Partners' Empathy Increases Pain Ratings: Effects of Perceived Empathy and Attachment Style on Pain Report and Display

Sarah Hurter,* Yannis Paloyelis,[†] Amanda C. de C. Williams,* and Aikaterini Fotopoulou[‡,§]

*Research Department of Clinical, Educational, and Health Psychology and [§]Division of Psychology and Language Sciences, University College London, United Kingdom.
Departments of [†]Neuroimaging and [‡]Psychology, Institute of Psychiatry, King's College London, United Kingdom.

Abstract: Pain can be influenced by its social context. We aimed to examine under controlled experimental conditions how empathy from a partner and personal attachment style affect pain report, tolerance, and facial expressions of pain. Fifty-four participants, divided into secure, anxious, and avoidant attachment style groups, underwent a cold pressor task with their partners present. We manipulated how much empathy the participants perceived that their partners had for them. We observed a significant main effect of perceived empathy on pain report, with greater pain reported in the high perceived empathy condition. No such effects were found for pain tolerance or facial display. We also found a significant interaction of empathy with attachment style group, with the avoidant group reporting and displaying less pain than the secure and the anxious groups in the high perceived empathy condition. No such findings were observed in the low empathy condition. These results suggest that empathy from one's partner may influence pain report beyond behavioral reactions. In addition, the amount of pain report and expression that people show in high empathy conditions depends on their attachment style.

Perspective: Believing that one's partner feels high empathy for one's pain may lead individuals to rate the intensity of pain as higher. Individual differences in attachment style moderate this empathy effect.

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P ain in everyday life often occurs in the presence of a partner. Partners may also be important support providers in medical settings, for example, during labor pain or chronic pain consultations.[32,37] Several models, ranging from early behaviorist models[21] to recent broader, cognitive-behavioral accounts,[8,19,22,57] have addressed the role of interpersonal factors in

pain. A handful of laboratory[18,34,65] and neuroimaging studies[16,66] have also examined causal relations between pain and partner support variables. These studies have focused on different facets of social support, ranging from active, solicitous partner behaviors[18] to "priming" partner support cognitions by picture viewing[34]; not surprisingly, they have found conflicting results.[29] Empathy has long been considered a critical feature of supporting, close relationships, but to our knowledge no experimental study has examined the effects of a partner's empathy on pain.

The precise definition of empathy has been debated in many fields. For example, empathy can be defined as a cognitive ability similar to cognitive perspective-taking (eg, a third-person perspective on someone else's pain), an embodied ability to share another's state (eg, a first-person perspective on sharing someone else's pain), or an interpersonal communicative phenomenon that can shape individual experiences. The latter second-person perspective on empathy[42] is highly relevant to health studies, as perceived emotional support and understanding by health professionals is considered a critical determinant of therapeutic effects and health outcomes.[2,56] To

experimentally investigate the potential modulatory effects of this latter notion of empathy on pain, we recently examined how perceived empathy, defined as the degree to which an individual knew that an observer understood and shared his or her pain, can affect pain.[48] Perceived empathy was found to influence pain ratings, but only when individual differences in attachment style were taken into account. The observer in that study was an unfamiliar research confederate. In the current study, we focused on perceived empathy from a highly attached, romantic partner, under the assumption that romantic partners are more likely to respond emotionally to each other.[10] We thus expected high perceived empathy to reduce subjective ratings of pain in comparison to low perceived empathy. We further expected high perceived empathy to reduce facial expressions of pain, a measure that we had not included in our previous study but that has been shown to be important when the role of other social variables on pain is considered.[59-61] Facial expression is considered by many to be the most prominent way of communicating affect,[44] and displaying and recognizing pain in facial expressions is a fundamental human ability.[63] Therefore, when empathy is perceived to be high, it may reduce the communicative need and thus reduce facial expressions of pain.

Because individual differences in attachment style have been found to be critical in moderating the relationship between the social context of pain and pain,[48,65] we also examined the role of attachment style in the relationship between perceived empathy and pain perception. Theories of adult attachment style emphasize 2 dimensions of insecurity[1]: *attachment anxiety* is associated with worry over the availability and responsiveness of others, with exaggerated appraisal of threat, ruminative worry, and reliance on others,[49] and *attachment avoidance* is associated with discomfort with closeness and a need to maintain autonomy, even in close relationships.[1]

Thus, we expected that the effects of perceived empathy would be moderated by attachment style. Specifically, based on our previous study,[48] we expected anxious attachment to be associated with amplified communication of pain to the partner, more so when the partner was perceived to be low in empathy. We also expected avoidant attachment to be associated with less expression of pain to the partner, and expression to be lower when the partner was perceived to be high in empathy.

Methods

Participants

The study was approved by the Ethics Committee of King's College London. All participants gave written, informed consent to participate in the study. Three hundred ninety-two people responded to a university circular email and completed an online survey. The online survey included questions on demographic characteristics and on the following inclusion criteria: 1) older than age 18 years and in a long-term romantic relationship (>1 year) with someone else older than age 18 years;

2) both partners should be available to attend testing at the same time and both should be willing to take part in the cold pressor task. Exclusion criteria were any previous psychiatric or neurologic history, previous or current chronic pain disorders, history of substance misuse, or drinking more than 28 units of alcohol per week. Participants were also selected based on their attachment style and divided into 3 groups, as explained in the following section.

The final sample consisted of 54 healthy volunteers aged between 19 and 33 years (mean [M] = 24, standard deviation = 3.2), 28 (52%) of whom were female. Most participants were in heterosexual couples (n = 48, 89%). Sixty-seven percent (n = 36) considered themselves to be of "White" ethnic background, 6% (n = 3) described their ethnic background as "Black," 17% (n = 9) as Asian, 7% (n = 4) as Chinese, 2% (n = 1) as Arab, and 2% (n = 1) as of mixed ethnic background.

Attachment Style Recruitment Strategy

Previous research has not attempted to sample individuals or couples on the basis of their attachment style but instead only measured attachment style retrospectively. This strategy results in participants who tend to score in the low-to-mid range of insecurity dimensions.[20,65] Because we aimed to answer specific hypotheses about the role of attachment anxiety and avoidance on the social modulation of pain, we were not interested in recruiting a representative sample of the population in terms of attachment style. Instead, we created our sample by selecting participants on the basis of their scores on the attachment anxiety and avoidance subscales of the Experiences in Close Relationships–Revised questionnaire (ECR-R; see measures). This measure derives these 2 main dimensions of attachment style on the basis of continuous scores. We ensured that each couple had to have at least 1 member who scored highly on either the anxiety or avoidance subscale of the ECR-R; a cut-off criterion of higher than the 60th percentile per category was set on the basis of normative data[20] in order to recruit participants who scored in the high end of the distribution of either the attachment anxiety or attachment avoidance subscale. As "secure" is the most common attachment style in the general population,[23] it was assumed that a sufficient number of partners' scores on the ECR-R would tend to be low in both anxiety and avoidance, so recruitment was not targeted in this respect. Finally, couples in which either of the partners scored above both the anxiety and avoidance cut-offs (suggesting a more disorganized-disorientated or fearful-avoidant attachment style, 18 in total) were not recruited, as previous studies have found that attachment anxiety and avoidance may have separate effects on social manipulations (see introduction). Accordingly, in this study we were primarily interested to examine the potential modulatory role of attachment anxiety and avoidance separately, and not their combined effect.

