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Predictors and Social Consequences of Daily Pain Expectancy among Adults with Chronic Pain

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Introduction

Anticipation of aversive experiences such as pain may be necessary for survival by allowing individuals to plan ahead to protect themselves against unpleasant future consequences. However, the expectation of pain can facilitate avoidant behaviors which in turn can undermine the acquisition and use of adaptive pain coping resources (e.g., [41, 57]). Empirical evidence is consistent with these claims. Experimental studies manipulating pain expectancy have found that pain expectancy is associated with increases in subsequent pain experience and higher levels of behavioral avoidance [19, 21, 49, 59, 68]. Likewise, evidence from longitudinal [10] and daily diary studies [1] shows that higher pain expectancy predicts greater pain and disability, even when controlling for negative affect, fear avoidance, and baseline pain level [9]. In sum, pain expectancy appears to be an important determinant of future pain experience and functional performance.

However, to date, few data are available regarding either the antecedents or consequences of pain expectancy in the daily lives of people with chronic pain. With regard to antecedents, theory and evidence point to the importance of cognitive and affective factors. Bandura's [5] self-efficacy theory, for example, posits that confidence in one's ability to cope with pain results in optimistic expectations regarding future pain experiences [18, 43]. In contrast, when pain interferes with the ability to pursue important daily activities, pessimistic expectations of future pain experiences may increase (e.g., [7, 8]). Affective experience may also predict pain expectancy. High negative affect elicits attentional narrowing and biased information processing such as hypervigilance to potential threats [22, 23, 28, 62], thus potentially increasing expectancies for pain. Positive affect, on the other hand, may interrupt catastrophic expectations of future pain by broadening the scope of an individual's thoughts and actions to facilitate flexible coping [22, 23, 29].

Also unexamined are the consequences of pain expectancy on day-to-day social functioning (i.e., interpersonal enjoyment and stress). Given that the ability to sustain social engagement

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serves important functions in attenuating pain-related disability and depression in the face of pain [36, 40], examining the indirect effect of pain expectancy on day-to-day interpersonal enjoyment and stress is a worthy goal. Recent studies have, for example, found that pain may interfere with individuals' engagement in pleasurable activities or goals [25, 46]. However, these studies have *separately* examined the associations between pain expectancy, pain, and social functioning. Thus, the current research sought to examine whether pain mediates the effects of pain expectancy on social functioning.

Through two daily diary studies, we sought to replicate the unique effect of pain expectancy on subsequent pain and to extend previous findings by examining the predictors and social consequences of pain expectancy. Study 1 tested in persons with rheumatoid arthritis whether high pain expectancy today predicted higher pain tomorrow, controlling for today's pain. Study 2 extended our inquiry by investigating the cognitive and affective predictors and social consequences of pain expectancy among individuals with Fibromyalgia (see Figure 1). Specifically, Study 2 examined whether: 1) variation in afternoon pain-related activity interference, pain coping efficacy, and negative and positive affect predicted elevations in evening pain expectancy; and 2) whether evening pain expectancy then indirectly predicted tomorrow afternoon's social enjoyment and stress via tomorrow morning's pain.

Study 1

Method

Participants—Participants were recruited from the Phoenix metropolitan area using a variety of approaches (i.e., newspaper advertisements, online postings, flyers placed in physician offices, mailings through the Arthritis Foundation) as part of a larger study on psychological treatments for RA [66]. Participants included both those who agreed to and those who declined treatment but agreed to take part in the baseline assessments, including daily diary measures which are the focus of the current study. Inclusion criteria for the present study were as follows: (1) physician-confirmed diagnosis of RA; (2) aged 18 or over; (3) medication use did not include any cyclical estrogen replacement therapies; (4) did not have a diagnosis of Systemic Lupus Erythematosus (SLE); (5) not pursuing litigation related to pain. A total of 231 participants were included in the present study (more detailed information on the total sample size for the present study is provided below).

Procedure—All procedures for data collection in the current study were approved by the Institutional Review Board at Arizona State University prior to initiating the study. Five hundred and eighty individuals who were interested in the present study were screened by phone to determine initial eligibility. Following screening, potential participants returned by mail a consent form and authorization for study personnel to contact their physicians to confirm their RA diagnosis. Of those screened, 262 met inclusionary criteria and were enrolled in the study. However, 31 individuals dropped out of the study after the enrollment period, primarily due to their time constraints.

