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The Influence of Social Threat on Pain, Aggression, and Empathy in Women



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Abstract: Only one published study has investigated the effect of a threatening social context on the perception and expression of pain, showing that social threat leads to increased pain reports but reduced nonverbal pain expression. The current study aimed to replicate and extend these findings to further explore the effects of a threatening social context. Healthy, female participants (N = 71) received 10 electrocutaneous stimuli delivered by a confederate. They were led to believe that the confederate was requested to administer 10 painful stimuli (control group) or that the confederate deliberately chose to deliver 10 painful stimuli when given the choice to deliver between 1 to 10 painful stimuli (social threat group). Self-reported pain intensity, unpleasantness, threat value of pain, and painful facial expression were assessed. Additionally, empathy and aggression toward the confederate were investigated. Social threat did not affect painful facial expression or self-reported pain intensity, but led to increased aggression toward the confederate. Moreover, perceived social threat predicted the threat value of pain and reduced empathy toward the confederate. We were not able to replicate the previously reported dissociation between pain reports and pain expression as a result of social threat. However, social threat was associated with an increased threat value of pain, increased aggression, and reduced empathy.

Perspective: A threatening social context affects how threatening pain is perceived and has interpersonal consequences such as increased aggression and reduced empathy, thereby creating a double burden on the individual suffering from pain.

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Key words: Social threat, pain expression, self-report, aggression, communication, retribution, empathy.

Recently, it has been proposed to acknowledge social components alongside sensory, emotional, and cognitive components in an updated definition of pain.⁵² This proposal follows a growing body of re-

search showing that the social context in which pain occurs modulates the perception and communication of pain itself.^{4,25} The most common way to communicate pain to others is through facial expressions.³² The social communication model of pain^{4,18} outlines how internal (eg, genetics or cognitive biases) as well as external factors (eg, ethnicity or clinical context), including the social context, can affect the encoding and decoding of pain signals. For example, the nonverbal expression of pain is modulated by gender²⁴ or the mere presence of others.^{45,46}

According to evolutionary theory, emotions in general and pain in particular are expressed when it is advantageous to do so (eg, to elicit help from others).⁵¹ However, expressing pain might not always be advantageous because it also signals vulnerability, which could be exploited by competitors or adversaries. Consequently, pain expression might be suppressed when in a threatening social situation (eg, in the presence of someone else who is intentionally trying to cause harm). This

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hypothesis has been supported in a recent study using agent-based modeling, a computer simulation in which the effects of selection pressures on behaviors over generations are modeled. In this study pain expression was reduced almost completely in a context of exploitation.⁵³ Although possibly adaptive in a threatening situation, suppression of pain expression might also have adverse side effects such as underestimation of pain by others, a bias that is common in lay observers^{17,34} as well as in health care professionals.^{21,35} This is especially relevant in a clinical context because there is mounting evidence that chronic pain patients are frequently confronted with threatening social interactions such as stigmatization,^{6,7,50} invalidation,^{8,9} and perceptions of injustice.^{38,41,42}

There is only limited experimental research investigating the effects of threatening social contexts on the perception and communication of pain.^{22,23} One study showed that pain that is inflicted intentionally by someone else led to higher verbal pain reports than pain that is inflicted nonintentionally but unfortunately, facial pain expression was not investigated in this study.¹⁶ To our knowledge, there is only 1 single experimental study that investigated verbal self-report as well as facial expression of pain in a threatening social context. This study showed that social threat in the form of intentionally administered electrocutaneous stimuli concurrently led to increased self-reported pain for high pain catastrophizers and decreased facial pain expression in high as well as low catastrophizing participants.³¹

In addition to impacting pain-related outcomes, social threat might have interpersonal consequences as well. For instance, an individual who is exposed to threat, might react with aggression and reduced empathy towards threatening others themselves, leading to further social isolation.^{13,49} Social isolation itself also has been implicated in the development of psychosomatic symptoms in general,^{11,13} and chronic pain in particular.⁴⁷

Taking into account the clinical relevance and the lack of experimental research in this area, we aimed to replicate and extend the study by Peeters and Vlaeyen³¹ investigating the effect of a threatening social context on pain. To this end, we compared a threatening social context with a nonthreatening social context using the same manipulation as in Peeters and Vlaeyen. In addition to self-reported pain intensity, unpleasantness, threat, and facial pain expression we also assessed aggression and empathy. We also investigated whether pain catastrophizing moderated the effects of social context. We hypothesized that a threatening social context 1) increases self-reported pain intensity, unpleasantness, threat, and aggression, but 2) decreases facial expression of pain and self-reported empathy compared with a nonthreatening social context.