We thus formed 3 mutually exclusive groups: 1) a group consisting of individuals characterized by high

anxious attachment scores (scoring above the 60th percentile on the ECR-R anxiety subscale but below the 60th percentile on the ECR-R avoidance subscale), hereafter referred to as the "anxious attachment group"; 2) a group consisting of individuals characterized by high avoidance attachment scores (scoring below the 60th percentile on the anxiety subscale but above the 60th percentile on the avoidance subscale), hereafter referred to as the "avoidant attachment group"; 3) a group consisting of individuals scoring below the 60th percentile cut-offs on both ECR-R subscales, hereafter referred to as the "secure attachment group." The accompanying partner (who was also tested; see below) was similarly classified as belonging to 1 of the 3 subgroups using the ECR-R questionnaire. The effects of the observing partner's attachment style were also taken into account in the analysis (see below).

On the basis of the survey responses, 42 couples (84 participants) were eligible to attend testing, and this sample included 25 people who scored above the cut-off on the anxiety subscale of the ECR-R and 27 people who scored above the cut-off on the avoidance subscale of the ECR-R. The remaining 32 participants scored below both cut-offs so were grouped in the secure attachment group. Therefore, all couples eligible had at least 1 member of the couple who scored high on either the anxiety or avoidance subscale of the ECR-R (ie, there was no couple in which both members had a secure attachment style). The precise attachment style scores of each group are presented in the results below. Of all 42 eligible couples invited to attend testing, 30 couples (60 participants) responded and attended. Although 30 couples completed the study, data from only 27 couples (54 participants) was used for the analyses for the following reasons: 2 couples' data were unusable because of filming errors and 1 couple spoke during testing, invalidating the empathy manipulation (see Procedure section below).

Design and Statistical Analyzes

Main Design and Analysis

This study used a mixed 2 (low or high perceived empathy levels, the *within*-subjects factor) by 3 (anxious, avoidant, or secure attachment group, the *between*-subjects factor) design. To test for the effects of each factor and their interactions on our 3 main measures, pain report at tolerance, pain tolerance time, and facial expressions of pain (see Measures section below for details), we implemented 3 separate analysis of covariance models, using the regression command in Stata (version 11; StataCorp, College Station, TX). We tested the skewness and kurtosis of distributions using the "sktest" command in Stata.[12,46] We used logarithmic transformations where it restored normality (pain report; see Fig 2 and Table 2 for the raw, untransformed data), and because of remaining distribution issues we conducted statistical inferences using nonparametric bootstrapping estimation (1,000 repetitions), which does not make distributional assumptions

on the data.[11] The bootstrap procedure in Stata uses chi-squared statistics to test for statistical significance, which we report (equivalent F values can be obtained by dividing the chi-squared statistic by its degrees of freedom). Finally, we corrected for the nonindependence of observations (the within-subjects factor and testing both partners in a couple) using robust regression methods that appropriately adjust the standard errors (using the "vce(cluster)" option in Stata).[64]

Secondary, Control Factors and Analyses

We also controlled for a number of factors that have been shown to be important moderators of the relationship between social support variables and pain.[29] Specifically, we controlled for gender and order effects by including them as covariates in all analyses. As age and relationship quality (7-item short form of the Dyadic Adjustment Scale [DAS-7]) were not statistically related to our dependent measures, and neither were there statistically significant subgroup differences in these variables, they were not included in the analyses. In addition, we repeated analyses controlling for individual differences in observing partner attachment style.[65] We also controlled, in the same manner, for individual differences in catastrophizing (Pain Catastrophizing Scale [PCS]), as according to the communal coping model of pain catastrophizing,[55] individuals differ in the extent to which they adopt interpersonal coping strategies to deal with pain, particularly in the presence of others.[53,55] Finally, we used the same approach as described in the Main Design and Analysis section to analyze the results of pre- and posttask control empathy questions to ensure that our manipulation worked (see Measures below).

Materials

Cold Pressor

The cold pressor apparatus was constructed from an insulated cool box (64.5 × 37.5 × 36.5 cm), a plastic division to keep the ice away from participants' hands, and a plastic arm rest, designed and constructed for the purposes of this experiment. Ice was used to maintain the water temperature between 2 and 4°C. This construction was similar to that used in previous studies.[4] The cold pressor task is considered a reliable and valid method of inducing pain.[15,58]

The partners sat facing each other, about 1 m apart. Both had a music stand positioned in front of them where rating scales were placed, so that they could rate their pain/empathy without seeing each other's responses but still seeing each other's faces. A digital video camera was positioned behind "the observing partner" (the partner observing their partner receiving the pain) to record the "participant partner's" (the partner receiving the pain) facial expressions during the cold pressor task. The camera recorded from the time the participant partner placed a hand in the water until 60 seconds after removing the hand. Another camera, placed behind the participant partner, was used to film

the observing partner and thus control for any facial expressions, gestures, or actions in the observing partner. These recordings were used to check whether the observing partner showed deviations from the task instructions (1 couple was indeed excluded from the analyzes on this basis; see above) and were not analyzed further.

Procedure

Prior to the Cold Pressor Task

Participants were required not to use analgesics or to have more than 1 caffeinated drink on the day of testing and to have abstained from alcohol in the 24-hour period prior to the testing. Before completing the cold pressor task, participants completed independently a measure of relationship quality (DAS-7) and the PCS. Additionally, to prime participants to think about empathy and to ensure they understood the concept, they were given the following definition of empathy "People often confuse the words empathy and sympathy. Empathy is defined as 'the ability to understand and share the feelings of another,' whereas sympathy is 'feelings of pity and sorrow for someone else's misfortune'" and they were asked to provide ratings of "empathy expectation" before the task (see Measures).

The Cold Pressor Task—Pre-empathy Phase

The procedure of each cold pressor trial is shown in schematic form in Fig 1. Each participant performed the same cold pressor task procedures twice, each time with a different hand, under a low empathy and a high empathy condition in a counterbalanced order and in the presence of his or her partner. Both members of the couple were tested, so that both participants experienced being the participant partner (the partner receiving the pain) and observing partner (the partner observing their partner receive the pain) in different trials. The order of these experimental roles was counterbalanced.