Participants with a physician-confirmed diagnosis received and returned by mail an initial packet of questionnaires that included demographic and personality measures. Participants

next completed a structured interview conducted by phone regarding their history of depression episodes. Following completion of the phone interview, participants completed pre-intervention assessments, which included diary reports.

Diary assessment: Participants were mailed a packet of 30 paper-and-pencil diary reports and 30 addressed, stamped envelopes. Before initiating their diary reports, participants were contacted by phone and provided with instructions regarding how to complete and return the diaries. They were instructed to complete a report each evening prior to bedtime, and to mail the completed report in the next day's mail using the postage-paid envelopes. They were also told that the postmark on each envelope would be used to monitor their compliance. Most of the diary reports were returned in a timely manner (i.e., 66% post-marked the next day, 87 % post-marked the second day), comparable to those reported by other diary studies that employed mail-based methods (e.g., [56]). Analyses that included versus excluded diaries returned more than two days following completion yielded similar findings; therefore, all diaries were retained in the current study. Participants received $2 for each completed diary and a bonus of an additional $1 per day for each diary when they completed at least 25 diaries, yielding a maximum of $90 in potential compensation. In our final sample of 231, participants completed an average of 29.31 diaries (*SD* = 1.64; range 18–30), with an overall completion rate of 97% (i.e., 6708 of 6930 observations completed).

Measures

Evening Pain: Each evening, approximately 30 minutes prior to bedtime, participants rated their pain for that day by selecting a number between 0 and 100 that "best describes your average level of arthritis pain today: A zero (0) would mean 'no pain' and a one hundred (100) would mean 'pain as bad as it can be'" [33].

Evening Pain Expectancy: Participants also rated "how much pain you expect tomorrow" on the same 0–100 scale.

Analytic Plan—First, descriptive statistics such as means, standard deviations, skewness, kurtosis, and intraclass correlations (ICCs) were calculated for all Study 1 variables. The data of the present studies have a two-level hierarchical structure: repeated daily diary assessments nested within a person. Thus, to address the main hypotheses of these studies requires a multilevel modeling approach in order to correctly estimate regression coefficients and standard errors. Multilevel structural equation modeling (MSEM) was employed by using the TYPE = TWOLEVEL command in Mplus software version 7 [45]. Maximum Likelihood Estimation with Robust Errors, which is the Mplus default setting, was used to estimate the present models. MSEM has a number of advantages over standard multilevel regression models. First, MSEM allows for more complex multilevel models such as path analysis [50]. Second, whereas traditional multilevel analysis cannot test the fit of a model, MSEM can do so [54]. Third, MSEM can account for measurement error [50]. MSEM automatically partitions the within- and between-person level variances; thus centering each study variable is not necessary prior to analyses and the coefficients can be directly interpreted at the corresponding levels of analysis [50]. Findings of only within-person model will be reported in the present study following two reasons: (1) the present studies

only address within-person hypotheses; and (2) that the associations between study variables in models at the between-person level are all cross-sectional because they represent means of 21-day diary assessments.

Note that in MSEM, the Mplus program automatically centers all within-person predictors using *person-mean centering*. Person-mean centering is used in multi-level modeling when researchers are interested in within-person variations over time. In the present study, these scores represent day-to-day deviations from a person's own mean score over the entire diary period for that variable. Person-centered predictors thus address questions that can be framed in the following way: "On days when individuals experience higher than their usual level of pain expectancy, do they also experience higher levels of next-day pain?"

Goodness of fit for our model was evaluated using the chi-square statistic[1], comparative fit index (CFI), root mean square of approximation (RMSEA), and the standardized root mean squared residual (SRMR). Values greater than .90 for CFI, less than .08 for RMSEA, and below .10 for SRMR indicate a reasonable model fit [11, 38].

In terms of missing data, we used the Full Information Maximum Likelihood (FIML; [3]) under the commonly used missing at random assumption (MAR; [42]). Under this assumption, FIML attempts to find parameter estimates that provide the best fit to the data [20]. Previous simulation studies have shown that FIML provides less biased parameter estimates and superior power compared to other conventional missing data treatment methods (e.g., listwise deletion, pairwise deletion, mean substitution, etc.; [20]).

