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Psychological Resilience Predicts Decreases in Pain Catastrophizing Through Positive Emotions

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Abstract

The study used a daily process design to examine the role of psychological resilience and positive emotions in the day-to-day experience of pain catastrophizing. A sample of 95 men and women with chronic pain completed initial assessments of neuroticism, psychological resilience, and demographic data, and then completed short diaries regarding pain intensity, pain catastrophizing, and positive and negative emotions every day for 14 consecutive days. Multilevel modeling analyses indicated that independent of level of neuroticism, negative emotions, pain intensity, income, and age, high-resilient individuals reported greater positive emotions and exhibited lower day-to-day pain catastrophizing compared with low-resilient individuals. Mediation analyses revealed that psychologically resilient individuals rebound from daily pain catastrophizing through experiences of positive emotion. Implications for research on psychological resilience, pain catastrophizing, and positive emotions are discussed.

Keywords

pain; catastrophizing; positive emotions; psychological resilience

It is estimated that chronic pain afflicts between 50 and 80 million people in the United States alone, with an increased prevalence among the elderly (Gatchel, 2004; Helme & Gibson, 2001). Pain catastrophizing, defined as an exaggerated negative response to actual or anticipated pain, has been identified as one of the most robust and reliable predictors of the chronic pain experience (Sullivan, 1995; Turk & Rudy, 1992). Empirical evidence demonstrates that pain catastrophizing contributes to increased pain severity, disability, and emotional distress (for a review, see Sullivan, Rodgers, & Kirsch, 2001; Sullivan, Thorn, et al., 2001). Although much research has examined pain catastrophizing as an individual characteristic that remains highly stable over time (Keefe, Brown, Wallston, & Caldwell, 1989; Sullivan, 1995), increasing evidence suggests that the magnitude of day-to-day variability in pain catastrophizing is much larger than is commonly expected (Holtzman & DeLongis, 2007; Turner, Mancl, & Aaron, 2004); this implies that important within- and between-person factors may be affecting the level of pain catastrophizing experienced over time.

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One factor that may play an important role in fostering adaptive responses to pain and its attendant consequences is positive emotion. Studies of emotional change in individuals experiencing chronic pain reveal that deficits in positive emotion during episodes of severe pain are associated with increased vulnerability to emotional distress (Zautra, Fasman, et al., 2005; Zautra, Johnson, & Davis, 2005; Zautra, Smith, Affleck, & Tennen, 2001). One central tenet of Fredrickson's (2001) broaden-and-build theory of positive emotions is the *broaden hypothesis*. This hypothesis posits that positive emotions broaden the scope of attention and thinking, widening the range of thoughts and action tendencies that come to mind (Fredrickson & Branigan, 2001). It is important to note that the cognitive flexibility that accompanies positive emotional states is thought to bolster the ways individuals resourcefully cope with stress (Fredrickson & Joiner, 2002; Fredrickson, Tugade, Waugh, & Larkin, 2003). To the extent that positive emotions reduce the focus on negative emotions, the broaden hypothesis implies that positive emotions should attenuate the cognitive narrowing engendered by pain catastrophizing. To our knowledge, no studies have directly tested this prediction. Nonetheless, indirect evidence consistent with this prediction can be drawn from studies showing that individuals with higher positive emotions report greater broad-minded coping (Folkman & Moskowitz, 2000a; Fredrickson & Joiner, 2002), fewer ruminative thoughts (Koole, Smeets, van Knippenberg, & Dijksterhuis, 1999; Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998), and more positive appraisals of stress (Folkman & Moskowitz, 2000b; Tugade & Fredrickson, 2004).

Additional empirical evidence suggests that there may be individual differences in people's abilities to capitalize on positive emotions during times of stress (Fredrickson et al., 2003; Tugade, Fredrickson, & Barrett, 2004). Recent attention has focused on psychological resilience as an important trait that may account for the adaptive ways in which life stressors are encountered, managed, and transformed (Tugade & Fredrickson, 2004, 2007). Theoretical writings suggest that psychological resilience is a relatively stable personal trait characterized by the ability to overcome, steer through, and bounce back from adversity (Block & Kremen, 1996). Empirical research with older adults, moreover, indicates that positive emotions are a crucial component of psychological resilience (Ong, Bergeman, Bisconti, & Wallace, 2006; Ong, Bergeman, & Boker, 2009).

