Behaviour Research and Therapy 50 (2012) 735–746

Contents lists available at SciVerse ScienceDirect

Behaviour Research and Therapy

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

Safety behavior can hamper the extinction of fear of movement-related pain: An experimental investigation in healthy participants

Stéphanie Volders [a,*,1], Ann Meulders [a,1], Steven De Peuter [a], Bram Vervliet [a,b], Johan W.S. Vlaeyen [a,b,c,1]

[a] Research Group on Health Psychology, Department of Psychology, University of Leuven, Leuven, Belgium
[b] Center of Excellence Generalization Research in Ill Health and Psychopathology, University of Leuven, Leuven, Belgium
[c] Department of Clinical Psychological Science, Maastricht University, Maastricht, The Netherlands

ARTICLE INFO

Article history:
Received 16 March 2011
Received in revised form
6 June 2012
Accepted 14 June 2012

Keywords:
Fear of pain
Extinction
Safety behavior
Protection from extinction
Avoidance
US-expectancy

ABSTRACT

Excessive fear of movement-related pain (FMRP), and its associated avoidance behavior, is considered a major risk factor for disability in chronic musculoskeletal pain. The current study aimed to investigate whether engaging in safety behavior, conceptualized as an avoidance response, hampers the extinction of FMRP. In a differential conditioning paradigm, we used joystick movements as conditioned stimuli (CSs) and a painful electrocutaneous stimulus as the unconditioned stimulus (US). In the Safety group, participants received the opportunity to avoid the pain-US by pressing a safety button during the extinction phase, whereas in the Control group, this option was not included. In a subsequent test phase, this safety button was no longer available. In two experiments, results demonstrate successful acquisition and extinction. Retrospective FMRP ratings in both experiments revealed a return of fear of pain in the test phase in the Safety group, but not in the Control group. In Experiment 1, mean eyeblink startle reflex amplitudes partly corroborated the self-report findings on fear of pain. The present results suggest that performing safety behavior during cognitive-behavioral interventions, i.e., exposure, might increase the risk of a return of FMRP.

A widely used cognitive-behavioral treatment for anxiety disorders consists of gradually exposing the patient to the feared object or situation until fear has abolished and daily functioning can be resumed; i.e., graded exposure therapy (GEXP). Exposure exercises can be quite threatening to the patient and may initially evoke substantial fear responding. This might encourage the patient to perform subtle safety behaviors during therapy sessions. Cognitive theories claim that safety behavior interferes with the reduction of fear because of a misattribution of safety (i.e., safety is attributed to the performance of safety behavior) which prevents the intended disconfirmation of catastrophic beliefs that GEXP tries to accomplish (Salkovskis, 1991, 1996; Salkovskis, Clark, Hackmann, Wells, & Gelder, 1999; Wells et al., 1995) or because it redirects attention away from threat, thereby reducing the processing of corrective information (Sloan & Telch, 2002). In turn, this increases the chances of fear to return and might cause relapse in the long run, even though GEXP seemingly worked in the short term.

A learning theory perspective can be adopted to cast light on this phenomenon. GEXP can be considered the clinical analog of Pavlovian extinction, a procedure in which a conditioned stimulus (CS) previously paired with an unconditioned stimulus (US), is presented alone, resulting in reduced conditioned fear responding (CR). The presence of a Pavlovian safety signal in the absence of the US is known to interfere with extinction, causing a return of fear, a phenomenon referred to as "protection from extinction" (Rescorla, 2003). According to the Rescorla–Wagner model (Rescorla & Wagner, 1972) the associative strength of a CS – and so conditioned responding – changes when the presence (or absence) of an US is unexpected. The US-expectancy depends on the associative value of all stimuli that are concurrently present on a given trial. Hence, when a CR is extinguished in the presence of another stimulus signaling the absence of the US, the associative strength of the CS is not expected to change (i.e., weaken). Consequently, conditioned responding to subsequent CS alone presentations has not decreased, in spite of apparent effective extinction (Rescorla, 2003). Conditioning studies have demonstrated that not only Pavlovian safety *signals* but also instrumental avoidance or safety

* Corresponding author. University of Leuven, Department of Psychology, Tiensestraat 102, Box 3726, B-3000 Leuven, Belgium. Tel.: +32(0)16 32 60 70; fax: +32(0)16 32 61 44.
E-mail address: stephanie.volders@ppw.kuleuven.be (S. Volders).

[1] These authors are supported by the Odysseus grant "The Psychology of Pain and Disability Research Program", Fund for Scientific Research – Flanders (FWO – Vlaanderen).

0005-7967/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.brat.2012.06.004

behaviors present during an extinction procedure can cause fear to return afterward (Lovibond, Davis, & O'Flaherty, 2000; Lovibond, Mitchell, Minard, Brady, & Menzies, 2009).

To date, the influence of safety behavior on fear extinction, more particularly, *fear of movement-related pain* (FMRP) remains under-investigated. FMRP is considered a major risk for long term disability and depressive mood in chronic musculoskeletal pain, e.g., chronic low back pain (CLBP) (Heuts et al., 2004; Jensen, Karpatschof, Labriola, & Albertsen, 2010; Leeuw et al., 2007; Swinkels-Meewisse et al., 2006; Vlaeyen & Linton, 2000; Wideman, Adams, & Sullivan, 2009) and is often successfully reduced by GEXP (Bailey, Carleton, Vlaeyen, & Asmundson, 2010; den Hollander et al., 2010; Leeuw et al., 2008; Vlaeyen, de Jong, Geilen, Heuts, & van Breukelen, 2001, 2002; Woods & Asmundson, 2008). Yet, subtle safety behaviors (e.g., bending over, but keeping one's back straight) are frequently observed during therapy sessions (Tang et al., 2007) while it remains unclear if and to what extent this affects the reduction of fear in the long run.

