Behaviour Research and Therapy 51 (2013) 633–640

Contents lists available at ScienceDirect

Behaviour Research and Therapy

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

Eye movements during recall of aversive memory decreases conditioned fear

Arne Leer*, Iris M. Engelhard, Annemarie Altink, Marcel A. van den Hout

Utrecht University, Utrecht, The Netherlands

ARTICLE INFO

Article history:
Received 4 February 2013
Received in revised form
28 June 2013
Accepted 5 July 2013

Keywords:
US devaluation
US deflation
Eye movements
Human fear conditioning
Extinction

ABSTRACT

Cognitive-behavioral therapy for anxiety disorders typically involves exposure to the conditioned stimulus (CS). Despite its status as an effective and primary treatment, many patients do not show clinical improvement or relapse. Contemporary learning theory suggests that treatment may be optimized by adding techniques that aim at revaluating the aversive consequence (US) of the feared stimulus. This study tested whether US devaluation via a dual task – imagining the US while making eye movements – decreases conditioned fear. Following fear acquisition one group recalled the US while making eye movements (EM) and one group merely recalled the US (RO). Next, during a test phase, all participants were re-presented the CSs. Dual tasking, relative to the control condition, decreased memory vividness and emotionality. Moreover, only in the dual task condition reductions were observed in self-reported fear, US expectancy, and CS unpleasantness, but not in skin conductance responses. Findings provide the first evidence that the dual task decreases conditioned fear and suggest it may be a valuable addition to exposure therapy.

Although cognitive-behavioral therapy (CBT) is the primary and most effective treatment for anxiety disorders (Deacon & Abramowitz, 2004; Hofmann & Smits, 2008; NICE, 2011), there is room for improvement. About 20%–50% of patients do not show clinically significant change after treatment (Barlow, Allen, & Choate, 2004). Moreover, relapse rates are considerable. For example, relapse rates are 18.5%–23% among panic disorder patients (2–14 years post-treatment; Fava, Zielezny, Savron, & Grandi, 1995; Fava, Grandi, et al., 2001; Fava, Rafanelli, et al., 2001), and 13% among social phobia patients (2–12 years post-treatment; Fava, Grandi et al. 2001). Fear may return when CSs are encountered outside the extinction (i.e., therapeutic) context (renewal of fear), by the mere passage of time (spontaneous recovery), or because of confrontations with the US after fear extinction (reinstatement) (for reviews, see Bouton, 2002; Hermans, Craske, Mineka, & Lovibond, 2006). The explanation for these phenomena is that the fear memory ("CS predicts US") is not erased or destroyed as a result of exposure-based extinction learning. Rather, a new extinction memory ("CS does not predict US") is formed (e.g., Craske, Liao, Brown, & Vervliet, 2012). Since extinction learning hardly generalizes across contexts, confrontations with CSs outside the therapeutic context more readily activate the acquisition memory than the extinction memory, which causes a return of fear (e.g., Bouton, 2002). Therefore, several CSs and contexts may need to be targeted during exposure-based therapy in order to successfully reduce fear.

A theoretical suggestion on how to further optimize treatment comes from Davey's refined model of fear conditioning (1997). According to this model, the conditioned response (CR) is not only a consequence of the strength of the CS-US association, but also of the cognitive representation of the US. Accordingly, there are two ways to influence the strength of the CR (i.e., the fear response). The first pathway focuses on the memory-encoded association between the CS and the US. Strengthening the CS-US association (e.g., increasing the number of CS-US pairings) intensifies the CR, whereas weakening the CS-US association (e.g., CS presentations in absence of the US, as in exposure therapy) results in a decreased CR. The second pathway is nonassociative and capitalizes on revaluation processes that may affect the UCS representation. For example, post-conditioning information that suggests that the US is more threatening than previously conceived, may cause US *inflation*, which should lead to an increase in conditioned fear. This has indeed been found. After establishment of a CS-US association, experience with a similar US of greater intensity causes later CS presentations to elicit a stronger CR (White & McKenna, 1989). More important for the current issue, the US may be reassessed

* Corresponding author. Department of Clinical & Health Psychology, Utrecht University, P.O. Box 80140, 3508 TC Utrecht, The Netherlands. Tel.: +31 302531470; fax: +31 302534718.
E-mail address: A.Leer@uu.nl (A. Leer).

0005-7967/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.brat.2013.07.004

more favorably when information is acquired that suggests that the US is less aversive than during conditioning, called US *devaluation*, which should decrease conditioned fear. Laboratory studies have shown that exposure to the US, in absence of a CS, that produces diminished responding to the US also results in a weaker CR upon next CS presentations (Davey & McKenna, 1983). Similarly, experience with the US at lower intensity compared to US intensity during acquisition evokes a weaker CR upon next CS presentations (Hosoba, Iwanaga, & Seiwa, 2001).

In view of their potential practical application it may be more fruitful to study memory processes that result in US devaluation, but do not require the physical presence of the US. For example, rehearsal (i.e., repeated imagination) of the US after fear acquisition maintains (Arntz, Spit, & Merckelbach, 1997; Jones & Davey, 1990; Joos, Vansteenwegen, & Hermans, 2012a) or increases (Davey & Matchett, 1994) conditioned responding. In line with Davey's theory, increases in self-reported aversiveness of the US are accompanied by increases in CR-strength (Matchett & Davey, 1995). Similar results were found for instructed worrying about the aversive consequences of a US (Gazendam & Kindt, 2012). Indeed, US devaluation by mental imagery may result in *reduction* of conditioned fear. Tentative support for this hypothesis was provided by Dibbets, Poort, and Arntz (2012) who tested the usefulness of imagery rescripting (IR; an effective treatment for various anxiety disorders; Holmes & Mathews, 2010) in reducing the return of fear after extinction. Participants first learned the association between a CS (picture of a car) and a US (picture of a mutilated child). Then the intervention group verbally rescripted the mental image of the US during extinction trials, while the control group was only exposed to extinction trials, which attenuated conditioned fear to the CS in a subsequent test phase. It should be noted, however, that both during the extinction phase and at offset, CR was stronger in the intervention condition than in the control condition, presumably because participants rehearsed the CS-US association as a part of IR *during* the extinction trials. Though the authors did correct for the offset difference, the question remains whether differences in the extinction process may have affected renewal.