More than being a simple by-product of psychological resilience, however, the experience of positive emotion is believed to have adaptive benefits in the stress process (for a discussion, see Folkman & Moskowitz, 2004). Supportive evidence for this prediction comes from research demonstrating that resilient individuals tend to draw on coping strategies that elicit positive emotions, such as benefit finding and positive reappraisal (Affleck & Tennen, 1996; Folkman & Moskowitz, 2000b), humor and infusing ordinary events with positive meaning (Folkman, Moskowitz, Ozer, & Park, 1997; Ong, Bergeman, & Bisconti, 2004), and goal-directed, problem-focused coping (Billings, Folkman, Acree, & Moskowitz, 2000; Folkman, 1997) to regulate negative emotional experiences. It is important to note that positive emotions are thought to be among the active ingredients that account for the adaptive benefits of psychological resilience (Fredrickson et al., 2003; Ong et al., 2006). To the extent that this is true, psychologically resilient individuals should be more adept at proactively eliciting positive emotions to effectively rein in the narrowed cognitions (i.e., rumination, magnification, helplessness) triggered by pain catastrophizing.

The present study addresses the question of how psychological resilience and positive emotions influence the way in which individuals respond to pain over time. Using a daily process approach, we aim to extend conceptual understanding of pain catastrophizing in four important ways. First, because little is known about the extent to which individuals vary in their daily experiences of pain catastrophizing (Holtzman & DeLongis, 2007; Turner et al., 2004), the study's use of daily process methodology extends previous research based on

cross-sectional, between-person designs that have relied on retrospective reports. Second, given that pain catastrophizing has been linked with neuroticism (cf. Sullivan, Thorn, et al., 2001; Turner & Aaron, 2001), any observed associations between psychological resilience and pain catastrophizing may be due to this shared neuroticism component rather than actual adaptive benefits of resilience. Thus, we examined whether psychological resilience has incremental effects, above and beyond the personality disposition of neuroticism in reducing pain catastrophizing over time. Third, we explored a potential mechanism (i.e., positive emotion) by which psychological resilience may affect the sequelae of day-to-day pain catastrophizing. Finally, given that a number of studies have reported gender differences in pain catastrophizing (Keefe et al., 2000; Sullivan, Tripp, & Santor, 2000), we probed the extent to which gender may moderate the relations between psychological resilience, positive emotions, and pain catastrophizing. Taken together, we hypothesized that reports of day-to-day pain catastrophizing would be higher for women than men (Sullivan, Thorn, et al., 2001). Compared with low-resilient individuals, high-resilient individuals would report lower pain catastrophizing from one day to the next (Karoly & Ruehlman, 2006). Positive emotions on a given day would predict declines in subsequent pain catastrophizing (Zautra, Johnson, & Davis, 2005). Finally, we predicted that positive emotions would mediate the effect of psychological resilience on day-to-day changes in pain catastrophizing (Ong et al., 2006).

Method

Participants

Participants consisted of patients enrolled in an academically affiliated primary care practice located in New York City who presented to the practice for a regularly scheduled appointment. At the conclusion of their appointment, patients with a chronic pain diagnosis were referred by their physician to participate in the study. In the current study, chronic pain was defined as the patient-reported presence of pain, aching, burning, or throbbing sensations on most days of every month for at least 3 months in a row during the previous year due to a condition other than cancer. The most common pain conditions (confirmed by interview with participants' physicians) included low back pain and osteoarthritis of the hip and/or knee. We supplemented physician confirmations of diagnoses with inclusionary and exclusionary criteria based on participant reports of pain during the past week. Only patients who reported a pain level during the week prior to Day 0 (baseline) that was higher than 5 on a numeric rating scale (where 0 = *no pain* and 10 = *pain as bad as you can imagine*) were included. Those who agreed were approached (except during periods of high patient flow) by a staff interviewer who accompanied them to a separate room where they were screened individually for (a) English-speaking status; (b) age, with age ≥ 50 years; (c) average pain level over the past the week, with a score greater than 5; and (d) absence of global cognitive impairment, as assessed by a Mini-Mental State Exam (Folstein, Folstein, & McHugh, 1975) score greater than 25.

