people are exposed to a violent or life-threatening situation during their lives, but only a minority develops a stress-related disorder. To examine risk factors for the development of stress-related symptoms, such as intrusions and avoidance, analogue trauma studies are necessary. The often-used trauma film paradigm has proven to be valuable to examine intrusions, but inherently to its technique is less suitable for assessing behavioral avoidance, a core symptom of stress-related disorders. The aim of the present study was twofold, first to further develop an analogue that explicitly addresses behavioral avoidance and second, to link previously-established risk factors for the development of stress-related symptoms.

Method: Eighty-two healthy participants were subjected to a trauma induction using virtual reality (VR). At follow-up, participants were placed in a similar VR environment and could approach or avoid the trauma-scene, a trauma-related scene or a neutral, unrelated scene. Several pre- and peri-trauma risk factors were measured.

Results: The VR paradigm increased negative mood and heart rate, decreased positive mood and heart rate variability, and resulted in stress-related symptoms as trauma-related thoughts and beliefs, intrusions and avoidance behavior. The most prominent risk factors that contributed to the stress-related symptoms were negative emotions during the trauma induction, trait anxiety, and avoidant coping strategies.

Limitations: The stress-related symptoms were mild, resulting in a vast amount of participants without intrusions and limited avoidance behavior.

Conclusion: The current VR paradigm can elicit stress-related symptoms, including avoidance; risk factors contributing to these symptoms were similar to those observed in clinical research, indicating the potential of the general set up.

1. Introduction

Most people will be exposed or witness a traumatic event during their life (Goldstein et al., 2016; Kilpatrick et al., 2013), with traumatic event being defined as an exposure to actual or threatened death, serious injury, or sexual violence (Diagnostic and Statistical Manual of Mental Disorders, DSM-5, American Psychiatric Association, 2013). This exposure might be a direct confrontation, but might also include exposure to aversive material via other ways such as television or films (Holman, Garfin, & Silver, 2014). Of these exposed people, a significant amount develops a trauma- and stressor-related disorder such as Acute Stress Disorder (ASD) or the more persistent Posttraumatic Stress disorder (PTSD). Prevalence rates of ASD after a traumatic event vary from less than 10% to over 30% (Schnurr, Lunney, & Sengupta, 2004); after a month the PTSD rates may vary between 3% to over 87%, depending on the type of traumatic event (Santiago et al., 2013). However, these numbers indicate that a substantial part never develops ASD or PTSD after a traumatic experience, generating considerable interest in factors that may contribute to the development or protection of trauma- and stressor-related disorders.

Factors that modify stress-related symptoms can be divided into pre-existing factors, factors present during the trauma (peri-traumatic factors) and post-traumatic factors. Several meta-analyses have examined these factors, indicating that the latter two factors are the strongest predictor of PTSD (Brewin, Andrews, & Valentine, 2000; see for a review,; Elwood, Hahn, Olatunji, & Williams, 2009; Ozer, Best, Lipsey, & Weiss, 2003). Although these studies do provide information regarding PTSD and vulnerability factors, they have several drawbacks. Firstly, most studies included in the meta-analyses are cross-sectional and use retrospective measures. This hinders strong conclusions regarding the temporal relationship between vulnerability factors and stress-related symptoms. Secondly, a relation has been observed between the type of

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trauma and the symptoms displayed (see for an overview Smith, Summers, Dillon, & Cougle, 2016). Finally, for each victim the type, duration and frequency of the traumatic event is unique, hindering a straightforward analysis of a putative association between vulnerability factors and stress-related symptoms.

As it is clearly unethical to expose people to real traumatic events, researchers often draw on experimental analogues. In these approaches, abnormal processes in nonclinical participants are used to examine and identify mechanisms underlying psychopathology. The trauma film paradigm (TFP) is often used to evoke stress-related symptoms, using film content that is listed as traumatic in the DSM-5. Additionally, the DSM-5 explicitly states that stress-related disorders can also occur after being exposed through "electronic media, television, movies or pictures".

Several studies have demonstrated that the TFP can indeed evoke stress-related symptoms (Weidmann, Conradi, Gröger, Fehm, & Fydrich, 2009). After watching aversive film material, participants report recurrent, involuntary and distressing memories of its contents. These so-called intrusions are a prominent feature of ASD and PTSD. Other experienced short-term stress-related symptoms are self-reported distress, increase in state anxiety and changes in heart rate (see for an extensive review James et al., 2016; Weidmann et al., 2009). As such, the TFP seems to be a suitable paradigm to assess risk factors associated with stress-related symptoms (James et al., 2016).

TFP-studies indicated that similar vulnerability factors underlie the development of stress-related symptoms as in PTSD and ASD patients (Ripley, Clapp, & Beck, 2017). Pre-risk factors as maladaptive coping strategies (Davis & Clark, 1998; Regambal & Alden, 2009), higher levels of trait anxiety, depressive symptoms, trait dissociation and higher vividness of general mental imagery are related to higher intrusive memory frequency upon trauma induction (James et al., 2016). Likewise, peri-traumatic factors linked to PTSD and ASD have also been observed in intrusion development after the TFP. That is, a meta-analysis indicated that higher negative emotional responses to the film were associated with a higher intrusive memory frequency and low emotional responses with the absence of analogue flashbacks (Clark, Mackay, & Holmes, 2015). Additionally, physiological measures support the relation between distress and stress-related symptoms. Both in clinical (Kuhn, Blanchard, Fuse, Hickling, & Broderick, 2006) and experimental settings (Weidmann et al., 2009) a higher heart rate (HR) after a traumatic event predicted subsequent stress-related symptoms.

Despite being a core symptom of stressor-related disorders (American Psychiatric Association, 2013), avoidance has only recently gained attention in trauma induction paradigms (e.g., Monds, Paterson, Kemp, & Bryant, 2013; Nixon, Nehmy, & Seymour, 2007; Regambal & Alden, 2009). The results of these studies indicated that initial distress at the film was a predictor for avoidance behaviors at follow up (Nixon et al., 2007) and that aversive film material resulted in more avoidance than neutral film material did (Monds et al., 2013). In these studies, avoidance was measured with the Impact of Event Scale questionnaire (Monds et al., 2013; Nixon et al., 2007) or with a three-item questionnaire (Regambal & Alden, 2009). To my knowledge, no study has explicitly addressed behavioral avoidance of trauma-related material and related risk factors to avoidant behavior. This important as both experiential and behavioral avoidance of trauma reminders play a central role in the maintenance of trauma-related symptoms. It prevents adequate emotional processing and habituation of traumatic experiences and hinders restructuring of maladaptive cognitions (see also Steil & Ehlers, 2000).

