Journal of Behavior Therapy and Experimental Psychiatry 62 (2019) 112–116

Contents lists available at ScienceDirect

Journal of Behavior Therapy and Experimental Psychiatry

journal homepage: www.elsevier.com/locate/jbtep

Dual-tasking during recall of negative memories or during visual perception of images: Effects on vividness and emotionality

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ARTICLE INFO

Keywords:
Virtual reality exposure
Eye movement desensitization and reprocessing
Virtual reality paradigm

ABSTRACT

Background and objectives: Several treatments are effective in reducing symptoms of post-traumatic stress disorder. We tested the effectiveness of an experimental intervention that consists of elements from two of these: virtual reality (VR) exposure therapy and eye movement desensitization and reprocessing. The latter is characterized by a dual-task approach: the patient holds a traumatic memory in mind while simultaneously making voluntary eye movements, resulting in reduced vividness and emotionality of the traumatic memory. If the experimental intervention is effective, it could provide a useful approach for highly avoidant individuals.
Methods: Participants recalled negative memories induced by a VR paradigm. The experimental group viewed VR screenshots that represented these negative memories while carrying out a dual-task. One control group recalled negative memories while carrying out the same dual-task (a standard dual-task condition) and another merely viewed the VR screenshots. Pre-to-post changes in self-rated memory vividness/emotionality were measured.
Results: The results indicate that viewing a screenshot only was outperformed by both dual-task interventions in terms of reductions in vividness/emotionality. Furthermore, the dual-task interventions had a comparable impact on vividness, but the screenshot variant led to greater decreases in emotionality.
Limitations: Changes in memory vividness/emotionality were only assessed shortly after the interventions and no measures of avoidance behavior were included in the study.
Conclusions: Looking at an image in VR that represents a memory while carrying out a dual-task may be at least as effective as recalling the memory during the dual-task. Interestingly, visually supporting a negative memory does not seem to prevent memory degrading by dual-tasking.

1. Introduction

Exposure to actual or threatened death, serious injury, or sexual violence may lead to the development of post-traumatic stress disorder (PTSD). Symptoms include the persistent re-experiencing of the traumatic event, persistent avoidance of stimuli associated with the trauma, hyperarousal, and negative alterations in cognitions and mood (American Psychiatric Association, 2013). There are several treatments that are effective in reducing these symptoms (for meta-analyses see e.g., Cusack et al., 2016; Watts et al., 2013). In the present study we aimed to test the effectiveness of an experimental intervention that consists of elements from two of these treatments: virtual reality exposure therapy (VRET) and eye movement desensitization and reprocessing (EMDR). This was done using a lab model of these interventions in a group of healthy participants, as has been done in previous studies (see van den Hout & Engelhard, 2012).

Exposure therapy involves exposing patients with anxiety conditions to fear-eliciting stimuli in order to decrease their threat expectancy, fear, and avoidance behavior. VRET is an increasingly common alternative to in vivo and in vitro exposure, in which exposure takes place in virtual environments that resemble feared real-life situations. Several meta-analyses showed that it is an efficacious method

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https://doi.org/10.1016/j.jbtep.2018.10.003
Received 5 April 2018; Received in revised form 29 July 2018; Accepted 4 October 2018
Available online 06 October 2018

of treating anxiety disorders (Morina, Ijntema, Meyerbröker, & Emmelkamp, 2015; Opriş et al., 2012; Parsons & Rizzo, 2008; Powers & Emmelkamp, 2008). Although most research involves effects of VRET in the context of specific phobias, research indicates that the use of virtual environments can effectively reduce PTSD symptoms as well (e.g., Beck, Palyo, Winer, Schwagler, & Ang, 2007; Gerardi, Rothbaum, Ressler, Heekin, & Rizzo, 2008; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001). VRET might be an interesting alternative in the context of PTSD treatment, because it allows for control over trauma-related exposure stimuli in a safe environment. Moreover, unlike in vivo exposure, it potentially allows the user to visually re-experience an entire traumatic event.

Unlike exposure therapy, EMDR was specifically introduced as a treatment for PTSD (Shapiro, 1989). One of its key components is a dual-task approach: the patient holds a traumatic memory in mind while simultaneously making voluntary eye movements by tracking the therapist's finger as it moves horizontally across the patient's visual field (Shapiro, 2001). Several theories have been proposed to explain the effects of this ‘eye movement’ component, but the present state of research points towards an explanation based on working memory (WM) as the most solid theory. According to this theory, keeping a memory in mind and making voluntary eye movements both tax the limited capacity of WM. As a result of this, the memory becomes less vivid and less emotional (Andrade, Kavanagh, & Baddeley, 1997; Gunter & Bodner, 2008; Smeets, Dijs, Pervan, Engelhard, & van den Hout, 2012) and is stored as such into long-term memory (van den Hout & Engelhard, 2012). This implies that keeping a memory in mind while carrying out another task that taxes working memory should also decrease memory vividness and emotionality. Indeed, studies showed that tasks such as copying the Rey complex figure (Gunter & Bodner, 2008), mental arithmetic (van den Hout et al., 2010), and playing the computer game Tetris (Engelhard, van Uijen, & van den Hout, 2010) are effective as well. In contrast, passive tasks, such as listening to tones, are barely taxing and are less effective (van den Hout et al., 2012). We aimed to investigate whether a dual-task intervention in which the recall element is replaced by a VRET element can reduce vividness and emotionality too. That is, instead of thinking of a memory, individuals look at an image in virtual reality (VR) that represents a memory while carrying out the dual-task. If this approach is effective, it could be clinically useful when patients show signs of avoidance behavior with respect to their traumatic memories during therapy. In those cases, (visual) retrieval cues might be particularly important for an intervention to take effect, because memories are only susceptible to updating when (re)activated (see Visser, Lau-Zhu, Henson, & Holmes, 2018).