Of the 370 patients who were screened, 123 met eligibility criteria. Of the 123 eligible patients, 16 chose not to participate, citing time concerns as their primary consideration, leaving a final sample of 107 participants (87%). Ninety-five participants (89%) provided complete data for the present analysis.[1] Comparisons between the group of 95 and those omitted from analysis for incomplete data showed no differences in baseline demographics of gender, age, marital status, income, or education. The final sample consisted of 72 women and 23 men between the ages of 52 and 95 years (M = 76.3, SD = 8.8). The average duration

[1]Of the 107 individuals who initially enrolled into the study, 12 did not complete the daily diary procedure to criterion (i.e., they did not turn in a minimum of 7/14 diary records), leaving 95 participants with complete data.

of pain was 98.44 months (*SD* = 103.12 months; range = 5 months to 46 years). Approximately a quarter of the participants (27%) were married at the time of the study. The majority were Caucasian (95%), with the remainder being African American (3%) and Hispanic (2%). Income was approximately normally distributed; 24.4% reported family income less than $14,999, 17.8% between $15,000 and $24,999, 35.5% between $25,000 and $75,000, and 22.3% greater than $75,000.

Procedure

After being screened into the study, participants read and signed an informed consent form approved by institutional review boards at Cornell University and Weill Cornell Medical College. Participants were then given a baseline packet of questionnaires containing demographic variables and personality measures, including psychological resilience, which they returned by mail. After completing these questionnaires, participants were sent a packet of 14 diary questionnaires containing emotion and pain measures along with 14 postage-paid envelopes. To insure compliance in completing the diaries on a daily basis, participants were given a folder with personalized training materials, including instructions for operating an electronic stamper. Participants sealed each day's responses in a self-addressed envelope and stamped the seal with a hand-held electronic time stamper (DYMO Corp., Stamford, CT) provided by the researchers. The stamper imprinted the current date and time and was programmed such that the date and time could not be altered. Participants were paid $75.

Before completing the diaries, participants were phoned by a research assistant and given instructions to fill out the diaries half an hour before bedtime each day. A weekly telephone contact was maintained to reinforce diary completion and to answer any questions. During the weekly telephone interview, participants were asked about the completeness of their diaries and then were given the opportunity to ask any questions related to the daily recording procedures, such as how to mark the pain rating scales. The time stamper method of monitoring diary completion, weekly phone calls, and monetary incentives resulted in a very high rate of compliance that did not differ by gender or age. Of a possible 1,330 person days, participants completed the time-stamped diary on 1,237 days (93%); of these, 85% were completed on time, either on the correct night or before noon the following day. The modal time of completing the diary was 8:00 p.m., and 96% of the diary checklists were completed between 6:00 p.m. and 12:00 a.m. Analyses examining only diaries completed on time revealed no significant difference from analyses using all completed diaries, regardless of when they were completed. All final analyses, therefore, are based upon analyses using all completed diaries.

Person-Level Measures

Psychological resilience—The Ego-Resiliency Scale (Block & Kremen, 1996) was used to assess psychological resilience, defined as "the capacity of the individual to effectively modulate and monitor an ever-changing complex of desires and reality constraints" (Block & Kremen, 1996, p. 359). The scale consists of 14 items, each responded to on a 4-point Likert scale, ranging from 1 (*does not at all apply*) to 4 (*applies very strongly*). Sample items include "I get over anger with someone reasonably quickly" and "I enjoy dealing with new and unusual situations." For this sample, the Cronbach alpha reliability was .78. Block and Kremen's (1996) reported alpha was .76.

Neuroticism—The Mini-IPIP, a 20-item short form of the 50-item International Personality Item Pool (IPIP), was used to measure neuroticism (Donnellan, Oswald, Baird, & Lucas, 2006). The neuroticism scale consists of four items, each responded to on a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Sample items include

"I have frequent mood swings" and "I get upset easily." For this sample, the Cronbach alpha reliability was .76. Donnellan et al. (2006) reported alphas that ranged from .68 to.70.

Day-Level Measures

Pain catastrophizing—Sullivan, Thorn, et al. (2001) have defined pain catastrophizing as a unitary construct comprised of three related but distinct factors: helplessness, rumination, and magnification. To measure daily pain catastrophizing, items with the highest total correlations in past research (Sullivan, 1995) were selected for the present scale, which was limited to seven items to minimize the burden placed on participants. In particular, two items were selected to capture the *helplessness* component of pain catastrophizing (i.e., "It's awful and I feel that it overwhelms me"; and "I feel I can't stand it anymore"). Three items were selected to capture the *rumination* component (i.e., "I keep thinking about how badly I want the pain to stop"; "I can't seem to keep it out of my mind"; and "I keep thinking about how much it hurts"). Two items were selected to capture the *magnification* component (i.e., "I wonder whether something serious may happen"; and "I become afraid that the pain may get worse"). Within-person estimates of internal consistency reliability were computed using three-level models in which items were nested within days, which were nested within participants (Bryk & Raudenbush, 1992, pp. 191–196). Using this procedure, we estimated the internal consistency of the seven-item measure of pain catastrophizing to be .91.