In order to address behavioral avoidance, it is important that it is possible to adapt the stimulus material presented. Virtual Reality, VR, might be a suitable technique to induce trauma-related symptoms and, at the same time, enabling assessment of behavioral avoidance. Recently, several researchers have used VR for trauma induction (e.g., Cuperus, Klaassen, Hagenaars, & Engelhard, 2017; Cuperus, Laken, van den Hout, & Engelhard, 2016; Dibbets & Schulte-Ostermann, 2015). These studies demonstrated that exposure to VR can result in stress-related symptoms as feelings of distress and intrusions (Cuperus et al., 2016, 2017; Dibbets & Schulte-Ostermann, 2015). In the study of Dibbets and Schulte-Ostermann (2015), a direct comparison was made between the TFP and a VR version using the same aversive content. The results indicated that both paradigms elicited a negative mood and induction-related intrusions. This indicates that VR is a suitable alternative for the TFP, but –most importantly– with the additional advantage that it enables assessment of behavioral avoidance.

The main aim of the current study is to examine behavioral avoidance of trauma- and trauma-related material using VR. Based on previous research, it is expected that pre- and peri-risk factors associated with increased avoidance and intrusion frequency/severity in a trauma film paradigm will also be associated in a VR analogue.

2. Method

2.1. Participants and experimenters

Eighty-four participants (17 males and 65 females) were recruited from Maastricht. Two participants were excluded as they did not fulfil the inclusion criteria (see below, one received psychological treatment, the other reported PTSD symptoms). The remaining 82 participants were mainly students from Maastricht University ($n = 76$). Participation was rewarded either with course credits or with a voucher of 15 euros. The experimenters were trained master students from the clinical studies neuropsychology and mental health. The study was protocolized and before onset, the experimenters practiced on each other and friends in the presence of the principle investigator.

2.2. Ethical concerns

Ethical permission was obtained by the Ethical Research Committee of Psychology and Neuroscience (ECP-01_08_2013_A1) and the experiment was carried out according to ethical principles of the Declaration of Helsinki (Williams, 2008). The present study is one of the first studies using VR to induce a trauma; therefore, a number of safety strategies were applied. First, as immersion might increase the intensity of the experience, a mild VR scene was used (rated by the ethical committee). Second, participant with current or recently received (< 6 months) psychological treatment, or on a waiting list for treatment were excluded. Third, participants that reported one or more PTSD symptoms during screening were excluded. Fourth, participants with suicidal tendencies were excluded (see below). Finally, a registered health care psychologist was part of the project team and available for consultation.

2.3. Material

2.3.1. Questionnaire screening

2.3.1.1. Jellinek-PTSD screening questionnaire (JPSQ). The JPSQ is a short self-report questionnaire that can serve as a first screening for possible PTSD (van Dam, Ehring, Vedel, & Emmelkamp, 2013). The questionnaire starts with a definition of traumatic events and a list of potentially traumatic experiences (e.g., rape, serious accident) that can be marked. Participants that have one or more traumatic experienced are asked to fill out four yes/no items reflecting on re-experiencing, avoidance, hyperarousal and numbing symptoms (e.g., "In the past month, did you experience involuntary nightmares or thoughts about an event?"). The score is the sum of positive answers (range: 0–4). Only participants with a score of 0 were included for the present study. The JPSQ has shown to have a high sensitivity (0.87) and specificity (0.75) (van Dam et al., 2013).

2.3.2. Questionnaires pre-trauma factors

2.3.2.1. Beck depression inventory II (Dutch version, BDI-II-NL). The Dutch version of the BDI-II was used to assess the presence of depressive symptoms in the past two weeks (Van der Does, 2002). The BDI-II-NL consists of 21 statements that can be scored on a 4-point Likert scale with higher scores indicating more depression (range: 0–63, example item: Crying (0) I don't cry any more than I used to, (1) I cry more than I used to, (2) I cry over every little thing (3) I feel like crying, but I can't). Participants that scored a two or three on the suicidal item (item 9, “) were excluded from the study; Cronbach's α was 0.87.

2.3.2.2. State-trait anxiety inventory DY (STAI-DY). The STAI-DY was uses to assess trait anxiety (Van der Ploeg, 1982). The inventory consists of 40 items that can be scored on a 4-point Likert scale. For the current study only the 20 trait items were used (e.g., “I lack self-confidence”, answer options: Almost never to Almost always). Higher scores represent higher levels of trait anxiety (range: 20–80); Cronbach's α was 0.84.

2.3.2.3. COPE-easy inventory. The Dutch version of the COPE to assess different coping styles (Kleijn, Van Heck, & Van Waning, 2000). The inventory consists of 56 items that can be scored on a 4-point Likert scale indicating the presence of a certain coping tendency (e.g., “I turn to work or other substitute activities to take my mind off things”, answer options: I usually don't do this at all to I usually do this a lot). Fourteen coping styles can be distinguished: active coping (ACTCO), planning (PLAN), suppression of competing activities (SUPCOM), use of emotional social support (SSSe), positive reinterpretation and growth (POSREIN), mental disengagement (MENTDIS), focus on and venting of emotions (FVEMO), use of instrumental social support (SSSi), denial (DENICO), religious coping (TURNRELI), behavioral disengagement (BEHDIS), restraint (RESCO), substance use (ALCODIS), and acceptance (ACCEPT). Cronbach's α ranged from 0.36 (MENTDIS) to 0.94 (TURNREL).

2.3.2.4. The adolescent dissociative experiences scale (A-DES). The A-DES is a 30-item self-report instrument to assess dissociation (Armstrong, Putnam, Carlson, Libero, & Smith, 1997). Items can be rated with an 11-point Likert scale and summed up for an overall index, with higher scores indicating more dissociative tendencies (range: 0–300). Cronbach's α was 0.87.

2.3.2.5. Questionnaire upon mental imagery (QMI). The short-form QMI was applied to assess imagery ability (Sheehan, 1967). This questionnaire consists of 35 items that can be scored on a 7-point Likert scale (e.g., perfectly clear to I think about it, but have no image). A sum score can be made by adding up all items (range: 35–245). Note that higher scores indicate lower imagery ability, Cronbach's α was 0.95.

