

Threatening Social Context Facilitates Pain-Related Fear Learning

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Abstract: This study investigated the effects of a threatening and a safe social context on learning pain-related fear, a key factor in the development and maintenance of chronic pain. We measured self-reported pain intensity, pain expectancy, pain-related fear (verbal ratings and eyeblink startle responses), and behavioral measures of avoidance (movement-onset latency and duration) using an established differential voluntary movement fear conditioning paradigm. Participants (N = 42) performed different movements with a joystick: during fear acquisition, movement in one direction (CS+) was followed by a painful stimulus (pain-US) whereas movement in another direction (CS-) was not. For participants in the *threat* group, an angry face was continuously presented in the background during the task, whereas in the *safe* group, a happy face was presented. During the extinction phase the pain-US was omitted. As compared to the safe social context, a threatening social context led to increased contextual fear and facilitated differentiation between CS+ and CS- movements regarding self-reported pain expectancy, fear of pain, eyeblink startle responses, and movement-onset latency. In contrast, self-reported pain intensity was not affected by social context. These data support the modulation of pain-related fear by social context.

Perspective: A threatening social context leads to stronger acquisition of (pain-related) fear and simultaneous contextual fear but does not affect pain intensity ratings. This knowledge may aid in the prevention of chronic pain and anxiety disorders and shows that social context might modulate pain-related fear without immediately affecting pain intensity itself.

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Key words: Social context, fear conditioning, pain-related fear, contextual fear, social threat, preparedness.

The importance of pain-related fear in the development and maintenance of chronic pain, originally suggested by fear-avoidance models,⁵⁵ has been supported by an increasing number of studies and also

has made pain-related fear a primary target in current treatments.^{11,12,24,58} For instance, there is experimental evidence that fear of pain is related to increased pain intensity,^{14,15} pain-related disability,⁴⁹ defensive reactivity,⁸ and behavioral avoidance.^{50,54} However, little is known about factors facilitating the development of sustained maladaptive fear of pain, making the prevention of chronic pain challenging.²⁸

One relatively novel approach that may shed light on this process is the study of pain in relation to contextual factors.^{11,56} For example, there is accumulating evidence in clinical and nonclinical pain research that social context modulates the appraisal, interpretation, and experience of pain and would therefore be a feasible target for intervention.²³ Yet, to our knowledge, the effects of social context modulation on pain-related fear have not been investigated.

Previous research suggests that a threatening social environment is associated with higher levels of acute and chronic pain,^{17,37,47} possibly because a threatening context increases anxiety, which in turn has been

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shown to increase pain intensity.^{27,33,40} The recognition of (social) threat is of paramount importance for a species' survival, facilitating a rapid detection and appraisal of the significance of the threatening stimulus.¹⁸ Therefore, it seems reasonable that the context in which fear learning occurs can modulate learning. A context signaling a threat to survival (eg, social threat) could "prepare" the individual and facilitate fear learning in the interest of promoting effective escape and avoidance of danger.⁴³ A similar phenomenon in learning theory has been termed "selective associations": Humans show superior fear conditioning with "fear-relevant" stimuli (eg, picture of a snake) and aversive outcomes (eg, a shock) than with fear-irrelevant stimuli (eg, picture of a flower).³⁶ Similarly, a fear-relevant context could promote faster or stronger acquisition of the conditioned response and/or enhanced resistance to extinction.³⁵ Consequently, social threat might facilitate the acquisition and impede the extinction of pain-related fear.