Just before the cold pressor task, participants were read standard instructions; they were asked to not speak to, gesture, signal, or touch one another throughout the testing process (in order to experimentally control the

perceived empathy manipulation; see below). The participant partner was asked to place his/her hand in the water, to keep it still during immersion, and to keep it in the water until it became too uncomfortable (or until 3 minutes had elapsed, a recommended safety measure when using the cold pressor task).[62] The participant partner was also instructed to raise his/her free hand when he/she began to feel pain in the hand still immersed in the water (T1) and to rate his/her pain by circling a number with the free hand on an 11-point scale, where 0 = "no pain" and 10 = "pain as bad as it could be" placed in front of them on the music stand (T1 rating). The observing partner could not see this rating. At that point, the perceived empathy manipulation was implemented as follows.

Perceived Empathy Manipulation

In order to operationalize and experimentally test the effects of a complex interpersonal variable such as empathy, we adopted the following procedures to generate conditions of low and high perceived empathy (see introduction): Although the participant partner gave his/her T1 pain rating (not visible to the observing partner), the observing partner was asked to rate the amount of empathy he/she felt for the participant partner on an 11-point scale ranging from 0 (no empathy) to 10 (maximum empathy). Subsequently, the participant partner was shown the empathy rating of the observing partner by the researcher, who first checked what number the observing partner circled on the stand in front of them (out of sight of the participant partner) and then moved across the room and circled the equivalent number on an identical empathy scale in front of the participant partner. However, unbeknownst to the couple, the participant partner was given false empathy ratings that were either low (the number 2 was circled: low empathy condition) or high (the number 8 was circled: high empathy condition), in counterbalanced order.

The Cold Pressor Task—Postempathy Phase

Participant partners held their hand in the water during and following the empathy manipulations until it became too uncomfortable (or until 3 minutes had
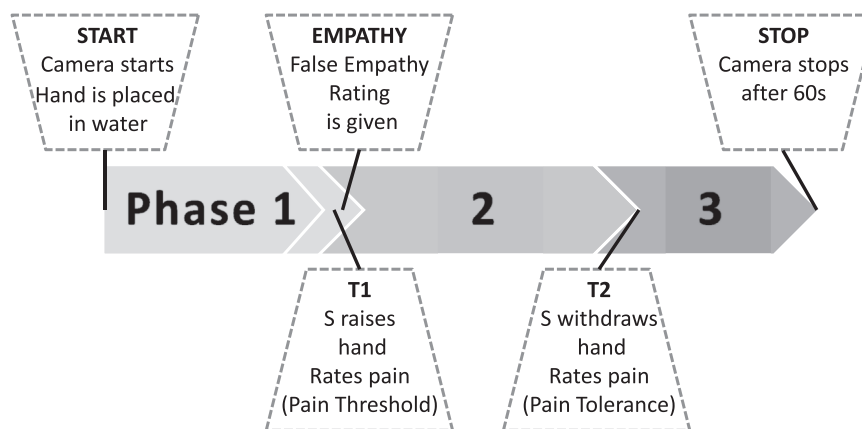

Figure 1. A schematic representation of the procedure during each cold pressor trial.

elapsed). At either of these points, the participant removed her/his hand from the water (T2) and rated her/his pain again by circling a number on an 11-point scale, where 0 = "no pain" and 10 = "pain as bad as it could be" (T2 rating).

Following the Cold Pressor Task

Participants completed posttask empathy ratings (see Measures section) and were fully debriefed about the empathy manipulation. No participant stated that he/she had guessed or suspected that the empathy feedback was false (see also below). Participants were paid for their time (£40 per couple).

Measures

Main Measures

Pain Report. Participants rated their pain on a numerical rating scale (NRS) ranging from 0 ("no pain") to 10 ("pain as bad as it could be"). The NRS is a widely used measure of pain and has been found to have an internal consistency of Cronbach's alpha = .88 when tested across different temperature values.[24] Participants rated their pain at 2 time points: "T1 rating," when they started to feel pain (prior to empathy manipulation), and "T2 rating," when they could no longer tolerate the pain and they withdrew their hand from the water.

Pain Threshold and Tolerance. The time (T1) participants indicated they were feeling pain (pain threshold) and the time (T2) they withdrew their hand (pain tolerance) were recorded to the nearest second. Only pain tolerance (T2) was used in the main design analyses, as this was the only pain rating after the empathy manipulation (see Fig 1).

Facial Expressions. In order to standardize the recorded clips, they were edited into 30-second clips for each cold pressor trial, without sound, consisting of the 10 seconds prior to and the 20 seconds after participants withdrew their hands (T2). These time intervals were chosen based on an examination of the video recordings by the first author that indicated that most participants displayed the greatest amount of pain during this interval. There were 108 excerpts, showing 54 participants experiencing pain twice. Video editing software REALbasic, release 5 (2007; REAL Software, Austin, TX), was used to randomize order of presentation.

Two naïve raters were selected to rate the recordings of participants' facial expressions.[47] Raters were naïve to the study hypotheses and design, had no personal experience of chronic pain, and were not employed in a context where they were normally exposed to people in pain. One woman and one man (25 and 27 years of age; 18 and 20 years of education, respectively) were recruited. Before rating the clips, each rater was given a brief description of the study, emphasizing that the individuals in the clips were in pain from a cold pressor task. They remained blinded to the study's aims and hypotheses. Each rater practiced on 4 clips not used in the analysis, and once the investigator was confident that each rater understood the task, they viewed the clips independently, on a 15-inch

laptop computer screen. Following each clip, they were asked to rate the clips electronically on the following 2 NRSs, and then to click the "next" button to move to the next clip in their own time: 1) "On the scale below, please rate the amount of facial expression of pain displayed (0 = no facial expression and 10 = maximum facial expression)"; 2) "On the scale below, please rate how much pain you think the person is in (0 = no pain and 10 = maximum pain)." Interrater reliability results are presented in the Results section.