2.3.3. Peri-trauma factors

2.3.3.1. Modified differential emotions scale (mDES). The mDES consists of 16 items/words measuring different aspects of emotion (e.g., fearful, scared, afraid or Joyful, amused, happy). Items can be rated on a Likert scale ranging from one (not at all) to seven (very intense) (Schaefer, Nils, Sanchez, & Philippot, 2010). A negative affect score (mDESneg) was calculated by averaging the eight negative items; the positive affect score (mDESpos) was calculated by averaging the five positive items (cf. Geschwind, Meulders, Peters, Vlaeyen, & Meulders, 2015). Cronbach's α for the negative and positive score were 0.78 and 0.70, respectively.

2.3.3.2. Heart rate. Heart rate (HR) and heart rate variability (HRV) were measured as a physiological response to the trauma scene using a Polar sports watch (RS800CX N) with HR sensor strap (Polar H3).

2.3.4. Trauma induction and avoidance task

2.3.4.1. Newspaper article and questionnaire. A (fictitious) short newspaper article about a collision between a car and train was used. The article stated that the two passengers of the car died; a man aged 28 and his 4 months old baby. Shortly before the accident, the driver was taking photos of the baby using his smartphone, this action might have caused the collision. The participants were told that they would view the scene from a bystanders' point of view in virtual reality. The aim was to increase the intensity of the VR scene by letting the participants believe that they were watching a reconstruction of a real accident. A questionnaire consisting of four open questions was presented after reading the article to check whether the participants had read the article carefully. The questions were: 1) What kind of vehicles were involved in the accident? 2) What is a putative cause of the accident? 3) How many people died? 4) What was the ages of the victim(s)? In case of an incorrect answer, the participants were urged to reread the article and correct their answer.

2.3.4.2. Virtual reality apparatus. The VR scene was shown to the participants through an Oculus Rift Development Kit 2 using the Unity game engine and running on an Alienware desktop PC. Unity version 5 was used to develop the scenes. 3D models, animations, textures and other assets were created in Blender 3D, 3D Studio Max 2012 and Adobe Photoshop.

2.3.4.3. Virtual reality trauma induction. The VR scene was a reconstruction of the newspaper article. The participant viewed the scene from a bystander perspective and was able shift position within 4 square meters (see Fig. 1). The participant enters the scene just after the crash, the car is already on fire. Two other bystanders are present and

Fig. 1. Picture of the trauma induction scene.

Fig. 2. Top panel, three unrelated environments, middle panel three related environment ranging from low (left) to highly (right) similar to the trauma scene. Bottom panel, trauma scene and example of the cross road with left and right indicator.

are screaming and calling for help. The driver of the car is yelling, the baby is crying. After a couple of minutes, the car explodes and the yelling and crying stop. In the distance you can hear the sound of an ambulance approaching. Note that in a previous, pilot version the train driver tried to rescue the passengers, but fails. This scenario was rated as less aversive and credible than the current version. The total duration of the scene was about 4 min.

2.3.4.4. Virtual reality avoidance task. The general set up of the avoidance task was similar to that of the trauma induction scene. The participants were placed at a cross section in a virtual environment (360° view); their hands were positioned on the left and right shift keys of a key board. Participants were instructed to press either the left or the right shift key. Pressing the left key resulted in turning left and zooming in on the scene depicted on the left side; pressing right led to zooming in on the scene on the right side. After zooming in, the screen faded and a new trial/selection was offered. Seven different VR scenes were displayed that were either identical, related or unrelated to the trauma induction scene (see Fig. 2). The related scenes varied in their grade of similarity to the VR trauma scene. A total of 20 trials was presented. The scenes and viewpoint (i.e., approaching the cross section from northern or southern direction) varied over trials and each type of combination of scenes was offered (e.g., unrelated scene on the left and trauma scene on the right). Avoidance was operationalized by summing up the number of times participants selected a less/no trauma related scene over a more trauma-related scene (range: 0–8) and by adding the number of times the VR trauma scene was avoided (range: 0–8). Note that trials with two unrelated scenes were not included in the avoidance scores as preference of one neutral scene over the other is not indicative of trauma-related avoidance (total avoidance range: 0–16).

2.3.5. Post-trauma measures

2.3.5.1. Intrusion diary. The participants recorded induction-related intrusions for seven days after the trauma induction on a paper tabular diary (cf. Brewin & Saunders, 2001; Hagenaars & Arntz, 2012; Holmes, Brewin, & Hennessy, 2004). They noted the content of each intrusion, the trigger, its emotional valence, and the level of distress, vividness, control and spontaneity on a scale ranging from 0 to 100. Additionally, they noted the time of day of the intrusion occurrence and whether the intrusion was a thought, image or a combination. The contact information of a clinical psychologist was provided at the bottom of the first page. For the present study, only intrusions containing a visual component were used (cf. Dibbets & Arntz, 2016).

2.3.5.2. Trauma memory questionnaire. A memory questionnaire was included to check the memory of the trauma scene. The questionnaire consisted of five multiple-choice questions (e.g., "How many bystanders were present?") and a list of seven putative presented noises (e.g., ambulance). Participants indicated whether or not they had heard a specific noise during the scene. The total scores was calculated by summing up all correct answers (range: 0–12).

2.3.5.3. The posttraumatic cognition inventory (PTCI). The PTCI measures trauma-related thoughts and beliefs (Foa, Ehlers, Clark, Tolin, & Orsillo, 1999). The Dutch version consists of 36 items that can be scored on a 7-point Likert scale ranging from completely disagree to completely agree (Van Emmerik, Schoorl, Emmelkamp, & Kamphuis, 2006). The items can be categorized in three categories: Negative cognition about self (NEGself), Negative cognitions about the world (NEGworld) and Self-blame. An example of an item is "I feel dead inside"(NEGself). Thirty-three items constitute a total score between 33 and 231. Cronbach's α ranged from 0.63 (Self-blame) to 0.93 (total score).

2.4. Procedure

The experiment consisted of two sessions, a trauma induction session and a follow-up session, spaced a week apart. Before onset, the participant was screened using the JPSQ.

2.4.1. Session 1: trauma induction

The participant was invited to the lab, read general information about the experimental set up and signed the informed consent. Subsequently, 5 min of baseline cardiac data were recorded while the participant was seated in a comfortable chair. Next, the mDES (mDES#1), the BDI-II-NL, STAI-DY, COPE, A-DES and QMI were filled out. Then the participant was asked to read the newspaper article and answer the accompanying questions and, in case of any incorrect answers, to reread the article. The experimenter explained that the VR scene would contain a reconstruction of the article and that the participant would experience the scene from a bystander's viewpoint. The Oculus rift was mounted, cardiac activity was recorded and a fan was switched on to increase immersion. Next, the VR scenes of about 4 min was displayed. The cardio- and VR equipment was removed and the participant filled out the mDES (mDES#2). Next, the experimenter explained the use of intrusion diary and indicated that, in case necessary, a clinical psychologist was available.