Lastly, a threatening context has been shown to lead to contextual fear, which is characterized by a chronic anticipation of threat.^{26,31} This was shown in the case of unpredictable pain stimuli, which render the context unsafe and lead to elevated startle responses during the interstimulus interval (ITI).²¹ Along the same lines, a threatening social context could also render the context unsafe and lead to contextual fear, which would parallel findings in individuals with social anxiety.¹⁰

The present study investigated the effects of social context on the acquisition and extinction of pain-related fear as measured by self-report, behavioral avoidance tendencies (reaction times), and psychophysiological reactivity (fear-potentiated startle responses). We hypothesized that a threatening social context facilitates fear learning. Specifically, we predicted for the threatening social context 1) enhanced (ie, faster or stronger) cued pain-related fear acquisition, 2) slowed down extinction of pain-related fear, 3) increased pain intensity ratings, and 4) increased contextual fear (ie, elevated startle responses during the ITI) compared with the safe social context.

Methods

Participants

Forty-two healthy individuals (12 males; mean age \pm standard deviation [SD] = 21 \pm .3 years, range = 17–29) volunteered to participate in the present study. The exclusion criteria were pregnancy; current or history of cardiovascular disease; chronic or acute respiratory disease (eg, asthma, bronchitis); neurologic diseases (eg, epilepsy); any current or past psychiatric disorders; acute and chronic pain; hearing problems; cardiac pacemaker or the presence of any other electronic medical devices; impaired vision that is not corrected for; or use of anxiolytics or antidepressants. Participants were recruited and compensated in 2 ways. First-year psychology students participated in return for course credits ($n = 5$, 11.9%), and volunteers recruited from the general student pop-

ulation of the KU Leuven by means of flyers were paid €12 for their participation ($n = 37$, 88.1%). Of the 42 participants, 38 (90.5%) were students.

Ethical Approval

The experimental protocol was approved by the Ethical Committee of the Faculty of Psychology and Educational Sciences of the University of Leuven (Belgium) (registration number = S-55530). All participants provided informed consent prior to participation. It was emphasized that participation was completely voluntary and that participants were allowed to stop the experiment at any time without any negative consequences.

Apparatus and Experimental Stimuli

Software

The entire experiment was run on a Windows XP computer (Dell Optiplex 755) with 2 GB RAM and an Intel Core 2 Duo processor at 2.33 GHz and an ATI Radeon 2400 graphics card with 256 MB of video RAM. Programming of the experiment was done in Affect (version 4.0).⁴⁶

Stimulus Material

A joystick (Attack 3; Logitech, Newark, CA) was used to perform the different movements (to the left/right) that served as conditioned stimuli (CSs) in the present experiment. An electrocutaneous stimulus of 2-millisecond duration served as the unconditioned stimulus (pain-US) in the present experiment. The electrical stimulation was delivered by a commercial stimulator (DS7A; Digi-timer, Welwyn Garden City, England) through surface electrodes (1 cm diameter; SensorMedics Corp, Homestead, FL) filled with K-Y gel (Johnson & Johnson, New Brunswick, NJ) that were attached to the wrist of the dominant hand of the participants, with which they also controlled the joystick. To select the intensity level of the pain-US, participants were repeatedly exposed to electrocutaneous stimulation of increasing intensity. They were asked to rate each stimulus on a scale ranging from 0 (feeling nothing) to 10 (worst pain imaginable). The participant was instructed to select a stimulus intensity with a rating of about 8, which was "moderately painful and demanding some effort to tolerate" (mean self-reported stimulus intensity was 8.00, SD = .53, range = 7–9). After selecting the pain stimulus, the participant was informed that he or she would receive a stimulus of maximally this amplitude during the remainder of the experiment. They were also given the possibility to increase or decrease the selected stimulus intensity at this point (mean physical stimulus intensity was 33.79 mA, SD = 18.35, range = 7–99 mA). Social context was manipulated using facial stimuli. Four angry, open-mouthed faces (2 male/2 female) were used to create a threatening social context, whereas 4 happy, open-mouthed faces (2 male/2 female) were used to create a safe social context. Social anxiety research has shown that angry faces increase social threat in both clinical and healthy populations.^{5,38} Facial stimuli were taken from the NimStim face stimulus set.⁴⁸ The NimStim set

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