In an attempt to resolve this issue, we tested whether safety behavior (i.e., an avoidance response) during an extinction procedure may protect against the extinction of FMRP. In two experiments, we used the "voluntary joystick movement paradigm" (VJMP) that was recently developed by Meulders, Vansteenwegen, and Vlaeyen (2011) as a more ecologically valid laboratory model for the development (Meulders et al., 2011) and extinction of fear of pain (Meulders & Vlaeyen, 2012). In this paradigm, proprioceptive stimuli are used as CSs (i.e., voluntary joystick arm movements to different directions, e.g., left, right, forward), while a phasic painful electrocutaneous stimulus is used as the US. Retrospective pain-US expectancy ratings were used as a manipulation check, and retrospective FMRP ratings and eyeblink startle modulation served as dependent variables. In Experiment 1, a between-subjects, differential conditioning design was employed: one group was instructed to use safety behavior during the extinction phase (Safety group); the other group was not (Control group). In Experiment 2, a similar between-subjects design was employed, but the FMRP measurement was adapted and a safety training phase was added to the design. In both experiments, we expected that when safety behavior was subsequently omitted during the test phase, FMRP would return in the Safety group, but not in the Control group, indicating protection from extinction.

Experiment 1

Method

Participants

Fifty-two healthy students from the University of Leuven (31 men, age $M = 22$, range 18–50 years) participated in this study and provided written informed consent. The experimental protocol was approved by the Ethical Committee of the Department of Psychology of the University of Leuven.

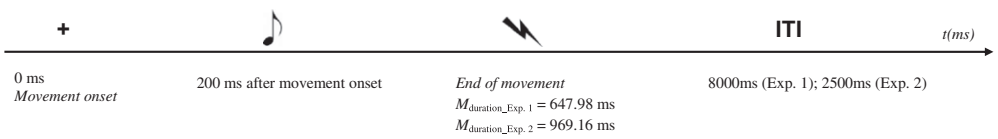
Apparatus and stimulus material

Software. The experiment was programmed using Affect (version 4.0; Spruyt, Clarysse, Vansteenwegen, Baeyens, & Hermans, 2010). The entire experiment was run on a Windows XP computer (Dell Optiplex 755) with 2 GB RAM and an Intel Core2 Duo processor at 2.33 GHz and an ATI Radeon 2400 graphics card with 256 MB of video RAM.

Experimental stimuli. Three proprioceptive stimuli (i.e., moving the joystick to the left, to the right, and forward) were used as CSs. A press on the joystick button served as safety behavior, as it prevented pain-US administration. The button had to be pressed at movement-onset and held down throughout the entire movement. The intertrial interval (ITI) was 8 s (see Fig. 1 for an overview of the trial timing). Electrocutaneous stimulation of 2 ms (pain-US) was delivered by a commercial stimulator (DS7A, Digitimer, Welwyn Garden City, England) through surface Sensormedics electrodes (8 mm) filled with K–Y gel that were attached to the wrist of the dominant hand. The individual shock-intensity level was selected during a pre-experimental calibration procedure and was "mildly painful and demanding some effort to tolerate" for the participant ($M_{\text{shock intensity}} = 26.52$ mA, $SD_{\text{shock intensity}} = 15.73$). No differences in the subjective level of pain-US unpleasantness nor painfulness could be detected between the two groups.

Verbal ratings. After each experimental block, participants indicated the extent to which they expected the pain-US to occur for each movement (i.e., pain-US expectancy; "To what extent did you expect the electrocutaneous stimulus to occur after a movement to the *left/right/forward in the previous block*?") as well as their level of FMRP during each movement ("To what extent were you afraid that the movement to the left/right/forward was going to *be painful in the previous block*?"), on a visual analog scale ranging from '*0*' (not at all) to'*10*' (extremely).

Eyeblink startle modulation. Orbicularis Oculi electromyographic activity (EMG) was recorded with three Ag/AgCl Sensormedics electrodes (4 mm) filled with a TECA electrolyte gel. After peeling the skin to reduce inter-electrode resistance, electrodes were placed on the left-hand side of the face according to the site specifications proposed by Blumenthal et al. (2005). The raw signal was amplified by a Coulbourn isolated bioamplifier with bandpass filter (LabLinc v75-04). The recording bandwidth of the EMG signal was between 90 Hz and 1 kHz (±3 dB). The signal was rectified online and smoothed by a Coulbourn multifunction integrator (LabLinc v76-23A) with a time constant of 20 ms. Data acquisition started 200 ms before probe onset at 1000 Hz, data were digitized for 1200 ms. Eyeblink startle responses were elicited with an acoustic startle probe i.e., a 100 dBA burst of white noise with instantaneous rise time presented binaurally for 50 ms through headphones (Hoher, Stereo Headphones HF92).



Note. A fixation cross "+" is used as a starting signal, a musical note drawing is used to indicate the startle probe administration, and a drawing of a lightning bolt indicates the pain-US administration. Pain-USs are presented during the C+ movement in ACQ1-2, ST (Exp. 2) and ACQ3 (Exp. 2) and during the B+ movement in ACQ1-2, EXT1-2 and TEST1-2. In Exp. 2, pain-USs are only presented during the B+ movement in the ST when the safety button is not pressed. Pain-USs are never presented during the A- movement. M_{duration} represents the average duration time of a CS movement.

Fig. 1. Overview of the trial timing of Experiment 1 and Experiment 2.