Methods

Participants

We recruited 71 female participants between the age of 18 and 38 years (mean = 21.51 years, SD = 3.50) by

spreading flyers at the Faculty of Psychology and Educational Sciences of the KU Leuven as well as through the departmental Experiment Management System (Sona Systems). The study was advertised as a study investigating the effect of personality traits on the administration and the receiving of painful stimuli, explaining that the participant will come to the laboratory alongside another participant and that there is a possibility that she will experience and/or administer painful/unpleasant stimuli. Sample estimates were on the basis of the earlier study by Peeters and Vlaeyen.³¹ Of the 71 participants, 67 were students (94%). The exclusion criteria for this study were presence/diagnosis of (acute or chronic) pain, the use of anxiolytics or antidepressants, the need to avoid stressful situations on medical advice, a neurological or psychiatric disorder, electronic implants (eg, pacemakers), pregnancy, impaired uncorrected vision, heart disease or other severe medical conditions, and nonfluency in Dutch. One participant fulfilled 1 of the exclusion criteria and therefore had to be excluded, bringing the total number of participants eligible for analysis to 70. Participants were recruited and compensated in 2 ways: first-year psychology students participated in return for course credit (n = 22; 31%); volunteers recruited by means of flyers were paid €8 for their participation (n = 49; 69%).

Ethical Approval

The experimental protocol was approved by the Social and Societal Ethics Committee of the KU Leuven (Belgium; registration number: G-2015 04 220). All participants provided informed consent before 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.

Experimental Design and Social Threat Manipulation

A between-subject design was used, with participants being randomized either into the social threat group (n = 36) or the control group (n = 34). The manipulation of social threat was borrowed from Peeters and Vlaeyen³¹: Participants came to the lab with a female confederate (Caucasian female, age 23 years) whom they believed to be another participant. On the basis of a bogus randomization procedure, the participant was allocated to receive painful electrocutaneous stimuli, whereas the confederate was allocated to administer them to the participant. The confederate was then asked to choose how many electrocutaneous stimuli she wanted to administer to the participant. In the social threat group, the confederate could choose from 1 to 10 stimuli and chose to administer the maximum of 10 painful stimuli. In the control group, the confederate did not have a choice and was requested by the experimenter to administer 10 painful stimuli. So although the number of painful stimuli in both groups was identical (10 stimuli), the participant was led to believe that the confederate intentionally chose to deliver the maximum of painful

stimuli in the social threat group, thereby increasing the degree of perceived social threat.

Apparatus and Experimental Stimuli

Electrocutaneous Pain Stimuli and Calibration

Electrocutaneous square wave stimuli of 600 ms were administered using a commercial stimulator (DS5; Digitimer, Welwyn Garden City, England) through 2 electrodes (1 cm diameter) filled with K-Y gel (Johnson & Johnson, New Brunswick, NJ) and attached approximately 2 cm from each other to the right ankle of the participants.

At the start of the experiment the intensity of the electrocutaneous stimulus, used during the remainder of the experiment, was individually calibrated. During this calibration procedure, the intensity of the stimulus was gradually increased while participants were asked to verbally rate the painfulness of each stimulus on an 11-point Likert scale. This Likert scale ranged 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, $SD = .70$, range = 4–10). After selecting the painful stimulus, the participant was informed that she would receive a stimulus of maximally this amplitude during the remainder of the experiment. She was also given the possibility to increase or decrease the selected stimulus intensity at this point (mean physical stimulus intensity was 6.06 mA, $SD = 3.14$, range = 1–15 mA). Note that the intensity of the stimulus presented throughout the remainder of the experiment did not vary.

Software and Computer

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).³⁷ At the start of the experiment, participant and confederate were allegedly allocated 1 of 2 roles: administrator or receiver of electrocutaneous stimuli (see Procedure). For this allocation a computer program was used to perform a bogus randomization.³¹ This program depicts a coin toss after the participant chose a side (heads or tails) by clicking on a button. The participant was always selected as the receiver of the electrocutaneous stimuli.

Apparatus

A webcam (HD Webcam C525, Logitech, Newark, CA) was used to record participants' facial expressions and the self-report ratings throughout the experiment. The webcam was placed on top of the computer screen, which was standing on the table inside the experimental room. An audiotape was recorded to provide the instructions throughout the experiment. The instructions were spoken by a male native Flemish speaker and indicated when the

electrocutaneous stimuli were to be administered and prompted for the self-report ratings of the participant (see Outcome Measures). Last, the confederate used a 2-button response box to administer the electrocutaneous stimuli after the audiotape instructions.

Experimental Setting

The experiment took place in a sound-attenuated experimental room, equipped with a table, a computer screen, and 2 chairs facing each other. Communication between the experimental and the experimenter's room was possible through an intercom system and the experimenter could observe the participant throughout the experiment.

