Daily and bidirectional linkages between pain catastrophizing and spouse responses

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Abstract

Pain catastrophizing has been shown to predict greater pain and less physical function in daily life for chronic pain sufferers, but its effects on close social partners have received much less attention. The overall purpose of the present study was to examine the extent to which pain catastrophizing is an interpersonal coping strategy that is maladaptive for patients and their spouses. A total of 144 older knee osteoarthritis patients and their spouses completed baseline interviews and a 22-day diary assessment. Multilevel lagged models indicated that, on days when patients reported greater catastrophizing in the morning, their spouses experienced more negative affect throughout the day. In addition, a higher level of punishing responses from the spouse predicted greater pain catastrophizing the next morning, independent of patient pain and negative affect. Multilevel mediation models showed that patients' morning pain catastrophizing was indirectly associated with spouses' negative affect and punishing responses via patients' own greater negative affect throughout the day. There was no evidence that spouses' empathic or solicitous responses either followed or preceded patients' catastrophizing. These findings suggest that cognitive-behavioral interventions that reduce pain catastrophizing should be modified for partnered patients to address dyadic interactions and the spouse's role in pain catastrophizing.

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Introduction

Pain catastrophizing, a negative cognitive orientation to actual or anticipated pain, varies from day to day and predicts greater pain and less physical function in daily life for chronic pain sufferers [5,10,15,16]. Two studies have examined this phenomenon in couples [5,15], but little is known regarding the effects of patients' pain catastrophizing on spouses' emotions and behavioral responses to patients' pain. Further, it remains an open question as to whether spousal responses affect patients' subsequent catastrophizing. Therefore, in the present study we examined lagged, bidirectional associations between daily pain catastrophizing and spouses' affective and behavioral responses, in a sample of older adults with knee osteoarthritis (OA) and their spouses. Osteoarthritis is one of the musculoskeletal disorders that are the primary cause of chronic or persistent pain in older adults [30].

Individuals with pain communicate their catastrophizing thoughts through nonverbal pain behaviors and emotional disclosure [7,40]. According to the Communal Coping Model, catastrophizing is an interpersonal coping strategy aimed at soliciting assistance or empathic responses from others [41]. Consistent with this model, research on chronic low back pain (CLBP) in middle-aged adults showed that patients reported receiving more emotional or instrumental support from their spouse during the 3 hours after increased catastrophizing [5]. However, for older couples who spend much of their time together, catastrophizing early in the day may set a negative tone for interactions in the day ahead, leading spouses to feel increasingly sad or worried [13,37]. Furthermore, spouses may respond with frustration or insufficient empathy, or provide excessive instrumental support (often referred to as solicitousness) [6,13,39].

Spousal responses to patients' pain may in turn lead to more or less catastrophizing by patients (Figure 1). Contemporary frameworks and research would predict that responses such as solicitousness and expressions of frustration intensify catastrophizing, whereas empathic behaviors may serve an adaptive function and lessen catastrophizing [6,8,29]. Although spouse instrumental and emotional support, criticism, and hostility were not associated with subsequent change in patient catastrophizing over 3 hours in CLBP [5], the effects of other types of responses on older patients and over longer time periods have not been examined.

The overall purpose of this study was to examine the extent to which pain catastrophizing is an interpersonal coping strategy that is maladaptive for patients and their spouses. Using a sample of older knee OA patients and their spouses who completed 22-day diaries, we tested the hypothesis that when patients catastrophize more about pain in the morning, spouses experience more negative affect and respond in ways that are unhelpful throughout the day (less empathic, more solicitous, and more punishing). We also explored whether the influence of patients' catastrophizing on spouses was due to patients' greater negative affect throughout the day, based on previous research suggesting that patients' daily pain has a negative impact on the spouse to the extent that it worsens patients' mood [3]. Our second hypothesis was that more helpful spousal responses would be associated with less patient catastrophizing the next morning, whereas more unhelpful responses would predict greater catastrophizing the next morning.

Methods

Study Design

Data presented in this report are from an observational (i.e., non-intervention) study of patients with knee OA and their spouses. The study combined in-person interviews conducted over an 18-month period (i.e., Time 1, Time 2 at a 6 month follow-up, and Time 3 at an 18 month follow-up) with a 22-day assessment of daily experiences immediately after the Time 1 interview. During the daily assessment protocol, patients and spouses used a handheld computer to answer questions 3 times per day (i.e., morning, afternoon, and end-of-day). The current report utilizes data from the Time 1 interview and the daily assessments (3 times per day for up to 22 days). The University of Pittsburgh Institutional Review Board approved this study.