2.4.2. Session 2: avoidance task and follow up

The participant returned to the lab one week later. The mDES (mDES#3) and Trauma memory questionnaire were filled out. Subsequently, the Oculus rift was mounted and the avoidance task was performed. Then, the mDES was presented (mDES#4) and the experimenter checked the diary and, if needed, clarification was asked. The participant received course credits or a 15 € voucher. Debriefing took place after the last participant was tested.

2.5. Statistical analysis

2.5.1. Missing values

One participant omitted one positive item of the first mDES questionnaire; this score was replaced by the mean of the remaining positive items. For the COPE, one person omitted one item of the FVEMO, this was replaced by the mean of the remaining items of this scale; one person omitted one page of the COPE (11 items), this person was left out of the COPE analyses. Likewise, three persons omitted one page of the PTCI (12 items), they were excluded for the PTCI analyses. Finally, for five persons the HR data were incomplete or not usable, they were left out in the cardiac data analyses.

2.5.2. Data reduction

An exploratory Principle Component Analysis, oblique rotation Promax (Scree plot inspection, Eigenvalues > 1, parallel analyses), was carried out to reduce the number of coping strategies. This analysis revealed five factors explaining > 70% of the variance and strongly resembled the outcomes of other studies as reported in the overview of Litman (2006): Problem-focused strategies (ACTCOP, PLAN, SUPCOM, SSSi, POSREIN, RESCO and ACCEPT), emotion-focused (SSSe and FVEMO), avoidance coping (BEHDIS, DENICO and MENTDIS), turning religious (TURNREL) and substance use (ALCDIS).

2.5.3. Data analyses

GLM repeated measures with time as within-subjects factor were carried out to examine the influence of the VR scenes. Stepwise linear regressions were used to examine the effect of the pre- and peri-trauma factors on the development of stress-related symptoms (i.e., PTCI scores, intrusions and avoidance behavior). In case both pre- and peri-trauma factors contributed to the dependent variable, additional stepwise regressions were carried out. The analyses were exploratory as this study was the first to incorporate these factors in combination with avoidance behavior. Standardized Beta coefficients and R^2 were reported; the rejection criterion was set at $p < .05$, throughout.

3. Results

3.1. VR paradigm

Table 1 summarizes all means and standard deviations. The GLM repeated measures with time, before and after the VR scene, as within-subject factor indicated an increase in negative mDES scores, $F(1, 81) = 46.24$, $p < .001$, $\eta p^2 = 0.36$, and a decrease in positive mDES scores, $F(1, 81) = 51.34$, $p < .001$, $\eta p^2 = 0.39$. Likewise, the VR avoidance task increased negative mDES scores, $F(1, 81) = 15.54$, $p < .001$, $\eta p^2 = 0.16$, and decreased the positive scores, $F(1, 81) = 46.55$, $p < .001$, $\eta p^2 = 0.37$. For the cardiac measures, during the trauma induction an increase in HR, $F(1, 76) = 6.48$, $p = .013$, $\eta p^2 = 0.079$, and a decrease in variability, $F(1, 76) = 7.71$, $p = .007$, $\eta p^2 = 0.092$, was observed compared to baseline.

Table 1
Mean scores, standard deviations (SD) and range for the risk factors and dependent variables.

	Mean	SD	Minimum	Maximum
Age (yr)	22.50	3.76	18	44
BDI-II-NL	5.90	5.77	.00	26.00
STAI-DY	35.37	7.36	22.00	52.00
COPE				
Problem-focused	.00	1.00	−2.82	1.86
Emotion-focused	.00	1.00	−2.60	1.79
Avoidance	.00	1.00	−1.97	2.95
Turning religious	.00	1.00	−3.04	2.52
Substance use	.00	1.00	−2.64	4.35
A-DES	29.89	21.89	2.00	112.00
QMI	88.98	28.44	35.00	173.00
mDES				
mDESpos#1	3.98	.81	1.80	5.80
mDESneg#1	1.51	.53	1.00	3.75
mDESpos#2	3.36	.92	1.00	5.40
mDESneg#2	2.30	1.15	1.00	6.50
mDESpos#3	4.16	.80	1.80	6.20
mDESneg#3	1.33	.46	1.00	3.50
mDESpos#4	3.68	.89	1.20	5.80
mDESneg#4	1.59	.75	1.00	4.50
Cardiac activity				
HR baseline	80.49	14.12	45.98	119.24
HRV baseline	78.77	48.19	18.00	356.00
HR trauma	83.61	14.80	56.96	128.25
HRV trauma	63.96	25.17	23.80	183.10
Trauma memory questionnaire	9.57	1.44	6.00	12.00
PTCI				
NEGself	30.42	9.93	21.00	83.00
NEGworld	15.87	7.44	7.00	40.00
Self-blame	7.48	3.16	5.00	18.00
Total	53.77	18.04	33.00	141.00
Intrusions				
Frequency	1.30	1.75	0	10
Distress	20.08	20.30	.00	70.00
Vividness	36.83	24.66	.00	100.00
Control	74.35	28.39	.00	100.00
Spontaneity	55.29	30.03	.00	100.00
Avoidance	5.51	2.43	1.00	13.00

3.2. Pre-trauma factors

3.2.1. PTCI scores

A stepwise linear regression was calculated to predict the total PTCI score based on gender and the scores of the BDI-II-NL, STAI-DY, five factors of the COPE, A-DES and QMI. A significant regression equation was found, $F(2, 76) = 12.90$, $p < .001$, $R^2 = 0.25$. The STAI-DY significantly predicted the PTCI score, $\beta = 0.27$, $p = .014$, as did the avoidance coping factor, $\beta = 0.33$, $p = .003$.

A similar analysis on the NEGself scale revealed similar results, with a significant regression equation, $F(2, 76) = 15.85$, $p < .001$, $R^2 = 0.29$, significantly predicted by STAI-DY, $\beta = 0.25$, $p = .019$, and the avoidance coping factor, $\beta = 0.39$, $p < .001$.

For the NEGworld only one significant predictor was found, $F(1, 77) = 11.50$, $p = .001$, $R^2 = 0.13$, namely, STAI-DY, $\beta = 0.36$, $p = .001$.

Finally, for Self-blame a significant regression equation was observed, $F(1, 77) = 4.24$, $p = .043$, $R^2 = 0.052$; with the BDI-II-NL being the only significant predictor, $\beta = 0.23$, $p = .043$.