Outcome Measures

Verbal Ratings

Participants were asked to orally rate the intensity, unpleasantness, and threat value of the painful stimulus after each stimulus presentation. They were asked how painful they found the painful stimulus (pain intensity) on a scale from 0 (feeling nothing) to 10 (worst pain imaginable), how unpleasant they perceived the painful stimulus (pain unpleasantness) on a scale from 0 (not unpleasant at all) to 10 (extremely unpleasant), and how threatening they found the painful stimulus (threat value of pain) on a scale from 0 (not threatening at all) to 10 (extremely threatening).

Pain Expression

Video tapes of each participant were rated using the Childhood Facial Action Coding System,¹⁰ a fine-grained anatomically based system that is considered the criterion standard when decoding facial expressions, including the facial expression of pain.³² Six facial action units, which have been reported to most reliably indicate pain (brow lowerer, eye squeeze, eye squint, nose wrinkle, cheek raiser, and upper lip raise)^{27,31-33} were rated by the first author, who is a certified Childhood Facial Action Coding System coder and independently by the confederate Elien Dewachter (E.D.), who was trained by the first author and rated a randomly selected 20% subset of all video fragments. Inter-rater reliability was acceptable for overall frequencies (>.83) and intensity (>.71). Each video fragment consisted of 10 four-second segments capturing 1 second before and 3 seconds after administration of the electrocutaneous stimulus. Each second of the 4-second interval was coded using a software program enabling the rater to view and review each second at normal rate and at a rate of one-tenth of a second. For each time interval, a mean score per second for each of the 6 facial actions was calculated. A total score was calculated by summing these mean scores per participant.³

Aggression

Aggression is commonly defined as behavior that is directed toward another individual with the intent to cause

harm, often in response to provocation or threat.¹ We operationalized aggression by asking the participant to choose the number of painful electrocutaneous stimuli that would be administered back to the confederate. They could choose between 1 to 10 stimuli. In this way we were able to directly assess the willingness of the participant to inflict pain upon the confederate. Unbeknownst to the participant, these electrocutaneous stimuli were never actually administered to the confederate. This operationalization of aggression was inspired by the Taylor Aggression Paradigm,¹² a well established and validated laboratory measure of direct physical aggression. In this paradigm, participants are asked to choose the intensity of electrocutaneous stimuli, or painful auditory blasts, which are allegedly administered to a fictitious opponent.

Social Threat

The Social Threat Questionnaire³¹ consists of 12 statements concerning the relation between the confederate and the participant. Participants were asked to rate the degree to which they agreed with each of the statements, using an 11-point Likert scale ranging from 0 = "completely disagree" to 10 = "completely agree". Social threat was conceptualized through 3 dimensions, namely: specific social threat (eg, "I had the feeling the other participant enjoyed hurting me"), social proximity (eg, "I feel close to the other participant"), and social likeability (eg, "the other participant is honest"). Eight items were reverse scored, so that reduced social proximity and social likeability were associated with increased social threat. The score ranges from 0 to 120, with higher scores reflecting increased perceptions of social threat.

Pain Catastrophizing

The Pain Catastrophizing Scale (PCS)³⁹ was used as a measure of catastrophic thinking associated with pain. Participants were asked to reflect on past painful experiences and indicate on a 5-point scale (0 = "not at all" to 4 = "all the time") the degree to which they experienced each of 13 thoughts or feelings. The PCS yields a total score and 3 subscales assessing rumination, magnification, and helplessness with a total score ranging from 0 to 52, with higher scores reflecting higher levels of pain catastrophizing.

Empathy

The assessment of empathy toward the confederate was on the basis of the work of Batson.² Participants were asked to rate a total of 4 self-oriented (worried, upset, anxious, sad) adjectives assessing empathic distress and 3 other-oriented (understanding, compassionate, sympathizing) adjectives assessing compassion/sympathy when imagining the confederate receiving painful electrocutaneous stimuli. Each adjective was rated on an 11-point Likert scale (ranging from 0 = "not at all" to 10 = "very much"). Scores could range from 0 to 40 for empathic distress, and 0 to 30 for compassion/sympathy with higher scores indicating higher levels of empathic

distress and compassion/sympathy, respectively.

Procedure

The participant and confederate both waited in the waiting area until the experimenter picked them up. To ensure that there was no previous communication between the participant and confederate, the confederate arrived shortly before the start of the experiment and was wearing headphones while waiting. They both entered the laboratory together and were seated, at a table, facing each other. They were first asked to provide informed consent, confirm that they did not meet any of the exclusion criteria, and provide permission to the video recordings during the study. Subsequently, it was explained that there were 2 roles, which would be randomly allocated to the participant and the confederate: A receiver, who receives electrocutaneous stimuli and an administrator, who is requested to administer the electrocutaneous stimuli to the receiver. Then a bogus randomization procedure was run, always allocating the role of the receiver to the participant and the role of administrator to the confederate.