Attachment Style. The ECR-R[20] is a widely used 36-item scale measure of attachment style in a current romantic relationship.[43] The ECR-R yields scores on 2 dimensions—attachment anxiety and attachment avoidance—corresponding to existing models of attachment theory.[1] Both subscales have been found to display excellent internal reliability (α = .93 and α = .91 for attachment anxiety and attachment avoidance, respectively) and temporal stability (86% shared variance over time).[51]

Secondary, Control Measures

Relationship Quality. We administered the DAS-7[25] to control for the potential effects of relationship quality on pain communication. Items on the level of disagreement or agreement—for example, "Amount of time spent together"—and joint activities—for example, "Calmly discuss something together"—are scored for frequency on a scale between 0 and 5, with possible total scores ranging from 0 to 36. The reliability of the DAS-7 has been found to range from .75 to .80 and the scale has good criterion validity.[25]

PCS. The PCS was developed for assessing pain catastrophizing in clinical and nonclinical populations.[54] The PCS contains 13 items describing different thoughts and feelings associated with the experience of pain, and participants are asked to rate the frequency of these thoughts and feelings on a scale from 0 ("not at all") to 4 ("all the time"). The internal consistency for the PCS was .95 in a community sample.[40]

Pre- and Posttask Empathy Questions. Prior to the task, participants were asked to provide ratings of "empathy expectation" to prime them to think of empathy concepts and their partners' empathy (see Procedure section), and to assess whether different attachment style groups had different empathy expectations from and toward their partners. These questions were 1) "How much empathy do you believe your partner will feel toward you during the cold pressor task, when you will be experiencing pain?" (0–10 NRS with anchor points of "no empathy" and "maximum empathy") and 2) "How much empathy do you believe you will feel toward your partner when they are undergoing the cold pressor task and are experiencing pain?" (0–10 NRS with anchor points of "no empathy" and "maximum empathy").

After the task, participants were asked questions about their perceived empathy during the cold pressor experience, to check their memory of, as well as the credibility and influence of, the false empathy feedback. Specifically, these questions were 1) "How much empathy did your partner rate (s)he felt for you during each of your

experiences of the cold pressor task?" (0–10 NRS with anchor points of "no empathy" and "maximum empathy"); 2) "Irrespective of the ratings your partner gave, how much empathy do you believe your partner felt toward you during each of your experiences of the cold pressor task?" (0–10 NRS with anchor points of "no empathy" and "maximum empathy"); and 3) "Do you think that the amount of empathy you believe your partner felt, during each of your experiences of the cold pressor task, affected your pain?" (0–10 NRS with anchor points of "not at all" and "considerably"). Participants' ratings in posttask empathy questions were used to check whether the empathy manipulation had been successful.

Results

Demographic Data

Table 1 presents demographic information by group. No significant group differences were found for age, $F(2, 53) = 2.33$, $P = .11$; catastrophizing, $F(2, 53) = 1.51$, $P = .23$; relationship quality, $F(2, 53) = 2.22$, $P = .12$; or gender, $\chi^2(2) = 2.82$, $P = .24$. As expected, given our recruitment strategy, the groups were significantly different in their ECR avoidance scores, $F(2, 53) = 70.43$, $P < .001$, and ECR anxiety scores, $F(2, 53) = 43.16$, $P < .001$.

The internal reliability of the ECR-R was high (ECR-R attachment anxiety $\alpha = .90$; ECR-R attachment avoidance $\alpha = .89$). Cronbach's alpha for the PCS and DAS-7 was .89 and .82, respectively.

Descriptive Data on Measures of Pain

There were no significant differences among attachment style groups in terms of T1 threshold (seconds till they perceived pain), $\chi^2(2) = .73$, $P = .69$ (see Supplementary Data for raw scores). Descriptive data (raw, untransformed data) of participants' pain report (T2 ratings), tolerance (time in seconds), and facial ex-

pressions of pain at the time they withdrew their hand (T2) are displayed in Table 2. In addition, we note that 7 participants kept their hand in the water for 3 minutes (the maximum duration for safety purposes; see Methods) in both empathy conditions, 6 participants did so in the high empathy condition only, and 3 participants in the low empathy condition only.

For facial expressions, Cronbach's alpha on the 2 sets of ratings (by the 2 raters) for *the amount of facial expressions* displayed in the high and low empathy conditions was .85 and .84, respectively. Cronbach's alpha for the corresponding estimates of *how much pain* each person was in was .72 and .75 for the high and low empathy conditions, respectively. Thus, we calculated the mean ratings per condition and participant across raters for both amount of facial expression and estimate of pain based on facial display. These measures, that is, amount of facial expression and pain estimates, were found to be highly correlated (low empathy: r = .93; high empathy: r = .91), so ratings on the 2 variables were combined by calculating the mean and creating a new variable hereafter named "facial expression" (see Table 2). Hence, each participant had 1 facial expression rating for the low and 1 for the high empathy condition.

Main Factors

Effects of Perceived Empathy and Attachment Style Group on Pain Report

There was a main effect of perceived empathy, $\chi^2(1) = 5.59$, $P = .018$, with higher pain ratings in the high than the low perceived empathy conditions. There was no main effect of attachment style, $\chi^2(2) = .46$, $P = .79$, on pain report, but we observed a significant interaction of perceived empathy and attachment style group on pain report, $\chi^2(2) = 6.48$, $P = .039$ (see Fig 2). Controlling for catastrophizing or partner's attachment style yielded similar results.

Post hoc analyses (corrected for multiple comparisons using the Bonferroni procedure, $\alpha_{adjusted\ threshold} = .025$)

Table 1. Descriptive Data of Demographic Variables, Grouped According to Attachment Style Group

	SECURE ATTACHMENT (N = 18)	AVOIDANT ATTACHMENT (N = 18)	ANXIOUS ATTACHMENT (N = 18)
Male, n (%)	11 (61)	9 (50)	6 (33)
Female, n (%)	7 (39)	9 (50)	12 (67)
ECR-R Avoidance	2.1 (.6)*	3.7 (.5)*	2.0 (.4)*
	1.3–3.1	3.2–4.9	1.4–2.8
ECR-R Anxiety	2.5 (.7)*	2.7 (.8)*	4.4 (.4)*
	1.1–3.6	1.2–3.7	3.9–5.9
Age (y)	25.0 (3.3)	24.0 (3.8)	22.8 (1.8)
	21–33	19–33	19–26
Catastrophizing	16.7 (1.3)	14.3 (6.5)	19.2 (8.4)
	0–41	3–25	5–35
Relationship quality	25.9 (4.8)	22.8 (5.5)	25.5 (4.0)
	17–33	13–32	20–32

NOTE. Values are mean (standard deviation) and range unless otherwise indicated.
*Significance level: $P < .001$.

Table 2. Descriptive Data of Pain Report, Facial Expression of Pain, and Pain Tolerance in the Low Empathy and High Empathy Conditions

	SECURE ATTACHMENT	AVOIDANT ATTACHMENT	ANXIOUS ATTACHMENT
Low empathy condition			
Pain report (0–10)	7.0 (2.6)	6.9 (2.2)	7.3 (1.7)
Facial expression	4.25 (2.66)	4.72 (2.45)	5.10 (2.23)
Pain tolerance (s)	84.5 (57.2)	98.6 (60.3)	75.5 (52.3)
	25.9–180.0	33.1–180.0	26.8–180.0
High empathy condition			
Pain report (0–10)	7.4 (2.5)*	6.6 (2.0)	7.8 (1.9)
Facial expression	5.10 (1.94)	3.71 (2.54)	5.85 (2.03)
Pain tolerance (s)	74.8 (49.9)	102.3 (66.5)	79.0 (57.6)
	25.0–180.0	25.5–180.0	23.7–180.0

NOTE. Values are mean (standard deviation) and range unless otherwise indicated.
*Significance level: $P < .05$.

revealed that attachment style did not have a significant effect in either the low, $\chi^2(2) = .79$, $P = .79$, or the high, $\chi^2(2) = 6.29$, $P = .043$, perceived empathy conditions, but the latter showed a trend toward significance. Given the above significant interaction of perceived empathy and attachment style and this trend finding, we performed further analyses on the high perceived empathy condition (corrected for multiple comparisons using Bonferroni corrections, $\alpha_{adjusted\ threshold} = .017$) that showed that the avoidant attachment group reported less pain than the secure attachment group ($P = .015$), and showed a trend toward significance when compared with the anxious attachment group ($P = .073$). The secure attachment group did not differ from the anxious attachment group ($P = .92$).