Pain intensity—Participants were asked to rate their pain for that day by selecting a number between 0 and 10 that "best describes your average level of pain today: A zero (0) would mean 'no pain' and a ten (10) would mean 'pain' as intense as you can imagine" (Jensen, Turner, Romano, & Fisher, 1999, p. 159). To estimate reliability, test–retest correlations were computed across weeks, yielding a week-to-week correlation of. 72.

Positive emotions and negative emotions—Daily positive and negative emotions were measured by asking participants to rate how they felt during the day using a circumplex model (Feldman Barrett & Russell, 1998) as a basis for these ratings. For positive emotions, each day participants rated how *enthusiastic, happy, energetic, alert, proud, active, joyful, interested, calm, satisfied, relaxed*, and *at rest* they felt. For negative emotions, participants rated how *disgusted, guilty, angry, upset, ashamed, embarrassed, nervous, afraid, sluggish, bored, sad*, and *tired* they felt. For each emotion item, they were asked, "How much have you felt this way today?" Participants responded using a 5-point Likert-type scale, ranging from 1 (*not at all*) to 5 (*extremely*). The internal consistency reliability was .95 for positive emotions and .91 for negative emotions.

Overview of Analyses

Because of the hierarchical nature of our data (14 consecutive days nested within 95 participants) and in order to increase the precision of predicting fluctuations in pain catastrophizing, we modeled the data using a multilevel modeling approach. In multilevel modeling, a regression equation is specified for each level of analysis; in the current study, we have a within-person equation (or Level 1 model) and a between-person equation (or Level 2 model). For the Level 1 model, within-person outcomes on a given day are regressed on within-person predictors. For the Level 2 models, within-person parameters derived from the Level 1 regression models are regressed on between-person predictors. The major advantage of these models over traditional approaches to analyzing repeated measures data is that they do not require that the data set be disaggregated to the level of individual assessments (which violates the assumption of independence of observations) or that the data be averaged across repeated observations (which would ignore the within-person variation).

To test our main hypotheses, we conducted multilevel regression analyses using Hierarchical Linear Modeling software (Version 6.05; Raudenbush, Bryk, Cheong, & Congdon, 2004). The Level 1 equation was specified to estimate changes in pain catastrophizing by computing the standardized residuals of next-day pain catastrophizing when regressed on prior day's pain catastrophizing. In such a model, the dependent variable can be interpreted as the residualized change in pain catastrophizing from day t to day $t + 1$. The analysis model for residual pain catastrophizing for each individual can be expressed using the following Level 1 equation:

$$\Delta\text{PCS}_{jt+1}=a_{0j}+a_{1j}(\text{PE}_{jt})+a_{2j}(\text{NE}_{jt})+a_{3j}(\text{Pain}_{jt})+r_{jt+1},$$

where ΔPCS_{t+1} is the change in person j's pain catastrophizing score between day t and day $t + 1$; a_{0j} is a regression intercept representing the mean day-to-day change in pain catastrophizing; a_{1j} is a partial regression slope representing an individual's level of positive emotions on day t; and r_{jt+1} is a residual component of change in pain catastrophizing. In addition to daily pain catastrophizing and positive emotions, Level 1 equations also included daily negative emotions and pain intensity. In all analyses, the Level 1 predictor variables were first summed before being centered for each participant by subtracting each person's mean rating from all their daily ratings.

The Level 2 equation was specified predicting between-person differences in the Level 1 intercepts. The equation for predicting the intercept can be written as follows:

$$a_{0j}=b_{00}+b_{01}\text{Resilience}_j+b_{02}\text{Gender}_j+b_{03}\text{Neuroticism}_j+b_{04}\text{Age}_j+b_{05}\text{Income}_j+u_{0j},$$

where person j's Level 1 intercept (a_{0j}) is predicted as a function of an intercept, psychological resilience, and a random error component. The resulting partial regression coefficients provide estimates of (a) b_{00}, the mean change in pain catastrophizing at average levels of predictor variables (e.g., psychological resilience); and (b) b_{01}, the effect of psychological resilience on mean changes in pain catastrophizing. In addition to psychological resilience, the Level 2 equation also included gender, age, income, and neuroticism to adjust for their known associations with pain catastrophizing (Sullivan, Thorn, et al., 2001). In all analyses, the Level 2 predictor variables were grand mean centered, such that each person's score was subtracted from the average of all the individuals.