At this point, the experimenter brought the confederate to an adjacent experimental room, allegedly to fill in a number of questionnaires which were administered using Qualtrics Research Suite (Qualtrics, Provo, UT). The experimenter then performed the calibration procedure of the electrocutaneous stimulus (see Electrocutaneous Pain Stimuli and Calibration) while the confederate was waiting outside. Upon completion of the calibration procedure, the experimenter brought the confederate back into the room. The experimenter then placed a button box in front of the confederate and instructed her to administer electrocutaneous stimuli by pressing the left button when prompted by audio instructions that would be played afterward.

Depending on the group allocation, the experimenter also explained that the confederate could choose the number of stimuli she would like to administer between 1 to 10 (social threat group) or that the confederate was requested to administer 10 stimuli (control group). The confederate was asked to verbally express her choice when prompted by the audio instructions. The participant was then instructed to orally respond to the questions posed by the audio instructions. Subsequently, the experimenter would leave the room and start the audio instructions. The instructions prompted the confederate to administer the electrocutaneous stimuli after a 3-second countdown. Nine seconds after each electrocutaneous stimulus, the participant was cued to provide the verbal ratings in the presence of the confederate (see Outcome Measures). During this procedure, the participant's facial expression was recorded.

After completion of the final verbal rating by the participant, the experimenter returned to the experimental room and asked the confederate to leave the experimental room. The experimenter then explained that the roles of administrator and receiver would be reversed for the next phase of the experiment, and that the participant would now be able to choose how many

electrocutaneous stimuli of similar intensity would be administered back to the confederate (between 1 to 10). The participant was asked to choose the number of stimuli she wanted to administer back to the confederate and empathy toward the confederate was assessed. Afterward, the participant was asked to fill in the questionnaires on the computer while the experimenter was allegedly performing the calibration procedure and administration of the electrocutaneous stimuli with the participant in another experimental room. After the participant filled in all questionnaires, the confederate as well as the experimenter re-entered the room and fully debriefed the participant.

Statistical Analyses

First, an independent samples t-test was run as a manipulation check to compare the scores on the Social Threat Questionnaire between the social threat and control group. Second, to test whether social threat affects self-reported pain intensity, unpleasantness, or threat value of pain (hypothesis 1), 3 separate 2 (Group [social threat/control] \times 10 [Trial (1–10)]) mixed repeated measures analyses of variance were carried out to examine group differences for self-reported pain intensity, unpleasantness, and threat value of pain. Pain catastrophizing (PCS) was included as a covariate to investigate moderation of these effects. This is in line with the study by Peeters and Vlaeyen,³¹ who reported that self-reported pain intensity was increased in high pain catastrophizers in a threatening social context, whereas facial pain expression was reduced independent of pain catastrophizing. Greenhouse-Geisser corrections are reported when appropriate. Uncorrected degrees of freedom and corrected *P* values are reported together with ϵ and the effect size indication η_p^2 for partial eta squared. Planned comparisons were carried out to test our a priori hypotheses. Third, to investigate whether social threat reduces pain expression (hypothesis 2), increases aggression (hypothesis 3), and reduces empathy (hypothesis 4), analyses of covariance with group as independent variable and pain catastrophizing as covariate were run to compare levels of pain expression, aggression, and empathy between the social threat and the control group.

In addition, following the approach of Peeters and Vlaeyen,³¹ multiple linear regression analyses were performed to investigate the effect of social threat, pain catastrophizing, and their interaction on self-reported pain intensity, pain unpleasantness, threat of pain, facial pain expression, aggression, and self-reported empathy. All variables were centered for the purpose of these analyses. The rationale to conduct these additional analyses was similar to the rationale presented by Peeters and Vlaeyen³¹: although the manipulation check indicated a significant difference between the social threat group and the control group, levels of social threat were rather high in both groups. Consequently, the responder analysis allowed us to study the effect of social threat scores as a predictor for the main outcomes independent of group allocation. An α level of .05 was used for all statistical

tests. Holm-Bonferroni was used to correct for multiple testing per hypothesis and to keep the experimentwise α at .05.¹⁹ All statistical analyses were run using SPSS version 20 (IBM Corp, Armonk, NY).