Effect sizes were also calculated. In multilevel modeling framework, calculating an effect size is not straightforward and there has been no agreement among researchers as to which effect size estimate is the most accurate [39]. However, calculation of the variance explained (R-squared) by predictors is generally accepted as a useful effect size index in this framework [43]. Mplus output provided the R-squared index for each of the endogenous variables and these indices were reported.

Results

Demographics of Sample—Table 1 shows the sample demographic characteristics for Study 1. Participants were primarily female, Caucasian, and middle-aged, with approximately 63.6% of the sample either married or partnered. On average, Study 1 participants completed 1 to 3 years of college, and earned a household income in the range of $40,000 to $59,999.

Preliminary Analyses—Table 2 displays descriptive statistics and ICCs for Study 1. Skewness and kurtosis of all variables fell within the acceptable range [53]. ICCs ranged from .62 (pain intensity) to .75 (pain expectancy), which suggests that there was sufficient within- and between-person variation in the data hierarchy to estimate a multilevel model. For instance, 62% of the variation in pain were explained by between-person differences and

[1]Although the Chi-square statistic was used, its value should be interpreted with caution because it is highly sensitive to sample size. Specifically, large sample size tends to produce large chi-squares that are statistically significant.

38% of the variation were explained by within-person differences. Pain and pain expectancy were highly correlated.

Today's Pain Expectancy Predicts Tomorrow's Pain: Findings of MSEM— Figure 2 shows the standardized path estimates for Study 1. This model was fully saturated; therefore, no fit indices were available. Higher pain intensity was correlated with greater pain expectancy. Consistent with hypothesis, higher than a person's usual pain expectancy today predicted greater pain intensity tomorrow ($B = .25$, SE = .02, $p < .001$), after controlling for today's pain intensity. With regard to effect size, the predictors, today's pain and pain expectancy, explained 21.4% of variance of next day pain at the within-person level. When only pain expectancy was included as a predictor of next day pain, 16.2% of variance was explained.

Study 2

Method

Participants—Participants were recruited from the Phoenix metropolitan area using various sources of advertisement (i.e., newspaper advertisements, online postings, and local physician offices) as part of a larger study on psychological treatments for fibromyalgia (FM). Inclusion criteria for the present study was as follows: (1) age between 18 and 72; (2) had pain for three months or more in at least three of four quadrants of the body, or in two quadrants of the body and they had substantial sleep disturbance and fatigue; (3) reported pain in at least 11 of 18 tender points during a home visit (described below), consistent with diagnostic criteria for FM established by the American College of Rheumatology [65]; (4) did not have any autoimmune pain disorders; (5) not currently in other research trials or receiving psychotherapy for pain or depression; and (6) not pursuing litigation related to their pain. Total two hundred and twenty participants participated the present study (more detailed information on the total sample size for the present study is described below).

Procedure—All procedures for data collection in the current study were approved by the Institutional Review Board at Arizona State University prior to initiating the study. Seven hundred and sixteen individuals who were interested in the present study were screened by phone to determine initial eligibility. Of those screened, 444 did not meet inclusionary criteria, primarily due to lack of interest and/or time to complete the study requirements. Those who passed an initial phone screening underwent a home visit, where they provided informed consent and underwent a tender point exam administered by a research nurse. To qualify for the present study, participants had to report some pain in response to pressure on at least 11 of 18 tender points, consistent with the diagnostic guidelines of American College of Rheumatology for FM [65]. Two hundred and seventy-two individuals were enrolled in the study. However, 52 individuals dropped out of the study after the enrollment period primarily due to their time constraints. The remaining participants completed an initial questionnaire packet that included measures of demographic information, physical health, emotional health, and pain. They also underwent a phone interview regarding mental health symptoms. Prior to being randomized to intervention condition, participants completed pre-intervention assessments that included 21 days of diary reports regarding interpersonal

events, pain, fatigue, sleep quality, mood, and coping. The current study draws on data from 220 individuals who completed the pre-intervention diary assessment.