3.2.2. Intrusions

A stepwise linear regression was calculated to predict the number of intrusions using the same predictors as for the PTCI scores. A significant regression equation was observed, $F(1, 79) = 6.58$, $p = .012$, $R^2 = 0.077$. Only the QMI predicted intrusion frequency, $\beta = 0.28$,

$p = .012$.

Similar analyses were carried out for the intrusion characteristics. A significant model was observed for distress, $F(1, 44) = 5.81$, $p = .020$, $R^2 = 0.12$, with STAI-DY being the only significant predictor, $\beta = 0.34$, $p = .020$. A significant model was also observed for amount of control, $F(1, 44) = 4.43$, $p = .041$, $R^2 = 0.092$, the avoidance coping strategy significantly predicted the (lack of) amount of experienced control, $\beta = -0.30$, $p = .041$. No significant regression equations were observed for the vividness and spontaneity of the intrusions.

3.2.3. Avoidance

The stepwise linear regression of the avoidance score yielded a significant model, $F(5, 75) = 6.70$, $p < .001$, $R^2 = 0.28$. Social support, $\beta = 0.26$, $p = .014$, avoidance coping, $\beta = 0.31$, $p = .005$, problem focused coping, $\beta = -0.31$, $p = .004$, turning to religion, $\beta = 0.21$, $p = .042$, and the BDI-II-NL, $\beta = -0.31$, $p = .004$, significantly predicted the avoidance score.

3.3. Peri-trauma factors

3.3.1. PTCI scores

A stepwise linear regression was calculated to predict the total PTCI score based on peri-traumatic factors (scores mDES#2 and cardiac measures) and the impact of the trauma on these factors (peri-trauma minus baseline). The analysis yielded a significant regression equation, $F(2, 72) = 12.54$, $p < .001$, $R^2 = 0.26$. The mDES#2 negative emotion score (mDESneg#2) during the trauma induction and change in this score significantly predicted the total PTCI score, $\beta = 0.95$, $p < .001$, and $\beta = -0.57$, $p = .013$, respectively. As these scores are interrelated, $r(82) = 0.89$, $p < .001$, separate Pearson correlation analyses were carried out revealing a positive relation between the PTCI and mDESneg#2 score, $r(79) = 0.44$, $p < .001$, and between the PTCI and change score, $r(79) = 0.28$, $p = .013$.

The analysis of the NEGself scale revealed similar results, with a significant regression equation, $F(2, 72) = 12.04$, $p < .001$, $R^2 = 0.25$, significantly predicted by mDESneg#2, $\beta = 0.92$, $p < .001$, and the negative change score, $\beta = -0.54$, $p = .018$. The correlation between the NEGself score and each predictor were, respectively, $r(79) = 0.44$, $p < .001$, and, $r(79) = 0.28$, $p = .012$.

For the NEGworld only one predictor was observed, $F(1, 73) = 8.97$, $p = .004$, $R^2 = 0.11$; mDESneg#2 predicted the NEGworld score, $\beta = 0.33$, $p = .004$.

Finally, for Self-blame a significant regression equation was observed, $F(2, 72) = 7.47$, $p = .001$, $R^2 = 0.17$; with MDESneg#2 and the accompanying change score being significant predictors, $\beta = 0.79$, $p = .001$, and, $\beta = -0.50$, $p = .039$, respectively. The Pearson correlations were, correspondingly, $r(79) = 0.36$, $p = .001$, and, $r(79) = 0.21$, $p = .059$.

3.3.2. Intrusions

No significant regression equation was observed upon entering the peri-trauma factors regarding intrusion frequency.

Similar analyses were carried out for the intrusion characteristics. A significant model was observed for distress, $F(1, 43) = 26.37$, $p < .001$, $R^2 = 0.38$, with mDESneg#2 being the only significant predictor, $\beta = 0.61$, $p < .001$. A significant model was also observed for amount of control, $F(1, 43) = 6.60$, $p = .014$, $R^2 = 0.13$, positive emotions during the trauma, mDESpos#2, significantly predicted the amount of experienced control, $\beta = 0.37$, $p = .014$. Finally, a significant model was also observed for the spontaneity of the experienced intrusions, $F(2, 42) = 4.73$, $p = .014$, $R^2 = 0.18$. The change in HR predicted spontaneity, $\beta = -0.35$, $p = .017$, as did the change in negative emotions, $\beta = 0.29$, $p = .046$. No significant regression equation was observed for the vividness of the intrusions.

3.3.3. Avoidance

The stepwise regression, including additionally the mDES scores during follow up (mDES#3 and mDES#4), yielded a significant model, $F(1, 75) = 5.16$, $p = .026$, $R^2 = 0.064$. Only the positive MDES score during the trauma, mDESpos#2, predicted the avoidance score, $\beta = 0.25$, $p = .026$.

Note that trauma memory, Trauma memory questionnaire, did not predict any of the dependent variables and was not predicted by any of the pre- and peri-trauma variables.

3.4. Pre- and peri-trauma factors

3.4.1. PTCI scores

The regression model revealed significant contributions to the PTCI score for the avoidance coping factor, negative emotion score (mDESneg#2) and the accompanying negative change score. Subsequent analyses indicated an R^2 of 0.19 for both the avoidance coping and mDESneg#2, for the change score R^2 was 0.078.

For the NEGself scale both avoidance coping and mDESneg#2 significantly contributed. The accompanying R^2 were 0.24 and 0.19, respectively.

Both the STAI-DY and mDESneg#2 predicted the NEGworld score of the PTCI; R^2 were 0.13 and 0.10, respectively.

The regression equation of the Self-blame score indicated two predictor variables: the mDESneg#2 and negative change score. The accompanying R^2were 0.12 and 0.045, respectively.

3.4.2. Intrusions

Intrusion distress was best predicted by the MDESneg#2 score, $R^2 = 0.38$. For the amount of control both positive emotions during the trauma scene, mDESpos#2, $R^2 = 0.14$, and avoidance coping, $R^2 = 0.092$, contributed.

3.4.3. Avoidance

For avoidance significant positive contributions were observed for: mDESpos#2, $R^2 = 0.076$, and avoidance coping, $R^2 = 0.044$; a negative contribution was observed for problem focused coping, $R^2 = 0.027$, and the BDI-II-NL score, $R^2 = 0.049$.

4. Discussion

The aim of the present study was twofold, first to explicitly address behavioral avoidance to trauma-related material and second, to link previously-established risk factors to the development of stress-related symptoms. To this end, a VR paradigm was developed depicting a train crash. Intrusions and trauma-related cognitions were measured; avoidance of trauma-related VR material was assessed during a follow-up session.