Results

Manipulation Check

Perceived social threat was significantly greater in the social threat group compared with the control group ($t_{68} = -2.86, P = .01, d = .68$) indicating that our manipulation of social threat was successful. It should be noted that despite this difference, perceived social threat levels were relatively high in both groups (threat: mean = 92.69, SD = 20.43; control: mean = 79.06, SD = 19.47). This finding was part of the motivation to perform a responder analysis. Moreover, it should be noted that a total of 8 participants, 4 in each group, expressed suspicion about the confederate and the true purpose of the study. A sensitivity analysis was performed (ie, excluding suspicious participants) but the conclusions remained stable for all analyses (see [Supplementary Table 1](#) for an overview of all variables).

Hypothesis 1: Does Social Threat Increase Pain Intensity, Unpleasantness, and Threat Value of Pain?

Three separate 2 (Group [social threat/control] \times 10 [Trial (1–10)]) mixed repeated measures analyses of variance were carried out to examine whether social context increased pain intensity, unpleasantness, or threat value of pain. It was decided to investigate pain ratings across trials, to also investigate possible differences in sensitization between groups. Pain catastrophizing was included as a covariate to investigate whether the effect of social threat on self-reported pain intensity, unpleasantness, and threat value of pain is especially pronounced in high pain catastrophizers. Last, there was some randomly missing data due to technical difficulties which was imputed using expectation maximization (5.6% for pain intensity, 6.9% for pain unpleasantness, and 7.4% for threat value of pain).

Pain intensity. There was no significant interaction between pain catastrophizing and trial ($F_{9,603} = .73, P = .68, \epsilon = .41, \eta_p^2 = .01$), pain catastrophizing and group ($F_{1,66} < 1, P = .87, \eta_p^2 < .01$), or group and trial ($F_{9,603} = 1.14, P = .33, \epsilon = .41, \eta_p^2 = .02$). Contrary to our hypothesis, pain intensity ratings were not higher in the social threat group compared with the control group ($F_{1,67} < 1, P = .52, \eta_p^2 < .01$). However, pain intensity ratings increased along with the number of painful stimulations in both groups ($F_{9,603} = 5.11, P < .01, \epsilon = .41, \eta_p^2 = .09$), showing overall sensitization.

Pain unpleasantness. Similar to the pain intensity ratings, there was no interaction between pain catastrophizing and trial ($F_{9,603} = .58, P = .81, \epsilon = .39, \eta_p^2 < .01$), pain catastrophizing and group ($F_{1,66} = 2.3,$

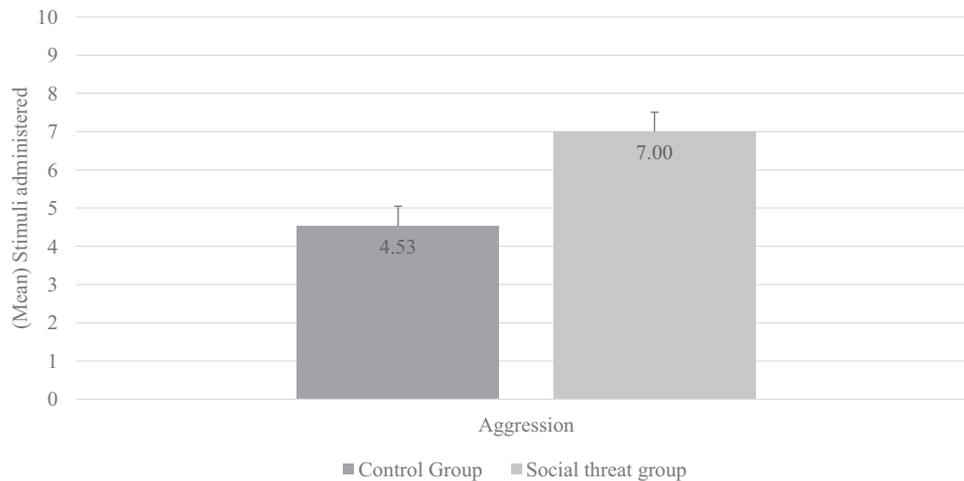


Figure 1. Stimuli administered to the confederate in the control and social threat group.

$P = .13$, $\eta_p^2 = .03$), or group and trial ($F_{9,603} = .83$, $P = .59$, $\epsilon = .39$, $\eta_p^2 = .01$). In contrast to our hypothesis, there was no difference in pain unpleasantness between the 2 groups ($F_{1,67} < .01$, $P = .76$, $\eta_p^2 < .01$). Again, pain unpleasantness ratings increased along with the number of painful stimulations in both groups ($F_{9,603} = 11.67$, $P < .01$, $\epsilon = .39$, $\eta_p^2 = .15$), indicating sensitization.