Participants

Eligibility criteria for the study included diagnosis of knee OA by a physician, usual knee pain of moderate or greater intensity, 50 years of age or older, married or in a long-term relationship, and shared residence with the partner [24]. Exclusion criteria were a comorbid diagnosis of fibromyalgia or rheumatoid arthritis, use of a wheelchair, and planned hip or knee surgery within the next six months. Couples were excluded from the study if the spouse had arthritis pain of moderate or greater intensity, used a wheelchair, or required assistance with personal care activities. Both partners had to be cognitively functional as indicated by the accuracy of their answers to questions regarding the current date, day of the week, their age, and birth date. Both partners also had to be free of any major hearing, speech, or language problems that would interfere with the comprehension and completion of data collection conducted in English.

Primary sources of recruitment were research registries for rheumatology clinic patients and older adults interested in research; flyers distributed to University of Pittsburgh staff and faculty, and word of mouth. A total of 606 couples were screened for eligibility. Of these, 221 couples declined to participate, most often due to a lack of interest ($N = 87$), or illness in the family ($N = 55$). A total of 233 couples were ineligible, most often due to lack of OA in the knee ($N = 55$) or knee OA pain that was only mild in severity ($N = 47$). The total enrolled sample comprised 152 couples (i.e., 304 individuals) which included 3 same-sex couples. A total of 145 couples completed the diary assessment component of the study.

Data Collection Procedures

Trained staff interviewed patients and spouses independently in their home. Following these interviews, couples were trained in use of the handheld computer (i.e., the Palm TX) as well as the format and content of the diary questions. The handheld computer and questionnaire were designed for easy use by older adults and people with minimal computer experience; accessible features included large font size and an oversized stylus for registering responses. Each patient and spouse were provided with their own personal handheld computer that was clearly labeled with his or her name. Participants were trained to complete their diary assessments independently of their spouse. Our goal was to capture participants' experiences within the general time frames of morning, afternoon, and end-of-day. Therefore,

participants were instructed to answer questions: 1) within 60 minutes of rising in the morning (i.e., morning), 2) between 2:00 and 4:00 p.m. (i.e., afternoon), and 3) upon retiring at night (i.e., end-of-day). Participants used a written log to record their daily rise time and bed time.

Completion and compliance rates were examined for the diary data. Out of 3,190 potential morning, afternoon or end-of-day assessments (145 participants × 22 days), patients completed a total of 2,948 morning assessments (92%), 2,900 afternoon assessments (91%), and 2,960 end-of-day assessments (93%). For spouses, the completion rate was 91% for morning, afternoon and end-of-day assessments. Morning assessments completed more than 120 minutes after waking, and end-of-day assessments completed more than 120 minutes before bedtime, were excluded from analysis. Among the 145 couples who completed the diary assessments, one couple was excluded from all analyses due to missing data on the key study variable (i.e., pain catastrophizing), leaving 144 couples in the final sample.

Measures

Pain catastrophizing.

Patients were asked to report their catastrophizing thoughts in the morning using two items from the Coping Strategies Questionnaire [35] which were validated by Jensen and colleagues for use in daily diary research [16]. The items are "Today, I feel that the pain is terrible and is never going to get any better" and "I feel I can't stand the pain anymore." Both items are rated on a scale from 1 (strongly disagree) to 6 (strongly agree). These two items capture the helplessness dimension of the catastrophizing construct [9] and were used in previous research that assessed daily catastrophizing [20]. The mean score for pain catastrophizing was 1.97 (SD = 0.85, Between-Person, BP reliability = 0.99, Within-Person, WP reliability = 0.63).

Negative affect.

Patients and spouses reported their negative affect over the past 30 minutes at the morning, afternoon, and end-of-day. This measure is the average of 5 items (depressed or blue, frustrated, angry or hostile, unhappy, and worried or anxious) that are rated from 0 (not at all) to 6 (extremely) [42]. The average daily negative affect score across the day (i.e., morning, afternoon, and end-of-day) was 0.53 for patients (SD = 0.62, BP reliability = 1.00, WP reliability = 0.83) and 0.47 for spouses (SD = 0.62, BP reliability = 1.00, WP reliability = 0.81).