The current study aimed to investigate another method to devalue a US representation that has been extensively studied in recent years. It involves a dual-task in which participants are typically instructed to visualize an aversive memory ('recall') and simultaneously make eye movements (EM) (e.g., Gunter & Bodner, 2008; Maxfield, Melnyk, & Hayman, 2008; van den Hout, Muris, Salemink, & Kindt, 2001). Experiments have repeatedly shown that the dual-task, relative to recall alone, results in a decrease in self-reported memory vividness and emotionality. These findings are substantiated by non-self-report data like fear-potentiated startle (Engelhard, van Uijen, & van den Hout, 2010) and motor behavior i.e. reaction times (Van den Hout, Bartelski, & Engelhard, 2012) data. Working memory theory offers an explanation: during the dual-task both tasks compete for limited working memory capacity (Andrade, Kavanagh, & Baddeley, 1997; Gunter & Bodner, 2008). As a result, the aversive memory will come to mind in a degraded form (i.e., less vivid and emotional) and will be reconsolidated as such (see van den Hout & Engelhard, 2012).

As the dual-task resembles a memory devaluation technique, we expected that making EM during recall of the US devaluates the US representation and alleviates the CR to CSs. A differential conditioning paradigm was used, in which a CS+ was paired with aversive film fragments (US), and a CS− was not paired. Subsequently, participants recalled the US memory while making EM ("EM") or without EM (recall only: "RO"). The latter condition controlled for an imaginal exposure effect (cf. Engelhard & van Uijen et al., 2010; Gunter & Bodner, 2008). Then, in a test phase, participants were exposed to CSs to test whether EM resulted in diminished CR. Conditioned fear was operationalized as ratings of self-reported fear and US expectancy, and skin conductance responses (as an objective measure of anxious arousal). In addition, we assessed evaluative CR, which involved ratings of CS pleasantness, because such responses are resistant to extinction (e.g., Engelhard, Leer, Lange, & Olatunji, 2013) and US revaluation has been shown to reduce the negative evaluation of the CS (Baeyens, Eelen, Van den Bergh, & Crombez, 1992; Walther, Gawronski, Blank, & Langer, 2009). Our hypotheses were that EM causes (1) a reduction in the vividness and emotionality of the US memory, (2) a reduction in conditioned fear, and (3) a reduction in the conditioned negative evaluation of the CS.

Method

Participants

We set out to test 30 participants per group and included 3 more to nullify the effect of excluding participants that might provide unreliable data. As all participants provided reliable data, the final sample consisted of 63 female students (mostly undergraduates), recruited at Utrecht University with a mean age of 22.83 (range: 18–39, $SD = 3.35$) who participated for course credit or a financial reward. Exclusion criteria were prior knowledge about EMDR and prior participation in an experiment in which the dual-task paradigm was used. By order of appearance, participants were randomly assigned to one of two groups: EM or RO.

Stimuli

A 600 Hz low tone and a 1200 Hz high tone served as CSs. A disgusting film clip[1] from *YouTube* (Cjdragano, 2010) with images and sounds of a male vomiting in a toilet served as US. The film clip was split into 3 fragments of 4 s each that covered 25% of a black screen. The task was programmed using E-Prime 2.0 (Psychology Software Tools).

Questionnaires

State and trait anxiety were assessed with the 40-item State Trait Anxiety Inventory (STAI-DY; Spielberger, Gorsuch, & Lushene, 1970). Each construct contains 20 items that are scored on a 1-4-point scale (1 = not at all, 4 = severely). This questionnaire was included to allow for comparing the conditions on levels of anxiety, which been identified to affect fear learning (Grillon et al., 2006; Lissek et al., 2005).

Skin conductance responses

Two 9-mm Sensor Medics Ag/AgCl electrodes were attached to the medial phalanges of the middle and index fingers of the non-

[1] A pilot study was conducted to select a film that participants could vividly recall and found distressing. Twelve students watched 4 clips (i.e., the current clip, a fragment from the aversive film used by Hagenaars, Van Minnen, Holmes, Brewin, and Hoogduin, 2008 and two clips showing a male vomiting used by Viar-Paxton and Olatunji, 2012) in counterbalanced order and rated each clip on unpleasantness (0 = not unpleasant at all, 10 = very unpleasant). They also rated their memory of each clip on vividness and emotionality (0 = not vivid/unpleasant at all, 10 = very vivid/unpleasant), and indicated how much they would dislike watching the clip again (0 = not at all, 10 = very much). The current film clip had highest ratings on unpleasantness ($M = 7.67$, $SD = 1.83$), memory vividness ($M = 8.63$, $SD = 1.03$), memory emotionality ($M = 7.00$, $SD = 2.05$), and aversion toward re-watching the clip ($M = 7.33$, $SD = 2.39$), $Fs > 7.57$, $ps < .01$. *T*-tests revealed that the current clip was rated higher than each of the other three clips on all of these measures, smallest $t = 2.92$, $p < .05$.