Threat value of pain. The interaction between pain catastrophizing and trial ($F_{9,603} = .28$, $P = .98$, $\epsilon = .32$, $\eta_p^2 < .01$), pain catastrophizing and group ($F_{1,66} < 1$, $P = .91$, $\eta_p^2 < .01$), or group and trial ($F_{9,603} = .76$, $P = .65$, $\epsilon = .32$, $\eta_p^2 = .01$), was also not significant. Again, we found no support for group differences in perceived threat value of pain ($F_{1,67} = .38$, $P = .55$, $\eta_p^2 < .01$). Mirroring the effects for pain intensity and unpleasantness, threat ratings increased across trials independent of group ($F_{9,603} = 3.00$, $P = .03$, $\epsilon = .32$, $\eta_p^2 = .04$), although this effect was no longer significant after Holm-Bonferroni corrections were applied ($P > .01$).

Hypothesis 2: Does Social Threat Reduce Pain Expression?

One participant in the control group had to be excluded from this analysis because of technical difficulties during the recording of the facial expression. There was no difference in painful facial expression between the social threat group and the control group ($F_{1,66} < .01$, $P = .99$, $\eta_p^2 < .01$), and also pain catastrophizing was not a significant covariate ($F_{1,66} = 1.71$, $P = .20$, $\eta_p^2 = .03$). The interaction between group and pain catastrophizing was also not significant ($F_{1,65} = 2.49$, $P = .12$, $\eta_p^2 = .04$).

Hypothesis 3: Does Social Threat Increase Aggression?

We did find support for hypothesis 3. Participants in the social threat group indicated a higher willingness to administer more electrocutaneous stimuli (mean = 7.00,

SD = 2.90) to the confederate than participants in the control group (mean = 4.53, SD = 3.20, $F_{1,67} = 11.57$, $P < .01$, $\eta_p^2 = .15$), thus showing increased aggression (see Fig 1). Pain catastrophizing was again not a significant covariate ($F_{1,67} = 1.56$, $P = .22$, $\eta_p^2 = .02$), and did not significantly interact with group, ($F_{1,66} = .94$, $P = .34$, $\eta_p^2 = .01$), suggesting that the group difference in aggression was not moderated by differences in pain catastrophizing.

Hypothesis 4: Does Social Threat Reduce Empathy?

Despite being more aggressive, participants in the social threat group did not show less empathic distress toward the pain of the confederate ($F_{1,67} < 1$, $P = .57$, $\eta_p^2 < .01$). There was also no interaction between pain catastrophizing and group ($F_{1,66} = .45$, $P = .51$, $\eta_p^2 = .01$). However, pain catastrophizing was a significant covariate in this analysis ($F_{1,67} = 7.75$, $P < .01$, $\eta_p^2 = .10$), showing that higher pain catastrophizing was associated with increased empathic distress. In contrast, neither group ($F_{1,67} < 1$, $P = .96$, $\eta_p^2 < .01$), nor pain catastrophizing ($F_{1,67} < 1$, $P = .60$, $\eta_p^2 < .01$), affected compassion/sympathy for the confederate. Also, there was no interaction between group and pain catastrophizing ($F_{1,66} = .66$, $P = .42$, $\eta_p^2 = .01 = .01$).

Regression Analyses

Verbal Ratings

Neither social threat ($\beta = .31$, $t_{65} = 1.02$, $P = .31$), nor pain catastrophizing ($\beta = .06$, $t_{65} = .50$, $P = .62$), or their interaction ($\beta = -.18$, $t_{65} = -1.45$, $P = .15$), significantly predicted pain intensity ratings. Similarly, neither pain catastrophizing ($\beta = .02$, $t_{64} = .63$, $P = .53$), nor the interaction between pain catastrophizing and social threat ($\beta = -.19$, $t_{64} = -1.56$, $P = .12$), explained pain unpleasantness ratings. However,

there was a slight trend toward social threat positively predicting pain unpleasantness ($\beta = .22$, $t_{64} = 1.85$, $P = .07$). Last, social threat ($\beta = .32$, $t_{64} = 2.83$, $P < .01$), as well as pain catastrophizing ($\beta = .26$, $t_{64} = 2.31$, $P = .02$), positively predicted ratings of threat value for pain. The interaction between social threat and pain catastrophizing did not reach statistical significance ($\beta = -.22$, $t_{64} = -1.95$, $P = .06$). We proceeded with a path analysis to investigate whether social threat affects the threat value of pain, which then in turn predicts self-reported pain intensity ratings. Indeed, the resulting linear regression analysis using pain intensity ratings as outcome and social threat, pain catastrophizing, and threat value of pain as predictors showed that social threat did not predict pain intensity ($\beta = .06$, $t_{65} = .47$, $P = .64$), but threat value of pain did positively predict pain intensity ratings ($\beta = .32$, $t_{65} = 2.43$, $P = .02$).