Spousal responses.

Spousal responses to patients' pain were assessed at the end of each day using patients' reports on 9 items with 3-point rating scales (1 = not at all, 2 = somewhat, 3 = very much) [45]. Six of these items were adapted for daily assessment from the West Haven-Yale Multidimensional Pain Inventory, a valid and reliable measure used in chronic pain research [19]. Three items measure solicitous behaviors of offering food or drink, taking over tasks, and encouraging rest (e.g., "Today, your spouse took over your jobs or duties to help you avoid pain"). Three items assess punishing behaviors—ignoring the patient, acting

frustrated, and seeming irritated (e.g., "Today, your spouse got frustrated with you when you seemed to be in pain"). The three remaining items measure empathic responses and were adapted from Stephens and colleagues' 7-item scale assessing spouses' emotional support in response to older patients' osteoarthritis pain [37]. These items refer to showing affection, understanding patients' feelings about the pain, and providing attention (e.g., "Today, your spouse tried to just be there for you when you seemed to be in pain, by giving you his/her undivided attention").

Responses were averaged to create a mean score for spouses' empathic ($M = 1.72$, $SD = 0.51$, BP reliability = 0.99, WP reliability = 0.67), solicitous ($M = 1.50$, $SD = 0.44$, BP reliability = 0.99, WP reliability = 0.56) and punishing ($M = 1.08$, $SD = 0.15$, BP reliability = 0.97, WP reliability = 0.51) responses, respectively. Empathic and solicitous responses were moderately correlated at the within-person level ($r = .52$), and both had low negative correlations with punishing responses ($r = -.11$ and $r = -.07$, respectively).

Covariates

Covariates for the analyses were chosen on a conceptual basis. At the person level, patients' sex (0= female, 1= male) and the baseline depressive symptoms of patients and spouses were controlled. Depressive symptoms were assessed using a 10-item short form of the Center for Epidemiologic Studies Depression Scale (CES-D) [33] that has been validated for use with older adult populations [2]. Items assess the degree to which participants experienced feelings and behaviors related to depression over the past week (e.g., being bothered by things that aren't usually a bother or not being able to get going). Item responses range from 0 (rarely or none of the time) to 3 (most of the time). Total summed scores range from 0 to 30, with higher scores indicating greater depressive symptoms (for patients, $M = 6.56$, $SD = 5.27$, Cronbach's $a = .82$; for spouses, $M = 5.87$, $SD = 4.51$, Cronbach's $a = .76$).

At the daily level, we controlled for patients' morning negative affect and pain because these factors may influence patients' concurrent pain catastrophizing and spouses' responses in the day ahead. Patients' knee pain was measured using items from the Rapid Assessment of Disease Activity in Rheumatology [25] which asks patients to report severity of pain in 10 sets of joints over the past 30 minutes using a scale from 0 (no pain) to 3 (severe pain). Patients' average level of pain in the morning was 0.56 ($SD = .46$, BP reliability = 1.00, WP reliability = 0.69).

Data Analysis

Multilevel modeling (MLM) in Mplus 8.0 [28] was used to examine daily bidirectional associations between patients' pain catastrophizing and spouses' affective and behavioral responses. The data were structured hierarchically with daily assessments (Level 1) nested within couples (Level 2). Maximum likelihood with robust standard errors was used for model estimation. All Level 1 predictors and covariates were centered relative to each person's mean score in order to remove between-person variance in these scores, and Level 2 covariates were grand-mean centered.

Analyses were conducted in a series of steps. Regarding our first hypothesis, within-day prospective associations were examined in a multivariate model simultaneously predicting spouses' daily negative affect and three types of responses (empathic, solicitous, and punishing). This initial model included only patients' morning pain catastrophizing as a Level 1 predictor and did not adjust for any covariates. A random intercept was included to allow the mean score of each outcome to vary across individuals and, if statistically significant, random slopes of the within-person (WP) effect of pain catastrophizing were included to allow the association between pain catastrophizing and spouse responses to vary between individuals. In the second step, covariates (i.e., patient sex, baseline depressive symptoms of patients and spouses, and patients' morning negative affect and pain) were added to the model in order to provide a more robust test of the unique predictive effects of patients' pain catastrophizing.