Diary assessment: For the pre-intervention phone diary assessment, research team members met with participants in person. Participants were provided with a cell phone to use for the diary reported and detailed instructions and training on how to complete the phone diaries. Participants were asked to complete diary assessments four times per day for 21 days through an automated system that called the cell phone, delivered audio recorded questions, and collected responses via phone keypad input from participants. The first morning assessment time was selected by the participant to occur approximately 30 minutes following usual wakening time in the morning. The other three calls for assessments were delivered at 11:00 am (morning), 3:30 pm (afternoon), and 7:00 pm (evening). If participants missed a call, they were able to call into the system within three hours of the automated call to complete the questions. Call completions were regularly monitored by research staff members, who checked in with each participant on his/her progress on diary assessments. If participants missed calls for several days in a row, study staff members contacted them to remedy any potential barriers to participation in the daily diary assessments. Participants were paid $2 for each day they completed diaries, with a bonus of $1/day for rates of completion that were at or above 50%. On average, participants completed 17.25 end-of-day reports (*SD* = 4.75, range = 1 – 21), with an overall completion rate of the diary assessments of 82% (3,796 out of 4,620 observations completed).

In Study 2, pain expectancy was measured only once a day (i.e., in the evening). Therefore, we selected the afternoon assessment (rather than morning assessment) of predictors because that assessment was the most proximal time point for predicting evening pain expectancy.

Measures

Afternoon Positive and Negative Affect: Afternoon positive and negative affect were measured with four items each (i.e., positive: energetic, calm, cheerful, and at ease; negative: lonely, afraid, sad, and angry) which were chosen from the positive and negative affect subscales of the Positive and Negative Affect Schedule [61]. Participants were asked to rate the intensity with which they felt each of affect items during the prior 2 to 3 hours using a scale ranging from 1 (not at all) to 5 (completely). The within-person reliability estimates of afternoon positive affect ($\alpha = 0.66$) and negative affect ($\alpha = 0.86$) suggested acceptable reliability.

Afternoon Effectiveness of Pain Coping: Pain coping effectiveness during the prior 2 to 3 hours was assessed via the following 1-item measure: “You coped effectively with your pain.” The item was rated on a scale ranging from 1 (not at all) to 5 (completely).

Afternoon Pain’s Activity Interference: Participants answered the following item to assess pain interference: “During the past 2–3 hours, how much did your pain interfere with your ability to carry on with your activities?” The scale ranged from 1 (not at all) to 5 (completely).

Afternoon Social Enjoyment: Afternoon social enjoyment during the prior 2 to 3 hours was assessed via the following 2 diary items: (1) "How enjoyable were your relations with spouse/partner?" and (2) "How enjoyable were your relations with others (not including spouse or partner)?" Each of these items was rated on a scale from 1 (not at all) to 5 (completely), and averages of two social enjoyment items were computed to yield a social enjoyment score. The within-person correlation between the two items were .43.

Afternoon Social Stress: Afternoon social stress during the prior 2 to 3 hours was assessed via the following diary items: (1) "How stressful were your relations with spouse/partner?" and (2) "How stressful were your relations with others (not including spouse or partner)?" Each of these items was rated on a scale from 1 (not at all) to 5 (completely), and averages of two social stress items were computed to yield a social stress score. The within-person correlation between the two items were .31.

End-of-day Pain: Each evening, participants answered the following question regarding the day's pain intensity: "What was your overall level of pain today? 0= 'no pain' and 100 = 'pain as bad as it can be'" [33].

End-of-day Pain Expectancy: Each evening, participants answered the following question to assess pain expectancy: "How much pain do you expect tomorrow? 0= 'no pain' and 100 = 'pain as bad as it can be'".

Analytic Plan—The analytic plan is identical to that of Study 1 except the Study 2 model includes three-path multilevel mediation, and therefore the mediation effect was tested for its significance.[2] The joint significance test of three path mediation was used to test the mediated effect. Taylor, MacKinnon, and Tein's [55] simulation study demonstrated that a joint significant test of three-path mediated effect is the most convenient method to test a three-path mediated effect with an excellent control of Type I error rates and good statistical power. Use of the test of joint significance for examining the three-path mediated effect requires three paths to be statistically significant at an alpha level of 0.05. These paths are: (1) the effect of the independent variable on the first mediator, (2) the effect of the first mediator on the second mediator, and (3) the effect of the second mediator on the dependent variable. If all three paths are significant at p-value less than 0.05, then a significant indirect (mediated) effect can be inferred.