Pain Expression

Similar to the between groups analysis, neither perceived social threat ($\beta = .05$, $t_{65} = .41$, $P = .31$), pain catastrophizing ($\beta = .18$, $t_{65} = 1.50$, $P = .14$), nor their interaction ($\beta = -.16$, $t_{65} = -1.32$, $P = .19$), predicted painful facial expression.

Aggression

In line with earlier analyses, perceived social threat predicted the number of stimuli that participants were willing to administer to the confederate ($\beta = .26$, $t_{66} = 2.21$, $P = .03$). After Holm-Bonferroni correction, this effect was only borderline significant ($P > .02$). Pain catastrophizing ($\beta = -.17$, $t_{66} = -1.46$, $P = .15$), and the interaction between pain catastrophizing and social threat ($\beta = .14$, $t_{66} = 1.19$, $P = .24$) was not a significant predictor.

Empathy

With regard to empathic distress, there was no interaction between pain catastrophizing and perceived social threat ($\beta = -.16$, $t_{66} = -1.43$, $P = .16$). However, as expected, increased social threat was related to reduced empathic distress ($\beta = -.23$, $t_{66} = -2.01$, $P = .05$). However, this effect was no longer significant after Holm-Bonferroni corrections were applied ($P > .02$). In addition, higher pain catastrophizing was associated with more empathic distress ($\beta = .36$, $t_{66} = 3.12$, $P < .01$). With regard to compassion/sympathy, higher social threat predicted less compassion/sympathy ($\beta = -.28$, $t_{66} = -2.36$, $P = .02$). Again, this effect was no longer significant after Holm-Bonferroni corrections were applied ($P > .01$). Pain catastrophizing ($\beta = .13$, $t_{66} = 1.05$, $P = .30$), and the interaction between pain catastrophizing and social threat ($\beta = -.12$, $t_{66} = -1.00$, $P = .32$) were not significant.

Discussion

This study aimed to replicate and extend a study by Peeters and Vlaeyen³¹ investigating the effects of a threatening social context on the perception and communication of pain, as well as on interpersonal aggression and

empathy. We hypothesized that a threatening social context would lead to 1) increased self-reported pain intensity, pain unpleasantness, and threat, 2) reduced painful facial expressions, and last, to 3) increased aggression and 4) reduced empathy toward the confederate.

With regard to hypothesis 1, there were no group differences in pain intensity, unpleasantness, or experienced threat value of pain. However, on the basis of the responder analyses we can conclude that the more participants experienced the confederate to be threatening, the more they also experienced the painful stimulus itself to be threatening, and this in turn predicted higher pain intensity ratings. This finding contrasts with earlier studies,^{16,31} which reported a direct effect of social threat in the form of intentional pain on pain intensity reports. Notably, some of these studies only assessed pain intensity and not unpleasantness or the perceived threat value of pain so pain intensity ratings in these studies possibly also contain elements of unpleasantness and/or threat. Instead, the current study supports the predictions of a free energy framework put forward in a recent systematic review of interpersonal effects on pain.²⁵ According to this view, social context might function as a predictive signal of contextual threat or safety and as such influence the salience of the painful stimuli within that context. Consequently, because participants perceived the (social) context in which pain occurred as more threatening, they also perceived the painful stimuli themselves as more threatening. This study provides further support that it is valuable to also assess affective dimensions of pain such as unpleasantness or threat value. There is growing evidence that contextual factors might affect affective dimensions of pain rather than perceived intensity itself.²⁵

In addition, we were not able to replicate the effect of pain catastrophizing on pain reports or the interaction between social context and pain catastrophizing as found in the study by Peeters and Vlaeyen.³¹ Instead, perceived social threat and pain catastrophizing independently predicted higher threat value of pain. This finding is in line with the idea that catastrophizing thoughts about pain are associated with the belief that pain is more harmful and threatening^{39,40} but it challenges the assumption that this association is modulated by the social context. Both inter- and intrapersonal factors seem to be able to independently affect the perceived threat value of pain.

Most importantly, we did not replicate the effect of social context on the facial expression of pain (hypothesis 2). There was no evidence for reduced painful facial expression in the social threat group and perceived social threat did not predict facial expressions of pain. Similarly, we also did not find any support for the predictions of the communal coping model of pain,⁴⁰ which predicts that people high in pain catastrophizing express more pain to others to elicit support than individuals low in pain catastrophizing. It should be noted that the communal coping model does not distinguish between different kinds of social environments and simply states that individuals who catastrophize about pain will likely maximize the probability that others in the environment

notice their pain. According to the evolutionary account proposed by Williams,⁵¹ threatening social contexts might lead to a reduction of pain communication because it would not be advantageous to express pain to someone who might exploit a state of vulnerability.