We also tested for within-person *indirect effects* of patients' morning pain catastrophizing on spouses' negative affect and responses through patients' negative affect during the day. Specifically, four mediation models were tested using multilevel structural equation modeling (MSEM) and Bayesian estimation [32,43]. The within-person and between-person effects were differentiated using implicit, model-based group mean centering approach (i.e., latent centering) [32]. Using the Markov chair Monte Carlo (MCMC) method, the posterior median point estimate and 95% Bayesian credible interval (C. I.) of the indirect effect of patients' pain catastrophizing on each outcome via patients' daily negative affect was obtained. An indirect effect was interpreted as statistically significant if the 95% C.I. did not include 0.

To test the second hypothesis, we examined whether spouses' behavioral responses predicted patients' pain catastrophizing the following morning. Spouses' empathic, solicitous and punishing responses assessed at the end of day t were included as Level 1 predictors to predict patients' pain catastrophizing assessed in the morning of day t+1. Patient sex, patient and spouse baseline depressive symptoms, and patient negative affect and pain in the morning of day t+1 were included as covariates in the model.

Prior to testing our hypotheses, we checked the distribution of each outcome included in our models. Due to the high positive skew of the punishing responses variable (skewness = 3.82), we tested alternative models in which this variable was recoded and tested as a binary outcome (0 = not at all, 1 = somewhat or very much) (no other variables showed high skew). All the effects of interest remained unchanged and thus we report the results from the original models for ease of interpretation. We also checked for potential multicollinearity between the three spouse response variables. We examined the Variance Inflation Factor (VIF) and Tolerance variance inflation factors of these predictors, and found no evidence of multicollinearity (i.e., VIFs <10, Tolerance >0.1) [36]. As an additional check, we tested three models, each of which only included one type of spouse response as the predictor, and all the effects of interest remained unchanged.

Results

Table 1 displays demographic characteristics of the sample. Individuals with knee OA were 65.50 years of age on average ($SD = 9.59$), primarily Caucasian (87%), and the majority was women (58%). On average, these patients had been married for 34 years ($SD = 16.72$). The average knee OA severity score was 34.82 ($SD = 14.67$), indicating mild-to-moderate severity for the sample. The amount of day-to-day (i.e., within-person, or WP) variability in morning catastrophizing was 32%, and the WP variability for negative affect and spouse responses ranged from 35% (empathic responses) to 59% (punishing responses).

Does Morning Catastrophizing Predict Spouse Affect and Responses Throughout the Day?

Our first hypothesis was that when patients catastrophize more about pain in the morning, spouses experience more negative affect and respond in ways that are unhelpful throughout the day (less empathic, more solicitous, and more punishing) (p .05). The results from the model without covariates indicated that patients' morning catastrophizing significantly predicted greater negative affect for spouses throughout the day (estimate = 0.026, standard error = 0.013, $p = .045$), but did not predict any of the spousal responses to patients' pain ($ps > 0.310$). As shown in Table 2, after adjusting for covariates the predicted effect of patients' morning pain catastrophizing on spouses' negative affect was reduced but remained significant ($p = 0.054$), whereas the predicted effects on spousal responses were not significant.

We tested whether patients' pain catastrophizing *indirectly* impacted spouses' negative affect and responses through patients' own negative affect during the day. As shown in Table 3, results from multilevel mediation models indicated that on days when patients catastrophized more about pain in the morning, they experienced greater negative affect throughout the day (estimate = 0.139, 95% C. I. = 0.112 – 0.171), which in turn was associated with spouses' greater negative affect (estimate = 0.095, 95% C. I.= 0.059 – 0.134) and more punishing responses (estimate = 0.072, 95% C. I.= 0.058 – 0.089) throughout the day. Both of these indirect effects were significant (for spouse negative affect: estimate = 0.013, 95% C. I. = 0.008 – 0.021; for punishing responses: estimate = 0.010, 95% C. I. = 0.007 – 0.013). These findings suggest that patients' morning pain catastrophizing is *directly* associated with spouses' negative affect throughout the day, and also *indirectly* associated with spouses' negative affect and punishing responses via patients' own greater negative affect throughout the day.

Do Patient Perceptions of Spouse Responses Predict their Catastrophizing the Next Day?