Effects of Perceived Empathy and Attachment Style Group on Pain Tolerance

The analysis of covariance revealed no main effect for perceived empathy, $\chi^2(1) = 1.08$, $P = .30$, or attachment style group, $\chi^2(2) = 1.24$, $P = .54$, on pain tolerance, and the interaction of perceived empathy and attachment style was not significant either, $\chi^2(2) = 1.31$, $P = .52$.

Effects of Perceived Empathy and Attachment Style Group on Facial Expression

Although there were no main effects for perceived empathy, $\chi^2(1) = .00$, $P = .96$, or attachment style group, $\chi^2(2) = .14$, $P = .93$, on facial expression, we observed a significant interaction between perceived empathy and attachment style group, $\chi^2(2) = 7.90$, $P = .019$ (see Fig 2 for a graphical representation). Controlling for catastrophizing or partner's attachment style yielded similar results.

Post hoc analyses (corrected for multiple comparisons using the Bonferroni procedure, $\alpha_{adjusted\ threshold} = .025$)

revealed that attachment style had a significant effect in the high perceived empathy condition only, $\chi^2(2) = 8.57$, $P = .014$; low empathy condition, $\chi^2(2) = .30$, $P = .86$. Specifically, in the high perceived empathy condition (analyses corrected for multiple comparisons using the Bonferroni procedure, $\alpha_{adjusted\ threshold} = .017$), those in the avoidant attachment group displayed less facial expression of pain than the anxious attachment group ($P = .014$) and the secure group ($P = .003$). The anxious attachment group did not differ from the secure attachment group ($P = .63$).

Pre- and Posttask Empathy Questions

The pretask questions were used to check for differences in expectations of empathy between the attachment style groups. With respect to expectations of empathy, there was a significant effect of attachment style group, $\chi^2(2) = 7.29$, $P = .026$. This effect was explained by participants in the avoidant attachment group expecting to receive less empathy compared to participants in the secure attachment group ($P = .008$, $\alpha_{adjusted\ threshold} = .017$). This difference meant that such lower empathy expectations in the avoidant compared to the secure group could not be distinguished from the attachment classifications of these individuals, and hence these scores were not included in the main analysis. There were no significant differences (only a trend) among the 3 attachment style groups in their expectations of the degree of empathy they believed they would feel when their partner underwent the cold pressor task, $\chi^2(2) = 5.19$, $P = .075$.

The posttask ratings were used to check whether the perceived empathy manipulation was successful. The results indicated that participants remembered that their partners felt lower empathy for them in the low perceived empathy condition (M = 2.41, standard error
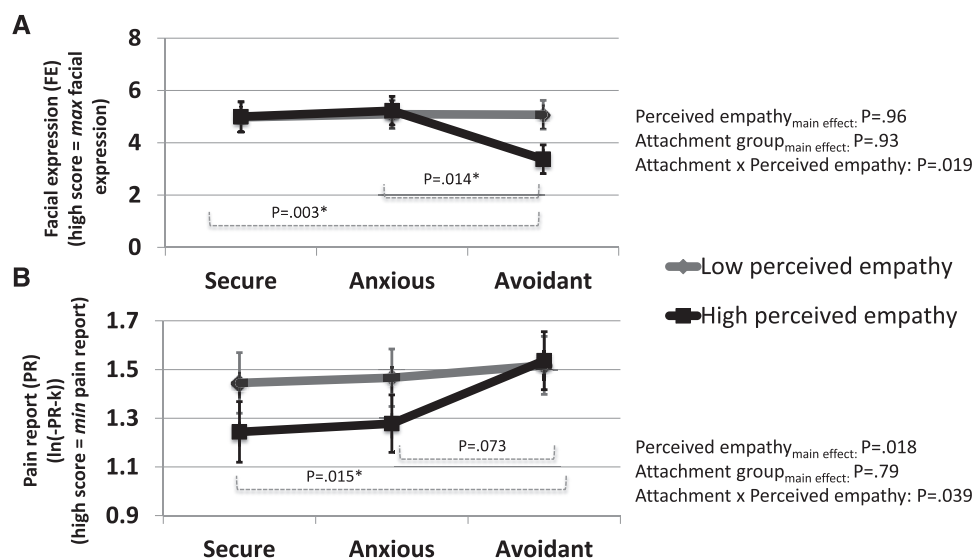

Figure 2. **(A)** Predictive marginal means and SE for composite facial expression ratings by attachment group and perceived empathy condition. **(B)** Predictive marginal means and SE for pain report ratings by attachment group and perceived empathy condition. Note: due to the logarithmic transformation ($\kappa = -11.73729$), high scores denote low pain report ratings. * Significant following correction for multiple testing.

[SE] = .26) and higher empathy for them in the high perceived empathy condition, M = 7.57, SE = .31; $\chi^2(1)$ = 91.03, P < .001. There were no significant differences among attachment style groups, $\chi^2(2)$ = 4.14, P = .13, nor an interaction between attachment style group and perceived empathy condition, $\chi^2(2)$ = 4.51, P = .11.

Similarly, when asked to rate how much empathy their partners felt for them, irrespective of the empathy ratings their partner actually gave, participants believed that their partners felt lower empathy for them in the low perceived empathy condition (M = 3.94, SE = .48) and higher empathy for them in the high perceived empathy condition, M = 6.82, SE = .39; $\chi^2(1)$ = 17.01, P < .001. Again, there were no significant differences among attachment style groups, $\chi^2(2)$ = 1.45, P = .48, or an interaction between attachment style group and perceived empathy condition, $\chi^2(2)$ = .13, P = .94. These results suggest that the perceived empathy manipulation had good validity. Finally, there was no significant difference, $\chi^2(1)$ = .08, P = .78, between the high (M = 3.06, SE = .51) and low (M = 2.89, SE = .47) perceived empathy conditions in how much participants felt that their pain was affected by their partner's empathy (and neither were there significant differences among attachment style groups, $\chi^2(2)$ = 2.75, P = .25, or an interaction between attachment style group and perceived empathy condition, $\chi^2(2)$ = 1.38, P = .50.