Results

Descriptive Statistics

Preliminary analyses were conducted to obtain summary statistics of the study variables. Each daily measure was analyzed with a totally unconditional model (i.e., a model in which there were no predictors at any of the two levels of the model). These analyses estimated the percentage of variance within (Level 1) and between (Level 2) persons. The results of these analyses, shown in Table 1, indicate that all of the daily measures were reliable and had sufficient within-person variability to allow for the possibility of modeling within-person relationships. Moreover, the means on each scale were sufficiently far from either endpoint so that floor and ceiling effects were not considerations.

Hypothesis 1: Gender and Pain Catastrophizing

To test for gender differences in day-to-day pain catastrophizing, we evaluated differences in individuals' intercept (from the Level 1 equation) as a function of gender. The results of

these analyses are summarized in the top half of Table 2. The intercept indicates that, on average, pain catastrophizing increased by .09 units from one day to the next (SE = .02, p < .001). There was also evidence that the day-to-day increase in pain catastrophizing was higher for individuals who were lower in income (b = −.14, SE = .03, p < .05) and higher in neuroticism (b = .14, SE = .013, p < .05). In support of Hypothesis 1, Table 2 shows that there was a significant main effect of gender, indicating that, on average, the increase in pain catastrophizing was .29 units greater in women than men (SE = .05, p < .001).

Hypothesis 2: Psychological Resilience and Pain Catastrophizing

To test the hypothesis that high-resilient individuals would exhibit greater decreases in day-to-day pain catastrophizing compared with low-resilient individuals, we evaluated differences in individuals' intercept as a function of scores on the measure of psychological resilience. In support of Hypothesis 2, there was evidence that resilience predicted decreases in subsequent pain catastrophizing (b = −.21, SE = .03, p < .001). Specifically, the increase in day-to-day pain catastrophizing was .21 units lower among high-resilient individuals compared with low-resilient individuals.

Hypothesis 3: Positive Emotions and Pain Catastrophizing

To test the hypothesis that positive emotions would predict decreases in subsequent pain catastrophizing, we evaluated differences in individuals' slopes. Here, positive emotion on a given day is hypothesized to affect changes in pain catastrophizing from one day to the next. In support of Hypothesis 3, there was a main effect of positive emotions on changes in pain catastrophizing. Specifically, participant reports of positive emotions on a given day were associated with a. 19 unit decrease (SE = .02, p < .01) in pain catastrophizing the following day. Gender significantly moderated this effect (b = −.25, SE = .05, p < .001). Figure 1 shows predicted mean pain catastrophizing change as a function of positive emotion for men and women. The figure reveals that elevations in positive emotions were related to decreases in pain catastrophizing to a greater degree in women than men.

Hypothesis 4: Positive Emotions Mediate the Resilience–Pain Catastrophizing Link

Our final hypothesis stated that positive emotions would mediate the influence of psychological resilience on changes in day-to-day pain catastrophizing. The statistical analysis framework suggested by Kenny, Kashy, and Bolger (1998) was used to test for mediation effects. This entailed conducting three separate equations. Step 1 is to test whether there is a significant main effect between the predictor (psychological resilience) and the outcome (pain catastrophizing change), which was supported by Hypothesis 2. Step 2 is to test whether there is a significant main effect between the mediator (positive emotions) and the outcome (pain catastrophizing change), which was supported by Hypothesis 3. Step 3 examines the effect of the predictor (psychological resilience) on the mediator (positive emotions). Consistent with Step 3, data indicated that psychological resilience predicted increases in daily positive emotions (b = .49, SE = .11, p < .001).