An interesting question might be why the present study did not find suppression of painful facial expression in the social threat group. One reason may be related to the control group, in which participants also appraised the situation as threatening. In general, perceived social threat was considerably higher than in the study by Peeters and Vlaeyen³¹ and overall pain expression was very low in both groups. So it could be that both groups experienced the interaction as threatening and showed inhibited painful facial expression. Interestingly, there was more variation in painful facial expression in the control group compared with the social threat group, suggesting that the control group manipulation may have been more ambiguous in terms of perceived threat and therefore individual differences may be more easily expressed.²⁹ In addition, this finding might support another idea that is increasingly supported by empirical evidence, namely that inhibition of pain expression may be the norm, rather than the exception. In previous research, several social contexts in which strangers or an observer with different ethnicity were present and which were intended as neutral contexts also led to reduced painful facial expression.^{20,25} Thus, it is possible that pain expression is commonly suppressed in a context of ambiguity or threat and that this suppression is only released in a safe context (eg, in the presence of supportive others like friends or family).⁵¹ This would make it even more crucial to create a safe and supportive clinical context, because even an ambiguous but nonthreatening context might lead to suppression of pain expression. This, in turn, would increase the chance for pain underestimation, which is a common concern in clinical practice.²¹ Future research could focus on pain expression in a context that is experienced as safe by the participants and contrast this with varying levels of ambiguity or threat. In addition, we observed large intraindividual variation in painful facial expression. The variation could have simply over-ruled the effect of social context, which might be subtler than initially expected. A remedy to this problem would be to use a within-subject design rather than to compare different groups.

In addition to pain-related outcomes, we also investigated interpersonal consequences of a threatening interpersonal interaction. We found strong support for hypothesis 3, namely that a threatening social context leads to more aggression than a control context. Participants in the social threat group were more willing to inflict pain on the confederate than participants in the control group and perceived social threat predicted the number of painful stimuli that participants wanted to administer. According to the aggression literature this form of aggression can be conceptualized as reactive aggression (also referred to as hostile or retributive aggression),¹ usually occurring after some form of provocation or perceived injustice and often driven by anger.¹² There is some evidence that pain by itself leads to increases in

aggression,²⁸ but the current experiment shows that motivation matters as well. In line with earlier research,⁴³ aggression was especially pronounced in a situation in which participants believed the confederate to intentionally hurt them. It is reasonable to assume that participants in the social threat group perceived this interaction to be especially unfair and provocative and retaliated with aggression to correct this injustice ("tit-for-tat").^{1,12,26,30,54} In fact, Anderson and Bushman¹ pp 37 stated that "the most important single cause of human aggression is interpersonal provocation." This finding nicely fits with earlier research showing that perceived injustice in the context of pain might lead to anger and aggressive behavior as well.^{36,44}

In line with these findings, we also found some support for hypothesis 4, namely that empathy for the confederate is reduced in a threatening social context. Although there were no group differences, we indeed found that the more threatening the confederate was perceived, the less empathic distress and the less compassion participants experienced for the confederate. This is in line with earlier research, indicating that perceived injustice is often met with reductions in empathy for, and punishment of, the offender.¹ Interestingly, pain catastrophizing also independently predicted empathic distress but not compassion for the confederate. This effect is not surprising because individuals who catastrophize about pain perceive it as more threatening, with regard to themselves as well as also with regard to others.^{14,15}

Although this study provides further support for the importance of social context in the study of pain, there are several limitations that should be mentioned. First, the regression analyses should be interpreted with caution because they were performed post hoc on the basis of the results of the manipulation check, similar to the study by Peeters and Vlaeyen.³¹ Second, the present study only recruited female participants and the confederate was female as well. Although this decision was predominantly made for practical reasons, sex and gender differences may play a role. As has been shown previously, men and women differ in the encoding (eg, expression) and decoding (eg, recognition) of pain.²⁴ From a social learning perspective, being emotionally expressive is often considered less acceptable in men than in women. Also, from an evolutionary perspective, it might be especially relevant for men not to betray vulnerability in a threatening context.⁵¹ Further research investigating possible sex differences in pain communication in threatening social environments would be very insightful. Last, although we focused solely on painful facial expressions, other forms of pain communication (eg, posture) might be affected as well.^{5,48}

In sum, although we were not able to replicate the dissociation between self-reported pain and painful facial expression reported in a previous study,³¹ we did find that a threatening social context was associated with increased threat perceptions about pain, increased aggression, and reduced empathy. This study showed that social context is associated with an increased threat value of pain but also has direct interpersonal consequences for the individual in pain.

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Supplementary Data

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