Discussion

This study examined how individuals' perceptions of empathy their partners felt for them during a cold pressor task influenced their subjective ratings of pain intensity, tolerance, and facial expressions of pain. We observed a significant main effect of perceived empathy on pain report (but not on tolerance or display), with greater pain reported in the high than low empathy condition. We also investigated how individual differences in adult attachment style might influence pain measures under different perceived empathy conditions. A significant interaction of attachment style and empathy on both pain report and facial expression was found. Contrary to our predictions, no significant main effect of attachment style was found on pain report, tolerance, or facial expression. However, the 3 attachment style groups did differ in the high empathy condition, with the anxious and the secure groups reporting and displaying more pain than the avoidance group.

Effects of Perceived Empathy on Pain

The concept of empathy, or the sharing and understanding of the emotional state of others, has recently received renewed research attention. In clinical settings, effects of empathic accuracy and related constructs on various health outcomes have been demonstrated,[8,56] often exploring associations between social support and chronic pain.[39] Most studies have investigated broad concepts of social support, such as solicitous behaviors, whereas specific dimensions of empathic understanding have rarely been studied[7,33] and consensus is lacking on the nature and role of such dimensions.[32] In laboratory-based research on experimental pain, new impetus has been given to older debates about the embodied versus the representational nature of empathy,[13,67] including the nature of empathy *for* pain: how an observer is affected by the pain of an individual.[26,52] To our knowledge, only 3 experimental studies have examined the possible effects of empathy *on* pain: how an observer's empathy can affect an individual's pain.[9,28,48]

Specifically, Chambers and colleagues[9] observed that girls' (but not boys') pain intensity ratings (but not tolerance) for cold pressor pain increased when their mothers interacted with them in a "pain promoting" way that included verbal expressions of empathy. Thus, in mother–daughter dyads, expressed empathy may contribute to increased pain intensity ratings, as in the current study. Jackson and colleagues[28] extended these findings to adult women and observed that speaking with an unfamiliar but empathic experimenter can lead to increased pain report. Sambo and colleagues[48] did not observe these gender-specific effects when they manipulated perceived empathy, but as in the current study, perceived empathy affected pain report depending on participants' attachment style (see below).

In the present study, we also found that, on average, perceived higher empathy from the partner led to significant increases in pain report, an effect uninfluenced by individual differences in catastrophizing. However, empathy had no effect on facial display or pain tolerance. These findings suggest that believing that one's partner feels high empathy for one's pain may lead individuals to experience the intensity of pain as higher, even though their behavioral responses to those stimuli and their communicative intent toward their partners may not be affected to the same degree. At first sight, this contrasts with predictions from the communal coping model of pain.[5,57] However, communal coping effects have been noted mainly for behaviors rather than for pain ratings.[53,59,60] A transactional perspective on pain[27] predicts that feedback from the environment can contribute to threat appraisals and alter pain coping efforts and tolerance, but such effects are independent of pain intensity ratings.[52-55]

It thus appears that the main empathy effect observed in this study is independent of communal coping mechanisms and of related threat appraisals. Based on our findings and a systematic review of the literature,[29] we speculatively propose that contrary to other facets of social support, such as social presence,[53] active empathic communications,[28] or social priming by picture viewing,[16,34,66] the belief that one's partner has high empathy for one's pain may function as an interpersonal signal of interoceptive salience, causing participants to focus their attention on pain. This proposal would need to be specifically tested in future studies, but it has been previously shown that attention to pain can increase pain ratings,[6] and attention away from pain can reduce them.[9,28] Although this interpretation is consistent with operant models, in which solicitous spouse responses are

thought to reinforce pain behaviors,[18,19] it nevertheless differs from such models in that our manipulation of perceived empathy targeted mental perceptions rather than enacted social support.[41]

Empathy, Attachment, and Pain

We also observed that individual differences in adult attachment style affected the relationship between perceived empathy and pain. Attachment theory[3] suggests that individuals respond to stressful situations according to specific mental models of close relationships and corresponding emotion regulation strategies.[38] Although developed initially on the basis of caregivers' responsiveness, internal working models of attachment are regarded as relatively stable, long-lasting, and relevant to romantic relationships.[50] Attachment theory has thus been used as a framework to understand how individuals' past experiences and expectations affect their responses to pain and has been proposed as a model for the vulnerability and adaptation to chronic pain.[35,36] Insecure attachment anxiety particularly has been associated with higher levels of various pain-related responses and corresponding negative cognitions.[45,65]

We did not observe a general effect of attachment style on pain measures, most likely because of the differential effects that the 2 empathy conditions had in the different attachment style groups, that is, the interaction effects. Specifically, the avoidance group reported and displayed less pain than the secure and the anxious groups in the high perceived empathy condition, whereas there were no differences between the 3 groups in the low empathy condition. This finding further supports the above interpretation of our main empathy effects, namely, that the effect of empathy on pain report may be unrelated to the motivation to seek support. Instead, we speculate that in individuals who trust others, perceived empathy may function as an interpersonal signal of interoceptive salience and related pain focus. Individuals with high attachment anxiety typically have a model of their partners that entails trustworthiness, whereas individuals with high attachment avoidance perceive others as less trustworthy.[37] Indeed, in the current study the avoidant group had lower expectations of empathy from their partners in comparison with the other groups. Although our study was not designed to be able to disentangle the effects of attachment style from that of such expectations on pain in each of the groups, these differences between the groups may explain why pain report in the secure and anxious groups was affected by empathy in the same direction, whereas the avoidance group showed the reverse pattern; when greater emotional response from one's partner is perceived, anxious and secure individuals may use increased pain display to seek emotional support from their partner, whereas avoidant individuals, who did not expect such a response, may behaviorally downplay their pain to avoid further emotional and potentially active support from their partners.[50]

Unlike Wilson and Ruben,[65] we did not find that partner's attachment style influenced the effects of empathy on pain report, further supporting the above notion that the effects of empathy on pain report may be different in nature from other, more general effects of social context in pain. Finally, only the aforementioned study by Sambo and colleagues[48] assessed the effects on pain of the interaction between empathy and attachment style. Unlike us, they found that higher scores in attachment anxiety, but not in attachment avoidance, predicted higher pain ratings in the low compared to the high empathy condition. However, as that study, and most other studies on the role of attachment style in pain, did not test couples and used unselected samples in terms of attachment style, direct comparisons require caution. Future studies need to assess whether pain in individuals with high attachment anxiety is differentially influenced by partners' versus strangers' empathy, and related facets such as their trustworthiness.