The results indicated that the trauma scene increased negative mood and decreased positive mood. At a physiological level, an increase in HR and a decrease in HRV were observed, indicating enhanced stress levels (Appelhans & Luecken, 2006). Additionally, trauma-related intrusions were reported and avoidance of trauma-related material was observed. In sum, the current paradigm seems to be able to induce mild stress-related symptoms, including avoidance behavior.

Pre-trauma factors, trait anxiety (STAI-DY) and the avoidance coping factor (COPE), positively contributed to higher levels of self-reported trauma-related cognitions (PTCI). Additionally, a small contribution was observed for depression scores (BDI-II-NL) on the Self-blame scale of the PTCI. Intrusion frequency was negative associated with mental imagery capability (QMI); trait anxiety and avoidance coping strategy positively attributed to the amount of, respectively, experienced distress and control over the intrusions. For avoidance, a positive relation was observed for coping strategies social support, avoidance coping, turning to religion; negative relations were observed for problem focused coping and depressive symptoms.

For the peri-trauma factors, (increase in) negative mood (mDESneg#2) predicted self-reported trauma-related cognitions and the experienced distress and spontaneity of the intrusions. Positive mood during the trauma induction (mDESpos#2) predicted more control over the intrusions and, unexpectedly, higher avoidance scores at follow up. For the remainder of the Discussion only the predictors that held after entering both the pre- and peri-trauma factors will be discussed.

Most of the observed pre- and peri-trauma predictors did not come as a surprise. For example, trait anxiety and avoidance coping strategies have also been associated with more PTSD symptoms in clinical (see for a review DiGangi et al., 2013) as well as non-clinical (see James et al., 2016, for a review) samples. Whereas more adaptive coping strategies, such as problem focused coping, are associated with less avoidance (see for reviews PTSD symptoms and coping, Olff, Langeland, & Gersons, 2005; Ozer et al., 2003). For the peri-trauma factors, the observation that the intensity of negative mood during trauma is related to stress symptoms also accords with previous research in clinical (Ozer et al., 2003) as well as non-clinical (James et al., 2016) samples. Even more, several authors claim that the experienced distress during trauma might be a better predictor for PTSD than pre-trauma factors (see for an overview Brewin et al., 2000; Elwood et al., 2009; Ozer et al., 2003).

However, contrary to our expectations and previous studies (Dibbets & Schulte-Ostermann, 2015; Morina, Leibold, & Ehring, 2013), lower levels of mental imagery abilities predicted more intrusions. This seems counterintuitive, as higher vivid imagery can be expected to result in a more vivid image of the traumatic event, including stronger psychophysiological responses and increased perception of reality and "nowness" of the memory (Kosslyn, 2005; Morina et al., 2013; but see recovered patients; Jelinek et al., 2010). However, one can also argue that higher ability to form vivid images might result in a better storage of contextually relevant information, resulting in less involuntary memory retrieval (Byrne, Becker, & Burgess, 2007; but see,; Pearson, Ross, & Webster, 2012). Additionally, one can also reason that mental imagery for non-traumatic material, as is the case for the QMI items, might not be the best predictor for intrusions of highly arousing trauma-related material (Jelinek et al., 2010). This could also be apparent in the present study as less than 8% of the intrusion frequency was predicted by the QMI score.

A second unexpected result is the observed relation between positive mood and more avoidance during follow up. Seemingly inappropriate, positive emotions are known to co-occur alongside negative emotions during stress exposure (Folkman, 2008). In our sample, the positive and negative scores were indeed not mutually exclusive, there was no strong (negative) association between the positive and (lack of) negative scores during the trauma scene ($r(82) = -0.15$, $p = .19$). Further analyses revealed that more than 75% of the scores ranged from not at all to neutral/moderate positive and for more than 68% the positive mood decreased after seeing the VR trauma, this indicates a negative rather than a positive mood. Nonetheless, and remaining unexplained, higher levels of positive mood did predict more avoidance.

Thirdly, a negative link was observed between depression and avoidance behavior, indicating that higher levels of depressive symptoms before the trauma induction predicted less avoidance of trauma-related material at follow-up. Depression is normally associated with increased avoidance behavior; however, higher levels of depression are also associated with negative information processing biases (see for an overview, Trew, 2011). As such, one can argue that participants with higher BDI-II-NL scores were more prone to check if their negative view still holds, resulting in approach rather than avoidance of the trauma-related material. For a future study, it would be wise to separate these concepts by, for example, asking the participants the motivation of their choices.

The current study suffers from several limitations. First, a non-clinical sample was used, making it difficult to extrapolate the results to a clinical population Second, the amount of observed intrusions was low. Thirty-five participants did not have any visual intrusion; the mean number of visual intrusions of the remaining participants was 3.15 (range: 1–10). This low amount might hinder the detection of risk factors associated with stress-related symptoms. However, even in case of exposure to a real train collision some people, though a minority, report no intrusions (Engelhard, van den Hout, Arntz, & McNally, 2002). Third, the avoidance scores were rather low, indicating that little avoidance took place. It is possible that the instructions were not clear enough; we stated that the participant could select one of two scenes. Perhaps some participants deliberately selected the most trauma-related scenes as they thought this was part of the assignment. Finally, the avoidance in the current set up did not come with direct costs besides being remembered of the trauma scene; selection of a particular scene did not prolong the experiment nor did it have other unbeneficial effects. In real life, avoidance often does come along with costs, such as taking a substantial detour to avoid the place where you have been raped.

Currently, we are revising the VR scene, taking the abovementioned limitations into account. In this novel scene, we try to increase the aversiveness by unexpectedly displaying a dead, decomposing body of a murdered child during a search for bike keys in a forest. This scene has a clear aversive image, increasing the probability on intrusive memories regarding this hotspot (Krans, Näring, Becker, & Holmes, 2009). Additionally, the uncontrollability and unpredicted disclosure of the body might also enhance PTDS-like symptoms (Lissek & van Meurs, 2015). Avoidance will be measured by replacing the participant in the forest with a different assignment (e.g., finding clues for solving a quest). The participant is allowed to move around freely, it is not necessary to revisit the crime scene, but it will shorten the duration of the experiment. The traveled pathway and time to solve the quest will be recorded. This novel set up might result in more avoidance behavior.