According to Kenny et al. (1998), if Steps 1 through 3 are to hold, mediation occurs if the effect of the predictor (psychological resilience) has no effect on the outcome (pain catastrophizing change) when the mediator (positive emotions) is controlled. Consistent with this final step, Table 2 shows the relationship between psychological resilience and pain catastrophizing change, with and without controlling for positive emotions. Thus, the data in the bottom half of Table 2 indicate that the beta for psychological resilience fell from −.21 to −.12.[2] The latter coefficient is the direct effect of psychological resilience on average change in catastrophizing, and it is nonsignificant (SE = .06, *ns*). The indirect effect of psychological resilience through positive emotions is −.10 units and reflects how much a 1-unit change in psychological resilience affects changes in day-to-day pain catastrophizing

through positive emotions.[3] Thus, the proportion of the indirect effect to the total effect is .44, indicating that positive emotions explained 44% of the resilience–pain catastrophizing relationship.[4] The significance of this mediation effect was evaluated following the procedure outlined by Mackinnon and colleagues (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002; MacKinnon, Lockwood, & Williams, 2004).[5] Specifically, asymmetric confidence limits (CL) were formed using the upper and lower critical values of the distribution of the product of two standard normal variables (Meeker, Cornwell, & Aroian, 1981). If zero was not in the 95% interval of the upper and lower confidence limits, we concluded that the mediation effect was statistically significant. Using this method, the lower and upper 95% confidence limits based on the distribution of the product were −.1494 and −.0484, suggesting that the mediated effect of positive emotions is statistically significant.[6]

Discussion

Previous studies have tended to regard pain catastrophizing as a variable that is either manipulated or measured as it occurs naturally (e.g., Sullivan, Thorn, et al., 2001). In the current study, we treated pain catastrophizing as an outcome. Guided by the organizing framework of the broaden-and-build theory (Fredrickson, 2001), we proposed that pain catastrophizing is a dynamic process that is subject to change and influenced by both person-level (e.g., psychological resilience) and day-level (e.g., positive emotions) factors. Although prior research has documented the beneficial role of psychological resilience and positive emotions in the emotion regulation process (e.g., Ong et al., 2006; Tugade & Fredrickson, 2004), to our knowledge, this is the first study to focus on the effects of psychological resilience and positive emotions on changes in day-to-day pain catastrophizing.

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[2]We examined whether the mediated process linking psychological resilience to changes in pain catastrophizing varied as a function of gender, but we found no evidence of moderated mediation. To further rule out reverse causal effects (Cole & Maxwell, 2003), we also tested two plausible alternative models of mediation. The first alternative model tested whether pain catastrophizing might in fact mediate the association between psychological resilience (as predictor) and positive emotions (as outcome). No evidence of mediation was obtained for this model (95% CL = −.02, .06). Resilience remained a strong predictor of positive emotions even when pain catastrophizing was controlled (b =.45, SE = .09, p < .001). A second alternative model tested whether the relationship between psychological resilience and pain catastrophizing change was mediated largely by negative emotions. Following the procedure outlined by Fredrickson et al. (2003), we calculated a modified index of negative emotions that removed its shared variance with positive emotions. Although this purified measure of negative emotions was found to correlate significantly with residual pain catastrophizing (r =.33, p < .01), it did not correlate with psychological resilience (r = −.09, *ns*), and when added to the regression equation, it did not significantly reduce the relationship between psychological resilience and residual pain catastrophizing (b = −.18, SE = .05, p < .01).

[3]The product of the α (the relation of the predictor to the mediator) and β (the relation of the mediator to the outcome) parameters, $\alpha\beta$, is the indirect or mediated effect. Owing to different standardization across different mediation equations, the ($\alpha\beta$) and ($\tau - \tau'$) estimators of the mediated effect, equivalent in the single-level modes, are not exactly equivalent in multilevel models. We note, however, that the extent of nonequivalence between estimates of $\alpha\beta$ (−.095) and = $\tau - \tau'$ (−.091), in the current study, was negligible and unsystematic (Krull & MacKinnon, 1999).

[4]We used MacKinnon et al.'s (2004) method of calculating the size of the mediated effects using the equation:

$$\text{Proportion of the mediation effect} = |\alpha\beta| / |\alpha\beta| + |\tau'|,$$

where (τ') represents the estimate of the direct effect (i.e., the coefficient relating the predictor to the outcome, adjusted for the mediator).

[5]Simulation studies have demonstrated that confidence limits for the indirect effect based on the distribution of the product method are more powerful and accurate than the normal-theory confidence limits (MacKinnon et al., 2002; MacKinnon et al., 2004).

[6]The upper and lower confidence limits for the indirect effect were calculated using PRODCLIN (distribution of the PRODuct Confidence Limits for Indirect effects). Specifically, the observed values for α, β, σ_α, σ_β, and $\alpha\beta$ were entered in the PRODCLIN program (α =.4914, = β −.1931, σ_α =.1124, σ_β = .0245, $\alpha\beta$ = −.0949). These values yielded lower and upper 95% confidence limits of −.1494 and −.0484. The SAS and R macro programming languages used to run PRODCLIN are described in MacKinnon et al. (2004).