Limitations

Caution is warranted in extrapolating to clinical pain; experimental pain is far less threatening and personally meaningful than clinical pain.[15] In addition, health professionals, friends, and family members may have different effects on pain than romantic partners. Furthermore, partner empathy, operationalized here by a rating, would normally be signaled differently in naturalistic contexts. Moreover, given the aims of the study, we used a within-subject design with a relatively small sample that was not representative of the general population in terms of attachment styles; for example, we excluded individuals with fearful/disorganized styles and couples in which both partners were secure. Given that our findings suggest contrasting results between individuals with high attachment avoidance and individuals with high attachment anxiety, individuals who score high on both dimensions are likely to present with intermediate results on reporting and displaying pain. This prediction would need to be tested in future studies. Future experimental studies could also usefully include an alone condition to contrast with partner present, and measure physiological reactions, as the attachment system may contribute to regulation of arousal.[14] Additionally, a limitation of our study is that we did not use a validated method of measuring the amount of pain displayed through facial expressions, as the available methods, for example, FACS,[17] do not measure the intensity of pain displayed. The development of future measures of this kind could provide more reliable conclusions in this respect. Finally, our results cannot be used to conclude that the absence of empathy from one's partner would lead to a reduction of pain; in our study, partners were represented (by false feedback) as always having some empathy. Although not examined in this study, a related construct of validation of pain has been explored by a number of researchers[9,30,31] and may be usefully included in future research. Thus, future studies could evaluate the effects of "true" and multidimensional partner empathy, the potential effects of absent perceived empathy, or even negative partner reactions such as intolerance, misunderstanding, and invalidation.

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Supplementary Data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jpain.2014.06.004.

References

1. Bartholomew K, Horowitz L: Attachment styles among young adults: A test of a four-category model. J Pers Soc Psychol 61:226-244, 1991

2. Di Blasi Z, Harkness E, Ernst E, Georgiou A, Kleijnen J: Influence of context effects on health outcomes: A systematic review. Lancet 357:757-762, 2001

3. Bowlby J: The making and breaking of affectional bonds. I: Aetiology and psychopathology in the light of attachment theory, II: Some principles of psychotherapy. Br J Psychiatry 130:201-210, 421-431, 1977

4. Brown JL, Sheffield D, Leary MR, Robinson ME: Social support and experimental pain. Psychosom Med 65:276-283, 2003

5. Budson AE, Simons JS, Sullivan AL, Beier JS, Solomon PR, Scinto LF, Daffner KR, Schacter DL: Memory and emotions for the September 11, 2001, terrorist attacks in patients with Alzheimer's disease, patients with mild cognitive impairment, and healthy older adults. Neuropsychology 18:315-327, 2004

6. Bushnell M, Duncan G, Dubner R, Jones R, Maixner W: Attentional influences on noxious and innocuous cutaneous heat detection in humans and monkeys. J Neurosci 5: 1103-1110, 1985

7. Cano A, Barterian JA, Heller JB: Empathic and non empathic interaction in chronic pain couples. Clin J Pain 24:678-684, 2008

8. Cano A, Williams ACDC: Social interaction in pain: Reinforcing pain behaviors or building intimacy? Pain 149:9-11, 2010

9. Chambers CT, Craig KD, Bennett SM: The impact of maternal behavior on children's pain experiences: An experimental analysis. J Pediatr Psychol 27:293-301, 2002

10. Cheng Y, Chen C, Lin C, Chou K, Decety J: Love hurts: An fMRI study. Neuroimage 51:923-929, 2010

11. Curran-Everett D: Explorations in statistics: The bootstrap. Adv Physiol Educ 33:286-292, 2009

12. D'Agostino RB, Belanger AJ, D'Agostino RB Jr: A suggestion for using powerful and informative tests of normality. Am Stat 44:316-321, 1990

13. Decety J, Svetlova M: Putting together phylogenetic and ontogenetic perspectives on empathy. Dev Cogn Neurosci 2: 1-24, 2012

14. Diamond LM, Hicks AM: Attachment style, current relationship security, and negative emotions: The mediating role of physiological regulation. J Soc Pers Relationships 22:499-518, 2005

15. Edens J, Gil KM: Experimental induction of pain: Utility in the study of clinical pain. Behav Ther 26:197-216, 1995

16. Eisenberger NI, Master SL, Inagaki TK, Taylor SE, Shirinyan D, Lieberman MD, Naliboff BD: Attachment figures activate a safety signal-related neural region and reduce pain experience. Proc Natl Acad Sci U S A 108: 11721-11726, 2011

17. Ekman P, Friesen W: Facial Action Coding System: A Technique for the Measurement of Facial Movement. Palo Alto, Consulting Psychologists Press, 1978

18. Flor H, Breitenstein C, Birbaumer N, Fürst M: A psychophysiological analysis of spouse solicitousness towards pain behaviors, spouse interaction, and pain perception. Behav Ther 26:255-272, 1995

19. Fordyce WE: A behavioural perspective on chronic pain. Br J Clin Psychol 21:313-320, 1982

20. Fraley R, Waller N, Brennan K: An item response theory analysis of self-report measures of adult attachment. J Pers Soc Psychol 78:350-365, 2000

21. Friedman H, Thompson R, Rosen E: Perceived threat as a major factor in tolerance for experimentally induced cold-water pain. J Abnorm Psychol 94:624-629, 1985

22. Hadjistavropoulos T, Hunter P, Fitzgerald TD: Pain assessment and management in older adults: Conceptual issues and clinical challenges. Can Psychol 50:241-254, 2009

23. Hazan C, Shaver P: Romantic love conceptualised as an attachment process. J Pers Soc Psychol 52:511-524, 1987

24. Herr KA, Spratt K, Richardson G: Pain intensity assessment in older adults. Clin J Pain 20:207-219, 2004

25. Hunsley J, Best M, Lefebvre M, Vito D: The seven-item short form of the Dyadic Adjustment Scale: Further evidence for construct validity. Am J Family Ther 29:325-335, 2001

26. Jackson P, Meltzoff A, Decety J: How do we perceive the pain of others? A window into the neural processes involved in empathy. Neuroimage 24:771-779, 2005

27. Jackson T, Huang X, Chen H, Phillips H: Effects of threatening information on interpersonal responses to pain. Eur J Pain 13:431-438, 2009

28. Jackson T, Iezzi T, Chen H, Ebnet S, Eglitis K: Gender, interpersonal transactions, and the perception of pain: An experimental analysis. J Pain 6:228-236, 2005

29. Krahe C, Springer A, Weinman JA, Fotopoulou A: The social modulation of pain: Others as predictive signals of salience—A systematic review. Front Hum Neurosci 7:1-21, 2013

30. Leong LE, Cano A, Johansen AB: Sequential and base rate analysis of emotional validation and invalidation in chronic pain couples: Patient gender matters. J Pain 12: 1140-1148, 2011