In order to test this idea, we induced negative memories in a group of healthy participants by letting them play a VR game of the horror genre (cf. Cuperus, Klaassen, Hagenaars, & Engelhard, 2017; Cuperus, Laken, van den Hout, & Engelhard, 2016). Like the well-established ‘trauma film paradigm’ (for a meta-analysis, see James et al., 2016), a benefit of this VR paradigm over the use of autobiographical memories is that it allows for experimental control. Furthermore, compared to the trauma film paradigm, VR can induce a greater ‘feeling of presence’ and allows interaction with the environment (for a comparison of both paradigms, see Cuperus et al., 2017). An obvious downside of both paradigms, however, is that personal relevance is still limited compared to actual events in which one's actions may have important consequences. In the present study, three-dimensional screenshots of participants' VR experience were recorded while they played the game (from participants' point of view). After playing, participants viewed the images of the gameplay moments that they found the most unpleasant, while they did a non-visual dual-task. This ‘shape sorter’ task consisted of putting wooden figures into matching holes in a box without visual feedback (Cuperus et al., 2016). We compared the effects of the experimental ‘screenshot + dual-task’ condition with two control conditions: a standard dual-task condition in which participants recalled the negative memories while carrying out the shape sorter task (‘recall + dual-task’) and a condition in which participants merely viewed the VR screenshots (‘screenshot only’). Before and after the intervention, participants recalled the most unpleasant memory of the VR game and rated how vivid and unpleasant it was. The dependent variables were the changes over time in vividness and emotionality of the targeted gameplay memories.

We tested three competing hypotheses. The first hypothesis, based on WM theory, was that both dual-task interventions would be more effective than the screenshot only intervention. We did not expect effects of habituation in any of the interventions, because the exposure periods were short (cf. Engelhard, van den Hout, Dek et al., 2011). However, there is substantial overlap in neural activation during visual imagery and perception (Ganis, Thompson, & Kosslyn, 2004; Holmes & Mathews, 2010). One may therefore argue that a VR image that represents a negative memory serves as a strong retrieval cue. Therefore, the second hypothesis was that the screenshot + dual-task intervention would be more effective than recall + dual-task. Alternatively, viewing the VR image may prevent the mental image from becoming less vivid and emotional. A previous study suggests that listening to an audio recording of a negative event may negate the blurring effects of the dual-task (Kearns & Engelhard, 2015). Therefore, the third hypothesis was that recall + dual-task would outperform both screenshot interventions. These three hypotheses were evaluated using Bayesian analysis (Hoijtink, 2012; Mulder, Hoijtink, & de Leeuw, 2012):

H_1. screenshot + dual-task = recall + dual-task > screenshot only

H_2. screenshot + dual-task > recall + dual-task > screenshot only

H_3. recall + dual-task > screenshot + dual-task = screenshot only

2. Methods

2.1. Participants

Participants, mostly students, were recruited via social media and flyers. They had to be at least 18 years old to be eligible and individuals with a self-reported medical history of heart disease or epilepsy were excluded. A total of 84 participants (40 male, 44 female) with a mean age of 23.7 years (range 18–35; SD = 3.5) were evenly distributed over the different conditions.

2.2. Materials

The VR game we used in this study was ‘Affected’ version 1.55 (Fallen Planet Studios; Southport, United Kingdom). Visuals were provided through an Oculus Rift Development Kit 2 head-mounted display (Oculus VR; Menlo Park, California) and audio was provided through a Sennheiser SD 449 headphone (Sennheiser electronic GmbH & Co. KG; Wedemark, Germany). Participants moved through the game using an Xbox 360 controller (Microsoft; Redmond, Washington). Screenshots were recorded with Fraps 3.5.99 (Beepa Pty Ltd.; Melbourne, Australia). The PC was equipped with an NVIDIA GeForce GTX 980 graphics card (NVIDIA; Santa Clara, California) and an Intel Core i5-4690 processor (Intel; Santa Clara, California). The shape sorter used in the dual-task conditions was made by Jouéco (Waddinxveen, The Netherlands) and the Sudokus were extracted from 1sudoku.net (level ‘easy’).

2.3. Conditions

2.3.1. Screenshot + dual-task

During the intervention phase, participants in the screenshot + dual-task condition viewed a three-dimensional screenshot of the moment from the VR game that they labelled as most unpleasant after playing it. This screenshot was shown through the head-mounted