Results

Participants—Table 1 shows the sample demographic characteristics for Study 2. Participants were primarily female, Caucasian, and middle-aged, with approximately 55.3% of the sample either married or partnered. On average, Study 2 participants completed 1 to 3 years of college, and earned a household income in the range of $40,000 to $59,999.

Of note, Study 1 and Study 2 samples were similar in age, ethnic configuration, education, marital status, and income level. However, the proportion of female participants was

[2]Percentile bootstrap method that provides confidence limits of a three-path mediated effect is not yet available in the multi-level framework.

considerably larger in Study 2 compared to Study 1. This is primarily because of the nature of FM, which is a chronic pain disorder that is predominantly diagnosed among females. In terms of employment status, Study 2 participants had slightly higher employment rates.

Predictors and Outcomes of Evening Pain Expectancy: Findings of MSEM— Figure 3 presents the summary of the MSEM findings, including the standardized path estimates. Model fit indices show good fit to the present data based on Kline [38] and Byrne's [11] model fit criteria, χ^2 (df = 12) = 8.05, p = .78, CFI = 1.00, SRMR-within = .01, SRMR-between = .02 and RMSEA < .01.

As indicated in Figure 3, all exogenous variables (i.e., afternoon pain's activity interference, effectiveness of pain coping, positive affect, negative affect, social enjoyment and stress, and evening pain) were significantly correlated in the expected directions and the correlations ranged from small to moderate level. On afternoons when both positive affect (Standardized B = −.07, SE = .03, p < .01) and pain's activity interference (B = .08, SE = .02, p < .01) were higher than a person's usual, participants reported greater ratings of evening pain expectancy. However, daily variations in both negative affect and effectiveness of pain coping did not significantly predict pain expectancy over and above positive affect and pain's activity interference. Consistent with findings of Study 1, when participants reported a level of pain expectancy that was higher than their usual level in the evening, they also reported greater next morning pain (B = .08, SE = .02, p < .001), over and above evening pain and all afternoon exogenous variables. When controlling for today's afternoon social enjoyment and all afternoon and evening predictor variables, next morning pain uniquely predicted next afternoon social enjoyment (B = −.12, SE = .03, p < .001) but not next afternoon social stress (B = .02, SE = .03, p = .45)

Using joint significant test, we assessed the significant three-path mediation. As indicated in Figure 3, there were two significant three-path mediated effects: (1) Afternoon Pain's Activity Interference → Evening Pain Expectancy → Next Morning Pain Intensity → Next Afternoon Social Enjoyment; and (2) Afternoon Positive Affect → Evening Pain Expectancy → Next Morning Pain Intensity → Next Afternoon Social Enjoyment.

With regard to effect sizes, afternoon affect, pain's activity interference, and effectiveness of pain coping explained 2.2% of variance of evening pain expectancy at the within-person level. In terms of next morning pain, 1.5% of the variance was explained by this evening's pain expectancy at the within-person level. Finally, for the next afternoon's social enjoyment, 1.4% of the variance was explained by the next morning's pain intensity at the within-person level.

Post-hoc Analyses—Post-hoc analyses were conducted to investigate whether the variance shared among predictors could account for the non-significant findings with regard to afternoon negative affect and effectiveness of pain coping as predictors of evening pain expectancy. When the analyses were rerun by adding the predictors of pain expectancy separately, we found that both afternoon negative affect (Standardized B = 0.05, SE = 0.02, p < .05) and effectiveness of pain coping (B = −0.09, SE = 0.02, p < .001) were significant predictors of pain expectancy.

Discussion

The present study sought to test and replicate the unique effect of pain expectancy on subsequent pain via two separate diary studies. In addition, it aimed to extend previous findings by examining the predictors and consequences of variations in day-to-day pain expectancy. As expected, across different chronic pain groups, when participants reported a level of pain expectancy higher than their usual level, they were more likely to experience greater pain intensity the next day, controlling for the effect of today's pain intensity. In Study 2, we found that increases in afternoon pain-related activity interference and positive affect were associated with higher evening pain expectancy. Pain expectancy, in turn, was related to impairments in the next afternoon's social enjoyment as mediated by higher pain intensity experienced the next morning.