Our second hypothesis was that more empathic spouse responses would be associated with less catastrophizing the next morning, whereas more solicitous and punishing responses would predict greater catastrophizing (p .05). As shown in Table 4, findings from our cross-day lagged analysis indicated that a higher level of punishing responses from the spouse significantly predicted more pain catastrophizing the next morning (estimate = .190, $SE = .088$, $p = .031$) independent of patient pain and negative affect the next morning as well as other covariates. Empathic and solicitous responses did not significantly predict patient catastrophizing the next morning.

Discussion

The implications of pain catastrophizing for patients' health are well documented and include pain-related disability [18,38], poor response to surgery [1,44], and greater misuse of opioid medications [22]. In contrast, the effects of pain catastrophizing on close social partners have received little attention. This study of older adults with knee osteoarthritis showed that on days when patients catastrophize more in the morning in regard to their pain, spouses experience worse negative affect throughout the day. Moreover, lagged effects across days suggest a cyclical process whereby catastrophizing leads to perceptions of punishing responses from the spouse, which in turn contribute to greater catastrophizing. Our findings support a social model proposed by Goubert and colleagues [13,14] in which both affective and behavioral responses to observing another person in pain are central features of pain empathy. In addition, our findings support theory and evidence for a model of the interpersonal effects of suffering on emotion in elder caregivers [26,27].

Pain catastrophizing has been conceptualized as an interpersonal coping strategy but rarely tested as such; the design of our study allowed us to do so. Although patients' catastrophizing did not directly predict spouses' responses within the same day, a punishing response from spouses did predict increases in patients' catastrophizing the following day. This finding suggests that patients may catastrophize as a communicative response to their spouses' dismissive or demoralizing reaction to their pain (e.g., ignoring the patient). That is, in order to increase the likelihood that their pain will be managed within a social or interpersonal context, patients may therefore increase their cries for help (i.e., catastrophize more) the following day [39]. Thus, patients' expression of catastrophizing thoughts through verbal or nonverbal means may be a strategic communicative and interpersonal coping strategy. Especially in the context of a chronic stressor such as chronic pain, this negative feedback loop may erode spouses' affective well-being and ability to avoid responding in a negative manner. Such interactions may also negatively impact the relationship more broadly.

Notably, neither empathic nor solicitous spouse responses followed patient catastrophizing, and these responses also did not "reinforce" catastrophizing the next morning. Other studies have similarly found that catastrophizing is correlated with punishing, but not solicitous responses [4]. It may be that dimensions of catastrophizing not assessed in our study (i.e., rumination, magnification) are more strongly tied to these spouse responses, as well as other non-verbal pain behaviors (e.g., grimacing, limping, slowing) [34].

This study revealed a central role for negative spouse responses (i.e., ignoring, acting frustrated, and seeming irritated) in a cyclical process of pain catastrophizing. In contrast, Burns and colleagues' study of individuals with chronic low back pain found that patients reported *less* criticism and hostility from their spouse during the few hours after increased catastrophizing, and these spousal responses did not in turn lead to greater catastrophizing [5]. Inconsistency in findings across the two studies may be due to different illness populations, time scales, or measures. For instance, the two questions used to measure daily catastrophizing in the current study capture helplessness whereas the three questions used by Burns and colleagues reflect the three dimensions of helplessness, rumination and

magnification. Interestingly, in a study testing the unique effects of each dimension of catastrophizing on patient outcomes, helplessness was the strongest predictor of pain severity and depressed mood.

To date, there has been little attention to whether spouses are distressed by patients' pain in daily life. Our findings are consistent with the observation that spouses find it challenging to cope with patients' catastrophizing when pain continues over a period of years [6]. Previous analysis of this dataset showed that spouses have poorer sleep quality after a day in which patients experience greater knee arthritis pain, independent of patients' affect and sleep quality [16]. Additional analysis showed that poor sleep quality negatively effects spouses' morning mood and interaction with patients throughout the following day [21]. Taken together, findings from this program of research highlight the consequences of patients' daily pain experience for spouses' functioning throughout the day and into the evening.

In previous research on women with metastatic breast cancer and their partners, Badr and colleagues [3] showed that daily pain may wear on couples' relationships through its adverse effects on patients' daily mood. Our finding of indirect effects of catastrophizing through patients' negative affect extends this model to a different illness population, and highlights that spouses become aware of patients' catastrophizing through the disclosure of negative thoughts and emotions as well as nonverbal behaviors [7,40]. A complementary line of research suggesting that patients sometimes withhold sharing their pain experience with the spouse [31,46] raises intriguing questions regarding the trade-offs of holding back versus sharing, for both partners' health and relational well-being. Our findings also suggest that interventions which target dyadic communication could reduce emotional distress in both parties and the negative impact of catastrophizing on the partner and their relationship.