Both theory and research indicate that psychological resilience is characterized by the capacity to resourcefully rebound from adversity (Block & Kremen, 1996; Masten, 2001). The current findings extend previous research by exploring the concomitants of psychological resilience in the context of daily negative cognitions about pain. The findings indicate that differences in day-today pain catastrophizing may follow from one's habitual outlook on life; that is, how individuals react to, appraise, and interpret daily pain-related cognitions. Compared with low-resilient individuals, high-resilient individuals reported less day-to-day pain catastrophizing. Overall, the present findings suggest that individual differences in psychological resilience may constitute an important pathway to understanding effective adaptation to pain catastrophizing over time (Karoly & Ruehlman, 2006).

A major finding from the study is that psychological resilience predicts increases in daily positive emotions, which in turn predict decreases in subsequent pain catastrophizing. Notably, we found that beyond simply making people "feel good" (Fredrickson, 2001), daily experiences of positive emotions have the potential to counteract the narrow modes of habitual thinking (i.e., rumination, helplessness, magnification) characteristic of pain catastrophizing (Sullivan, Thorn, et al., 2001) and thereby bolster people's cognitive resilience to subsequent pain (Zautra, Johnson, & Davis, 2005).

Also of interest are the gender differences we uncovered in this study. Women reported greater use of pain catastrophizing compared to men, similar to other studies of maladaptive response (e.g., Nolen-Hoeksema & Jackson, 2001). However, women also benefited more than men from positive emotion, a finding that is consistent with a hypothesis offered by McRae, Ochsner, Mauss, Gabrieli, and Gross (2008). They found greater neural activation in women who were faced with an emotion regulation task both in a region associated with negative emotion and in another associated with positive emotion; they suggested that women may have more difficulty in emotion regulation and may also recruit positive emotions to a greater extent than men to aid recovery. Davis, Okun, Kruszewski, and Zautra (2010) found that women in chronic pain reported both more negative affect in response to stressors and more positive affect in response to beneficial events. Meriting further investigation is whether emotion regulation tasks require more effort and are also resolved more readily through recruitment of positive emotion for women. Clearly, interventions for women in chronic pain would benefit from enhancing attention to sources of positive emotion along with the useful admonishment against maladaptive cognitive responses such as pain catastrophizing. More generally, our findings on psychological resilience suggest that changing the appraised personal significance of catastrophic thinking (e.g., vis-à-vis reframing and perspective taking) may be one effective means by which to cultivate positive emotions in the midst of stress (Park & Folkman, 1997; Tugade & Fredrickson, 2004).

The results of this study are subject to several important limitations. A foremost limitation is our use of a primary care sample, which raises some concern regarding the generalizability of study findings to patients with specific chronic pain disorders, including inflammatory (rheumatoid arthritis) and neuropathic (diabetic neuropathy) conditions. Indeed, some evidence suggests that compared with osteoarthritis patients, fibromyalgia patients may show greater signs of positive affect disturbance during pain episodes (Finan, Zautra, & Davis, 2009). Furthermore, additional research is needed to determine whether the findings obtained in the current sample can be generalized to samples of individuals with specific chronic pain disorders and/or less severe pain. Similarly, although the nonsignificant age effect we observed is consistent with the available cross-sectional literature on pain catastrophizing (Keefe & Williams, 1990; Sullivan, Thorn, et al., 2001), it must be tempered by not being based on longitudinal data.

A number of variables known to have an impact on pain catastrophizing were not examined. In particular, we did not attempt to measure variation in depression (Tennen, Affleck, & Zautra, 2006), coping (Keefe et al., 1989), or social networks (Cano, 2004) as possible predictors of day-to-day pain catastrophizing. Thus, it will be important for future studies to determine the unique ways in which interpersonal variables interact with emotion and personality factors to influence pain catastrophizing responses in older adults. A final limitation stems from the study's design. Even though our mediation analyses suggest that resilience leads people to experience greater positive emotions and these emotions, in turn, lead to decreases in day-to-day pain catastrophizing, we cannot draw conclusive causal inferences because of the observational nature of our data. For instance, given the methodology used, it is difficult to disentangle whether those with greater positive emotions (high-resilient individuals) are less likely to catastrophize or whether positive emotions lead high-resilient individuals to catastrophize less from day-to-day. An experimental design, thus, would enable stronger inferences regarding the causal order implied by our meditation findings.