The finding that pain expectancy increases subsequent pain intensity has been shown to be consistent and robust across different research designs and samples in addition to present findings (e.g., [1, 10, 21, 49, 59, 68]). A number of neurobiological studies have begun investigating the potential mechanisms underlying this association. For instance, it has been suggested that the hyperalgesic effect of pain expectancy is facilitated through the central activation of the pain matrix [39]. Relatedly, previous findings suggest that when individuals anticipate pain, a number of neural substrates associated with affective and cognitive processing are activated due to increased anxiety [68]. The elevation of anxiety can increase attentional bias in information processing [6, 47], and can therefore result in a more hypervigilant perception of nociceptive stimuli [21, 49]. Pain expectancy may also modulate pain transmission via its effect on neurotransmitter systems. For example, a review on nocebo hyperalgesia posited that pain expectancy can activate the cholecystokininergic system, which increases pain transmission [16]. Likewise, the mechanisms linking pain expectancy and pain experience are very complex and need to be elaborated further. However, it seems quite clear that pain expectancy can serve a unique role in individuals' experience of pain from one day to the next.

The discrepancy between the pain expectancy effect sizes for Study 1 and Study 2 was somewhat surprising. One possibility is the biomedical differences between rheumatoid arthritis (RA) and fibromyalgia (FM). Previous studies show that compared to individuals with FM, individuals with RA show higher levels of state anxiety and hopelessness [13]. This might be one reason that the effect of pain expectancy was larger in RA than FM in the present study. It is also possible that there are far more factors that can contribute to individuals' experience of pain in FM compared to RA--as RA is an autoimmune disorder that has an identifiable pathology, whereas FM is a chronic pain syndrome that does not yet have a clearly established etiology [64]. For example, individuals with FM have shown higher levels of depression, perceived social stigma, HPA-axis disturbances, and lower social support compared to other autoimmune disorders; and these are thought to be associated with higher pain perception [44, 51]. Hence, day-to-day pain variability explained by pain expectancy might be smaller in individuals with FM compared to RA.

As hypothesized, activity interference due to pain was found to predict pain expectancy. The finding is consistent with the self-regulatory framework in that interruption or failure to

achieve meaningful personal goals and having to engage in pain control activities can promote the construction of self-defeating negative schemas [32, 34, 35]. It is plausible that the greater than usual experience of pain interference may undermine individuals' self-efficacy in tolerating or coping with pain, and therefore, they become more pessimistic in their expectations of pain experience.

The finding that higher positive affect was associated with lower pain expectancy is in line with the previous literature that positive affect is an important source of resilience in chronic pain [66]. The broaden-and-build theory [22, 23] also provides a plausible explanation for the relation between positive affect and pain expectancy. According to this theory, positive affect broadens attention and supports cognitive flexibility and mindfulness [15, 27, 23, 24]. In this way, positive affect may promote more flexible cognition allowing people to foresee future pain experiences in a less catastrophic light. In fact, a recent experimental study showed that an increase in positive affect attenuated the impact of pain expectancy on fear of movement-related pain [29].

Contrary to our expectations, neither negative affect nor appraisals of pain coping efficacy emerged as significant predictors of pain expectancy. However, post-hoc analyses revealed that when predictors of pain expectancy were examined one at a time, both negative affect and pain coping efficacy were significant predictors. This phenomenon is not uncommon in regression models. It suggests that positive affect and pain-related activity interference are relatively stronger predictors of pain expectancy than negative affect and pain coping efficacy. Replication is necessary to determine the relative importance of positive affect and pain's activity interference.

In addition to identifying the antecedents of pain expectancy, of particular interest in this study was the indirect effect of expectancy on social enjoyment and stress operating through pain. We found that higher pain expectancy contributed to a subsequent decrease in positive social functioning via increases in pain intensity, but was unrelated to social stress. These findings are consistent with those from a previous diary study, which found that variations in pain predicted reduced engagement in positive interpersonal experiences [54]. Sturgeon et al. [54] also found that days with increased pain were not days with more *negative* social experiences. They speculated that, during times of increased pain, individuals may perseverate on achieving relief from pain at the cost of sustaining their engagement in enjoyable social experiences, but may neither avoid nor provoke more negative interactions.