In sum, negative emotions during the induction seemed to be, overall, the most valid predictor for trauma-induced symptoms. As trauma films typically result in high levels of negative emotions, one could wonder if a VR alternative is necessary (see also Dibbets & Schulte-Ostermann, 2015). This probably depends on the research question, with the TFP favoring research on intrusions and negative emotions and the VR paradigm being more suitable for examination of avoidance-related questions. As such the present experimental set-up seems to be a promising step towards a novel paradigm to assess stress-related symptoms and avoidance behavior.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbtep.2019.01.001.

References

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders : DSM-5*. Washington, D.C: American Psychiatric Association.

Appelhans, B. M., & Luecken, L. J. (2006). Heart rate variability as an index of regulated emotional responding. *Review of General Psychology, 10*(3), 229.

Armstrong, J. G., Putnam, F. W., Carlson, E. B., Libero, D. Z., & Smith, S. R. (1997). Development and validation of a measure of adolescent dissociation: The adolescent dissociative experiences scale. *The Journal of Nervous and Mental Disease, 185*(8), 491–497.

Brewin, C. R., Andrews, B., & Valentine, J. D. (2000). *Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults*. American Psychological

Association.
Brewin, C. R., & Saunders, J. (2001). The effect of dissociation at encoding on intrusive memories for a stressful film. *British Journal of Medical Psychology, 74*, 467–472.
Byrne, P., Becker, S., & Burgess, N. (2007). Remembering the past and imagining the future: A neural model of spatial memory and imagery. *Psychological Review, 114*(2), 340.
Clark, I. A., Mackay, C. E., & Holmes, E. A. (2015). Low emotional response to traumatic footage is associated with an absence of analogue flashbacks: An individual participant data meta-analysis of 16 trauma film paradigm experiments. *Cognition & Emotion, 29*(4), 702–713. https://doi.org/10.1080/02699931.2014.926861.
Cuperus, A. A., Klaassen, F., Hagenaars, M. A., & Engelhard, I. M. (2017). A virtual reality paradigm as an analogue to real-life trauma: Its effectiveness compared with the trauma film paradigm. *European Journal of Psychotraumatology, 8*(sup1), 1338106. https://doi.org/10.1080/20008198.2017.1338106.
Cuperus, A. A., Laken, M., van den Hout, M. A., & Engelhard, I. M. (2016). Degrading emotional memories induced by a virtual reality paradigm. *Journal of Behavior Therapy and Experimental Psychiatry, 52*, 45–50.
van Dam, D., Ehring, T., Vedel, E., & Emmelkamp, P. M. (2013). Screening for posttraumatic stress disorder in civilian substance use disorder patients: Cross-validation of the jellinek-PTSD screening questionnaire. *Journal of Substance Abuse Treatment, 44*(1), 126–131. https://doi.org/10.1016/j.jsat.2012.03.005.
Davis, M. I., & Clark, D. M. (1998). Predictors of analogue post-traumatic intrusive cognitions. *Behavioural and Cognitive Psychotherapy, 26*(4), 303–314.
Dibbets, P., & Arntz, A. (2016). Imagery rescripting: Is incorporation of the most aversive scenes necessary? *Memory, 24*(5), 683–695.
Dibbets, P., & Schulte-Ostermann, M. A. (2015). Virtual reality, real emotions: A novel analogue for the assessment of risk factors of post-traumatic stress disorder. *Frontiers in Psychology, 6*. https://doi.org/10.3389/fpsyg.2015.00681.
DiGangi, J. A., Gomez, D., Mendoza, L., Jason, L. A., Keys, C. B., & Koenen, K. C. (2013). Pretrauma risk factors for posttraumatic stress disorder: A systematic review of the literature. *Clinical Psychology Review, 33*(6), 728–744.
Elwood, L. S., Hahn, K. S., Olatunji, B. O., & Williams, N. L. (2009). Cognitive vulnerabilities to the development of PTSD: A review of four vulnerabilities and the proposal of an integrative vulnerability model. *Clinical Psychology Review, 29*(1), 87–100.
Engelhard, I. M., van den Hout, M. A., Arntz, A., & McNally, R. J. (2002). A longitudinal study of "intrusion-based reasoning" and posttraumatic stress disorder after exposure to a train disaster. *Behaviour Research and Therapy, 40*(12), 1415–1424.
Foa, E. B., Ehlers, A., Clark, D. M., Tolin, D. F., & Orsillo, S. M. (1999). The posttraumatic cognitions inventory (PTCI): Development and validation. *Psychological Assessment, 11*(3), 303–314.
Folkman, S. (2008). The case for positive emotions in the stress process. *Anxiety, Stress, and Coping, 21*(1), 3–14.
Geschwind, N., Meulders, M., Peters, M. L., Vlaeyen, J. W. S., & Meulders, A. (2015). Can experimentally induced positive affect attenuate generalization of fear of movement-related pain? *The Journal of Pain, 16*(3), 258–269. https://doi.org/10.1016/j.jpain.2014.12.003.
Goldstein, R. B., Smith, S. M., Chou, S. P., Saha, T. D., Jung, J., Zhang, H., ... Grant, B. F. (2016). The epidemiology of DSM-5 posttraumatic stress disorder in the United States: Results from the national epidemiologic survey on alcohol and related conditions-III. *Social Psychiatry and Psychiatric Epidemiology, 51*(8), 1137–1148. https://doi.org/10.1007/s00127-016-1208-5.
Hagenaars, M. A., & Arntz, A. (2012). Reduced intrusion development after post-trauma imagery rescripting; an experimental study. *Journal of Behavior Therapy and Experimental Psychiatry, 43*(2), 808–814.
Holman, E. A., Garfin, D. R., & Silver, R. C. (2014). Media's role in broadcasting acute stress following the Boston Marathon bombings. *Proceedings of the National Academy of Sciences, 111*(1), 93–98. https://doi.org/10.1073/pnas.1316265110.
Holmes, E. A., Brewin, C. R., & Hennessy, R. G. (2004). Trauma films, information processing, and intrusive memory development. *Journal of Experimental Psychology: General, 133*(1), 3–22. https://doi.org/10.1037/0096-3445.133.1.3.