It is important to acknowledge limitations of this research and important next steps for future research. First, as noted above, our measure of pain catastrophizing captured only the helplessness dimension. A more comprehensive measure of daily catastrophizing, such as one developed by Darnall and colleagues [10] could be used in future dyadic research to identify specific catastrophizing thoughts that are most distressing to spouses and also influenced by spouse responses. Second, the spouse responses examined in this study were relatively narrow in scope (empathic, solicitous, punishing) and our use of a 3-point Likert scale may have limited the amount of variability observed in these measures. It would strengthen future research to measure a broader range of behaviors and their effects, such as instrumental support provided in a hostile manner [6,29], using a wider range of response options. Third, our finding that patients' morning catastrophizing is directly associated with spouses' negative affect in the day ahead ($p = .054$) should be considered preliminary and in need of replication. Finally, interesting next steps in this line of research are to examine the manifestation of catastrophizing with observational data collected in the home, in order to better understand how spouses' become aware of patients' catastrophizing in daily life, and the extent to which the within-couple associations found in the current study generalize to chronic pain conditions other than knee OA.

To conclude, our findings extend the literature by examining the social context of pain catastrophizing at the daily level. The vast majority of research on couples and chronic pain

has been cross-sectional or conducted in the laboratory. For example, previous research on cancer pain showed that increased support seeking by high catastrophizers was associated with concurrent caregiver stress [17]. The examination of differences between couples involves asking *who* questions such as "do patients who catastrophize more have spouses with greater negative affect?," whereas our examination of within-couple variation over time addresses whether spouses are more likely to have negative affect throughout the day *when* patients have more catastrophizing thoughts about their pain in the morning. Such data can be highly useful for intervention development. Cognitive-behavioral interventions that reduce pain catastrophizing [11,12] could be modified for partnered patients to address the spouse's role in pain catastrophizing. Moreover, mobile technology that successfully intervenes in patients' daily lives to reduce pain catastrophizing may help to protect both partners' health and well-being [23].

Acknowledgments

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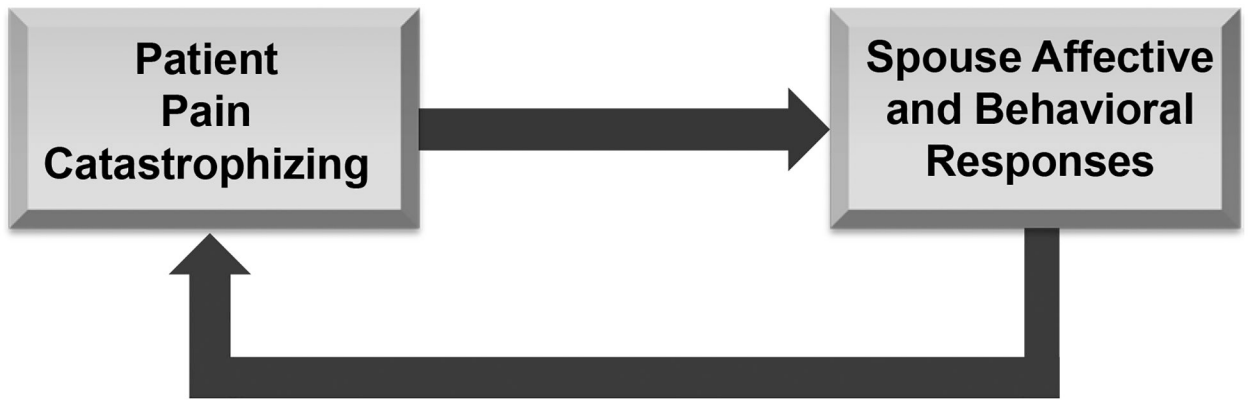
Figure 1.
Model depicting the proposed bidirectional linkages between pain catastrophizing and spouse responses.