31. Linton SJ, Boersma K, Vangronsveld K, Fruzzetti A: Painfully reassuring? The effects of validation on emotions and adherence in a pain test. Eur J Pain 16:592-599, 2012

32. Lumley MA, Cohen JL, Borszcz GS, Cano A, Alison M, Porter LS, Schubiner H, Keefe FJ: Pain and emotion: A biopsychosocial review of recent research. J Clin Psychol 67: 942-968, 2011

33. Martire L, Keefe F, Schulz R, Ready R, Beach S, Rudy T, Starz T: Older spouses' perceptions of partners' chronic arthritis pain: Implications for spousal responses, support provision, and caregiving experiences. Psychol Aging 21: 222-230, 2006

34. Master S, Eisenberger N: A picture's worth partner photographs reduce experimentally induced pain. Psychol Sci 20:1316-1318, 2009

35. Meredith P, Ownsworth T, Strong J: A review of the evidence linking adult attachment theory and chronic pain: Presenting a conceptual model. Clin Psychol Rev 28: 407-429, 2008

36. Meredith P, Strong J, Feeney JA: Adult attachment, anxiety, and pain self-efficacy as predictors of pain intensity and disability. Pain 123:146-154, 2006

37. Mikulincer M: Attachment working models and the sense of trust: An exploration of interaction goals and affect regulation. J Pers Soc Psychol 74:1209-1224, 1998

38. Mikulincer M, Shaver PR, Sapir-Lavid Y, Avihou-Kanza N: What's inside the minds of securely and insecurely attached people? The secure-base script and its associations with attachment-style dimensions. J Pers Soc Psychol 97: 615-633, 2009

39. Newton-John TRO: Solicitousness and chronic pain: A critical review. Pain Rev 9:7-27, 2002

40. Osman a, Barrios FX, Gutierrez PM, Kopper B, Merrifield T, Grittmann L: The Pain Catastrophizing Scale: Further psychometric evaluation with adult samples. J Behav Med 23:351-365, 2000

41. Paulsen JS, Altmaier EM: The effects of perceived versus enacted social support on the discriminative cue function of spouses for pain behaviors. Pain 60:103-110, 1995

42. Pfeiffer UJ, Timmermans B, Vogeley K, Frith CD, Schilbach L: Towards a neuroscience of social interaction. Front Hum Neurosci 7:22, 2013

43. Porter L, Davis D, Keefe F: Attachment and pain: Recent findings and future directions. Pain 128:195-198, 2007

44. Rinn WE: The neuropsychology of facial expression: A review of the neurological and psychological mechanisms for producing facial expressions. Psychol Bull 95:52-77, 1984

45. Rowe AC, Carnelley KB, Harwood J, Micklewright D, Russouw L, Rennie CL, Liossi C: The effect of attachment orientation priming on pain sensitivity in pain-free individuals. J Soc Pers Relat 29:488-507, 2012

46. Royston P: sg3.5: Comment on sg3.4 and an improved D'Agostino test: In: Stata Technical Bulletin Reprints, Vol. 1. College Station, TX, Stata Press, 1991, pp 110-112

47. Saarela MMV, Hlushchuk Y, Williams ACDC, Schürmann M, Kalso E, Hari R: The compassionate brain: Humans detect intensity of pain from another's face. Cereb Cortex 17:230-237, 2007

48. Sambo CF, Howard M, Kopelman M, Williams S, Fotopoulou A: Knowing you care: Effects of perceived empathy and attachment style on pain perception. Pain 151:687-693, 2010

49. Shaver P, Mikulincer M: Attachment-related psychodynamics. Attach Hum Dev 42:133-161, 2002

50. Shaver P, Mikulincer M: Dialogue on adult attachment: Diversity and integration. Attach Hum Dev 4:243-257, 2002

51. Sibley CG, Fischer R, Liu JH: Reliability and validity of the revised Experiences in Close Relationships (ECR-R) self-report measure of adult romantic attachment. Pers Soc Psychol Bull 31:1524-1536, 2005

52. Singer T: The neuronal basis and ontogeny of empathy and mind reading: Review of literature and implications for future research. Neurosci Biobehav Rev 30:855-863, 2006

53. Sullivan MJL, Adams H, Sullivan ME: Communicative dimensions of pain catastrophizing: Social cueing effects on pain behaviour and coping. Pain 107:220-226, 2004

54. Sullivan MJL, Bishop SR, Pivik J: The Pain Catastrophizing Scale: Development and validation. Psychol Assess 7: 524-532, 1995

55. Sullivan MJL, Thorn B, Haythornthwaite JA, Keefe FJ, Martin M, Bradley LA, Lefebvre JC: Theoretical perspectives on the relation between catastrophizing and pain. Clin J Pain 17:52-64, 2001

56. Tait RC: Empathy: Necessary for effective pain management? Curr Pain Headache Rep 12:108-112, 2008

57. Thorn BE, Ward LC, Sullivan MJL, Boothby JL: Communal coping model of catastrophizing: Conceptual model building. Pain 106:1-2, 2003

58. Van Damme S, Crombez G, Van Nieuwenborgh-De Wever K, Goubert L: Is distraction less effective when pain is threatening? An experimental investigation with the cold pressor task. Eur J Pain 12:60-67, 2008

59. Vervoort T, Caes L, Trost Z, Sullivan M, Vangronsveld K, Goubert L: Social modulation of facial pain display in high-catastrophizing children: An observational study in schoolchildren and their parents. Pain 152:1591-1599, 2011

60. Vervoort T, Goubert L, Crombez G: The relationship between high catastrophizing children's facial display of pain and parental judgment of their child's pain. Pain 142: 142-148, 2009

61. Vlaeyen JWS, Hanssen M, Goubert L, Vervoort T, Peters M, Van Breukelen G, Sullivan MJL, Morley S: Threat of pain influences social context effects on verbal pain report and facial expression. Behav Res Ther 47:774-782, 2009

62. Von Baeyer CL, Piira T, Chambers CCT, Trapanotto M, Zeltzer LK: Guidelines for the cold pressor task as an experimental pain stimulus for use with children. J Pain 6:218-227, 2005

63. Williams ACDC: Facial expressions of pain: An evolutionary account. Behav Brain Sci 25:439-488, 2002

64. Williams RL: A note on robust variance estimation for cluster-correlated data. Biometrics 51:645-646, 2000

65. Wilson CL, Ruben M: A pain in her arm: Romantic attachment orientations and the tourniquet task. Pers Relat 18: 242-265, 2011

66. Younger J, Aron A, Parke S, Chatterjee N, Mackey S: Viewing pictures of a romantic partner reduces experimental pain: Involvement of neural reward systems. PLoS One 5:e13309, 2010

67. Zaki J, Ochsner K: The neuroscience of empathy: Progress, pitfalls and promise. Nat Neurosci 15:675-680, 2012