Despite these limitations, the study provides new data that demonstrate that fluctuations in pain catastrophizing are strongly linked to individual differences in psychological resilience. In addition, the study is the first to document that pain catastrophizing is susceptible to change in response to positive emotions present in people's daily lives, increasing or decreasing in a manner that is reflective of changes in these emotions. Overall, the data establish that for psychologically resilient individuals, positive emotions may function in the service of well-being not only by interrupting the ongoing experience of pain catastrophizing but also by averting delays in adaptation to subsequent catastrophic thinking.

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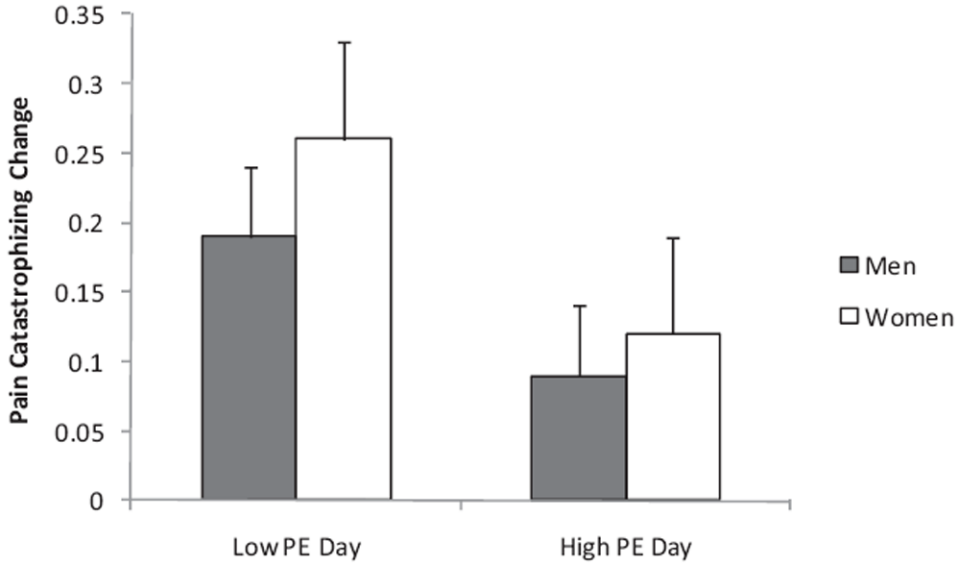

Figure 1.
Gender differences in pain catastrophizing change as a function of positive emotions (PE). High and low PE were defined as one standard deviation from the mean. Error bars represent one standard error of the mean.

Table 1

Summary Statistics of Day-Level and Person-Level Variables

Variable	1	2	3	4	5	6
Day-level variables						
1. Negative emotions	—	.28	.32	−.28	−.27	.42
2. Pain intensity		—	.34	−.29	−.28	.29
3. Pain catastrophizing[a]			—	−.42	−.39	.31
4. Positive emotions				—	.41	−.27
Person-level variables						
5. Psychological resilience					—	−.28
6. Neuroticism						—
M	1.38	5.27	0.07	3.09	3.04	2.83
SD	0.54	2.59	1.82	0.91	0.88	0.64
Between-person variance	.43	.61	.58	.64		
Within-person variance	.57	.39	.42	.36		

Note. All correlations are significant; $p < .01$, two-tailed. $N = 95$ persons; $N = 1{,}237$ person days.

[a]Pain catastrophizing scores represent the average change in pain catastrophizing from day t to day $t + 1$.

Table 2

Parameter Estimates for Pain Catastrophizing, With and Without Controlling for Positive Emotions

	Change in pain catastrophizing from day *t* to day *t* + 1		
Predictor	**Estimate**	***SE***	***p***
Without positive emotions			
Intercept	.094	.021	.018
Gender	.291	.048	.001
Age	−.017	.013	.167
Income	−.138	.027	.035
Neuroticism	.142	.031	.029
Psychological resilience	−.208	.033	.001
With positive emotions			
Intercept	.091	.017	.031
Gender	.241	.051	.001
Age	−.014	.011	.159
Income	−.133	.024	.044
Neuroticism	.139	.036	.032
Psychological resilience	−.117	.062	.094

Note. All models adjust for prior-day levels of negative emotion and pain intensity. Gender: 0 = male; 1 = female. Income: 0 = ≤$24,999; 1 = ≥ $40,000.