Table 1

Background information for patients and spouses (N = 144 couples)

Variable	Patient		Spouse	
	Mean or %	SD	Mean or %	SD
Gender: male	42.40%		58.30%	
Age (years)	65.50	9.59	65.30	11.44
Race: White	86.80%		85.40%	
Education (years)	16.05	2.02	15.83	2.06
Employed	42.40%		45.80%	
Household income	US$40,000–59,000			
Marital duration (years)	34.35	16.72		
Duration of knee OA (years)	12.80	11.33		
Knee OA severity[a]	34.83	14.67		

Note. OA = Osteoarthritis.

[a]Patients' knee OA severity was measured by the Western Ontario McMaster Universities Index (WOMAC) with a possible range of 0 to 96.

Table 2

Multivariate multilevel models predicting spouse negative affect and responses from patient morning pain catastrophizing

Fixed Effects	Spouse Negative Affect[a]			Spouse Empathic Response[b]			Spouse Solicitous Response[b]			Spouse Punishing Response[b]		
	Est.	SE	p	Est.	SE	p	Est.	SE	p	Est.	SE	p
Intercept	0.440	0.054	.000	1.713	0.053	.000	1.508	0.045	.000	1.073	0.014	.000
Covariates												
Patient sex	0.070	0.086	.414	0.022	0.083	.791	−0.034	0.067	.615	0.011	0.026	.657
Patient depressive symptoms	0.007	0.007	.339	0.025	0.008	.002	0.028	0.007	.000	0.002	0.002	.423
Patient morning negative affect	0.013	0.014	.342	0.013	0.017	.457	0.016	0.016	.323	0.017	0.010	.112
Patient morning pain	−0.050	0.054	.355	0.085	0.050	.089	0.081	0.042	.054	0.030	0.023	.181
Spouse depressive symptoms	0.072	0.014	.000	−0.009	0.010	.357	−0.005	0.009	.573	0.006	0.004	.111
Patient pain catastrophizing	0.025	0.013	.054	0.000	0.024	.985	0.011	0.019	.568	0.000	0.007	.976

Notes. Number of couples = 144; number of observations = 2605. Est. = unstandardized coefficients; SE = standard error.

[a] averaged over morning, afternoon, and end of day assessments

[b] reported at the end of day and in regard to the entire day

Table 3

Multilevel mediation models predicting spouse negative affect and responses from patient morning pain catastrophizing via patient negative affect

Effect (Path)	Est.	Posterior S.D.	95% C.I.
IV→M (a)			
Patient PC → Patient NA	0.139	0.014	[0.112, 0.171]
M→DV (b)			
Patient NA→ Spouse NA	0.095	0.021	[0.059, 0.134]
Patient NA→ Spouse empathic response	−0.029	0.021	[−0.062, 0.026]
Patient NA→ Spouse solicitous response	−0.021	0.017	[−0.052, 0.019]
Patient NA→ Spouse punishing response	0.072	0.008	[0.058, 0.089]
*Indirect Effect (a*b)*			
Patient PC → Patient NA → Spouse NA	0.013	0.003	[0.008, 0.021]
Patient PC → Patient NA → Spouse empathic response	−0.004	0.003	[−0.009, 0.003]
Patient PC → Patient NA → Spouse solicitous response	−0.003	0.002	[−0.007, 0.003]
Patient PC → Patient NA → Spouse punishing response	0.010	0.002	[0.007, 0.013]

Note: Number of couples = 144; number of observations = 2616. PC= pain catastrophizing. NA=negative affect. Est. = posterior median point estimate. Posterior S.D.= standard deviation of the posterior distribution. 95%C.I. = 95% Bayesian credible interval. Patient sex, depressive symptoms, morning pain and spouse's depressive symptom were controlled.

Table 4

Multilevel models predicting patient morning pain catastrophizing from previous day spouse responses

Fixed Effects	Patient pain catastrophizing		
	Est.	*SE*	*P*
Intercept	1.937	0.082	.000
Covariates			
Patient sex	0.071	0.122	.557
Patient depressive symptoms	0.082	0.013	.000
Patient morning negative affect	0.169	0.029	.000
Patient morning pain	0.450	0.084	.000
Spouse depressive symptoms	0.006	0.017	.730
Spouse empathic response previous day	−0.014	0.057	.804
Spouse solicitous response previous day	−0.011	0.037	.769
Spouse punishing response previous day	0.190	0.088	.031

Note: Number of couples = 142; number of observations =2132. Est., unstandardized coefficients; SE, standard error.