James, E. L., Lau-Zhu, A., Clark, I. A., Visser, R. M., Hagenaars, M. A., & Holmes, E. A. (2016). The trauma film paradigm as an experimental psychopathology model of psychological trauma: Intrusive memories and beyond. *Clinical Psychology Review, 47*(Supplement C), 106–142. https://doi.org/10.1016/j.cpr.2016.04.010.
Jelinek, L., Randjbar, S., Kellner, M., Untiedt, A., Volkert, J., Muhtz, C., et al. (2010). Intrusive memories and modality-specific mental imagery in posttraumatic stress disorder. *Zeitschrift für Psychologie/journal of Psychology, 218*(2), 64–70.
Kilpatrick, D. G., Resnick, H. S., Milanak, M. E., Miller, M. W., Keyes, K. M., & Friedman, M. J. (2013). National estimates of exposure to traumatic events and PTSD prevalence using DSM-IV and DSM-5 criteria. *Journal of Traumatic Stress, 26*(5), 537–547. https://doi.org/10.1002/jts.21848.
Kleijn, W. C., Van Heck, G., & Van Waning, A. (2000). Ervaringen met een Nederlandse bewerking van de COPE copingvragenlijst: De COPE-Easy. *Gedrag & Gezondheid, 28*, 213–226.
Kosslyn, S. M. (2005). Reflective thinking and mental imagery: A perspective on the development of posttraumatic stress disorder. *Development and Psychopathology, 17*(3), 851–863.
Krans, J., Näring, G., Becker, E. S., & Holmes, E. A. (2009). Intrusive trauma memory: A review and functional analysis. *Applied Cognitive Psychology, 23*(8), 1076–1088. https://doi.org/10.1002/acp.1611.
Kuhn, E., Blanchard, E. B., Fuse, T., Hickling, E. J., & Broderick, J. (2006). Heart rate of motor vehicle accident survivors in the emergency department, peritraumatic psychological reactions, ASD, and PTSD severity: A 6-month prospective study. *Journal of Traumatic Stress: Official Publication of The International Society for Traumatic Stress Studies, 19*(5), 735–740.
Lissek, S., & van Meurs, B. (2015). Learning models of PTSD: Theoretical accounts and psychobiological evidence. *International Journal of Psychophysiology, 98*(3), 594–605.
Monds, L. A., Paterson, H. M., Kemp, R. I., & Bryant, R. A. (2013). Do distress responses to a traumatic film predict susceptibility to the misinformation effect? *Journal of Trauma & Dissociation, 14*(5), 562–575. https://doi.org/10.1080/15299732.2013.804475.
Morina, N., Leibold, E., & Ehring, T. (2013). Vividness of general mental imagery is associated with the occurrence of intrusive memories. *Journal of Behavior Therapy and Experimental Psychiatry, 44*(2), 221–226. https://doi.org/10.1016/j.jbtep.2012.11.004.
Nixon, R. D. V., Nehmy, T., & Seymour, M. (2007). The effect of cognitive load and hyperarousal on negative intrusive memories. *Behaviour Research and Therapy, 45*(11), 2652–2663. https://doi.org/10.1016/j.brat.2007.06.010.
Olff, M., Langeland, W., & Gersons, B. P. (2005). The psychobiology of PTSD: Coping with trauma. *Psychoneuroendocrinology, 30*(10), 974–982.
Ozer, E. J., Best, S. R., Lipsey, T. L., & Weiss, D. S. (2003). Predictors of posttraumatic stress disorder and symptoms in adults: A meta-analysis. *Psychological Bulletin, 129*(1), 52–73.
Pearson, D. G., Ross, F. D. C., & Webster, V. L. (2012). The importance of context: Evidence that contextual representations increase intrusive memories. *Journal of Behavior Therapy and Experimental Psychiatry, 43*(1), 573–580. https://doi.org/10.1016/j.jbtep.2011.07.009.
Regambal, M. J., & Alden, L. E. (2009). Pathways to intrusive memories in a trauma analogue paradigm: A structural equation model. *Depression and Anxiety, 26*(2), 155–166.
Ripley, A. J., Clapp, J. D., & Beck, J. G. (2017). A prospective examination of risk factors in the development of intrusions following a trauma analog. *Behaviour Research and Therapy, 94*(Supplement C), 71–80. https://doi.org/10.1016/j.brat.2017.05.001.
Santiago, P. N., Ursano, R. J., Gray, C. L., Pynoos, R. S., Spiegel, D., Lewis-Fernandez, R., ... Fullerton, C. S. (2013). A systematic review of PTSD prevalence and trajectories in DSM-5 defined trauma exposed populations: Intentional and non-intentional traumatic events. *PLoS One, 8*(4), e59236.
Schaefer, A., Nils, F., Sanchez, X., & Philippot, P. (2010). Assessing the effectiveness of a large database of emotion-eliciting films: A new tool for emotion researchers. *Cognition & Emotion, 24*(7), 1153–1172.
Schnurr, P. P., Lunney, C. A., & Sengupta, A. (2004). Risk factors for the development versus maintenance of posttraumatic stress disorder. *Journal of Traumatic Stress, 17*(2), 85–95. https://doi.org/10.1023/B:JOTS.0000022614.21794.f4.
Sheehan, P. W. (1967). A shortened form of Betts' questionnaire upon mental imagery. *Journal of Clinical Psychology, 23*(3), 386–389.
Smith, H. L., Summers, B. J., Dillon, K. H., & Cougle, J. R. (2016). Is worst-event trauma type related to PTSD symptom presentation and associated features? *Journal of Anxiety Disorders, 38*(Supplement C), 55–61. https://doi.org/10.1016/j.janxdis.2016.01.007.
Steil, R., & Ehlers, A. (2000). Dysfunctional meaning of posttraumatic intrusions in chronic PTSD. *Behaviour Research and Therapy, 38*(6), 537–558.
Trew, J. L. (2011). Exploring the roles of approach and avoidance in depression: An integrative model. *Clinical Psychology Review, 31*(7), 1156–1168.
Van Emmerik, A., Schoorl, M., Emmelkamp, P., & Kamphuis, J. (2006). Psychometric evaluation of the Dutch version of the posttraumatic cognitions inventory (PTCI). *Behaviour Research and Therapy, 44*(7), 1053–1065.
Van der Does, A. J. W. (2002). *BDI-II-NL handleiding; de nederlandse versie van de Beck depression inventory*– (2nd ed.). Enschede: Ipskamp.
Van der Ploeg, H. M. (1982). De zelf-beoordelings vragenlijst (STAI-DY). *Tijdschrift Voor Psychiatrie, 24*, 576–588.
Weidmann, A., Conradi, A., Gröger, K., Fehm, L., & Fydrich, T. (2009). Using stressful films to analyze risk factors for PTSD in analogue experimental studies – which film works best? *Anxiety, Stress & Coping, 22*(5), 549–569. https://doi.org/10.1080/10615800802541986.
Williams, J. (2008). Revising the declaration of Helsinki. *World Medical Journal, 54*(4), 120–124.