Studies on pain and motivation provide an interesting point of view in which to consider the present finding (i.e., the association between pain and social enjoyment). When in pain, individuals experience conflict between multiple goals, for example, pain control vs. engaging in important life or social goal (see [14, 52]). Gandhi, Becker, and Schweinhardt [25] found that when individuals are in pain their motivation to obtain a reward increases significantly depending on the incentive level (i.e., higher incentive leads to higher motivation to obtain reward). However, participants' ratings of pleasure during the rewarding stimulation did not significantly change based on the presence of pain [25]. These findings suggest that if the incentive of rewarding goal (e.g., enjoyment gained from social interaction) is much higher than the goal of controlling pain, individuals will be more likely

to pursue the higher incentive goal (i.e., social goal). However, this does not mean that they will gain pleasure from pursuing the social goal when they are in pain. This helps provide a possible explanation for the present finding that although individuals had social experiences, their social enjoyment decreased when in pain. Future studies on pain and motivational dynamics can shed more light on the influence of pain on social functioning by including goal-related measures.

Strengths and Limitations

The present investigation has several strengths. First, we relied on data from ecologically valid daily diaries, allowing for the examination of the spontaneous daily process of pain expectancy as it unfolds in a real-world setting. Second, the unique effects of pain expectancy on subsequent pain intensity were replicated across two different chronic pain samples. In addition, the ratings of perceived pain intensity for both studies were similar to those with other daily diary studies on rheumatoid arthritis and fibromyalgia (e.g., [2, 17, 26]. Hence, the generalizability of our findings is strengthened. Third, we were able to explore both predictors and outcomes of pain expectancy at the within-person level by employing MSEM.

There are, however, several limitations in the present investigation. First, pain expectancy was measured only in the evening, although it is likely that the level of pain expectancy varies over the course of the day. Thus, multiple assessments of pain expectancy in future work may allow for a more nuanced understanding of both factors that influence pain expectancy and of how pain expectancy undermines various aspects of daily functioning of individuals with chronic pain. Second, the pain expectancy measure ("How much pain do you expect tomorrow?") that was used in the present study is not highly specific. Thus, some participants may have interpreted this question as referring to 'overall pain level expected for tomorrow' while others may have interpreted it as 'most intense pain expected for tomorrow'. Development of more specific and comprehensive pain expectancy measures that can be readily used in ecological momentary assessments is called for. Third, although the present study established temporal precedence among the study variables, the effects should not be viewed as causal. Experimental manipulations of key predictors in the mediational chain can more firmly establish that the relations we observed are causal. Last, effect sizes of the present study were overall quite small. However, these effects may accumulate over time, contributing to larger impact over a lifetime of chronic pain.

Clinical Implications

Pain expectancy is a component of our natural defense system. It allows individuals to prevent threat or to protect themselves against potential threat and danger. Therefore, altering the expectancy system will not be easy. However, as the present findings show, helping individuals with chronic pain to slightly disengage from moderate levels of pain expectancy may be beneficial in daily pain management. In that regard, mindfulness-based interventions (MBIs) may be useful with following reasons. First, MBIs have been found to promote positive affect in various samples including individuals with chronic pain (e.g., [30, 66]). Second, a number of meta-analyses have demonstrated that MBIs have large effect size on reducing anxiety [31, 37, 60]. Third, mindfulness training may help individuals interrupt

cognitive biases such as negative expectancies of future pain by increasing the capacity to bring attention back to the present moment. For instance, it was found that participants in the MBI group showed more efficient engagement and disengagement with a pain-related threat compared to those in the control group [58]. Evaluating the efficacy of MBIs in reducing pain expectancy may be a potential avenue for future studies.

Conclusion

Previous research on individuals with chronic pain has established the relation between increases in pain expectancy and subsequent reports of increased pain. Our findings contribute a more nuanced understanding of this relation by identifying not only within-day affective and cognitive factors that predict increased pain expectancy, but also pain expectancy's consequences for subsequent pain experience and social functioning. The results of the study highlight the importance of increasing positive affect and reducing negative expectancies of future pain in order to minimize their detrimental effects on later pain and the enjoyment of social experiences.

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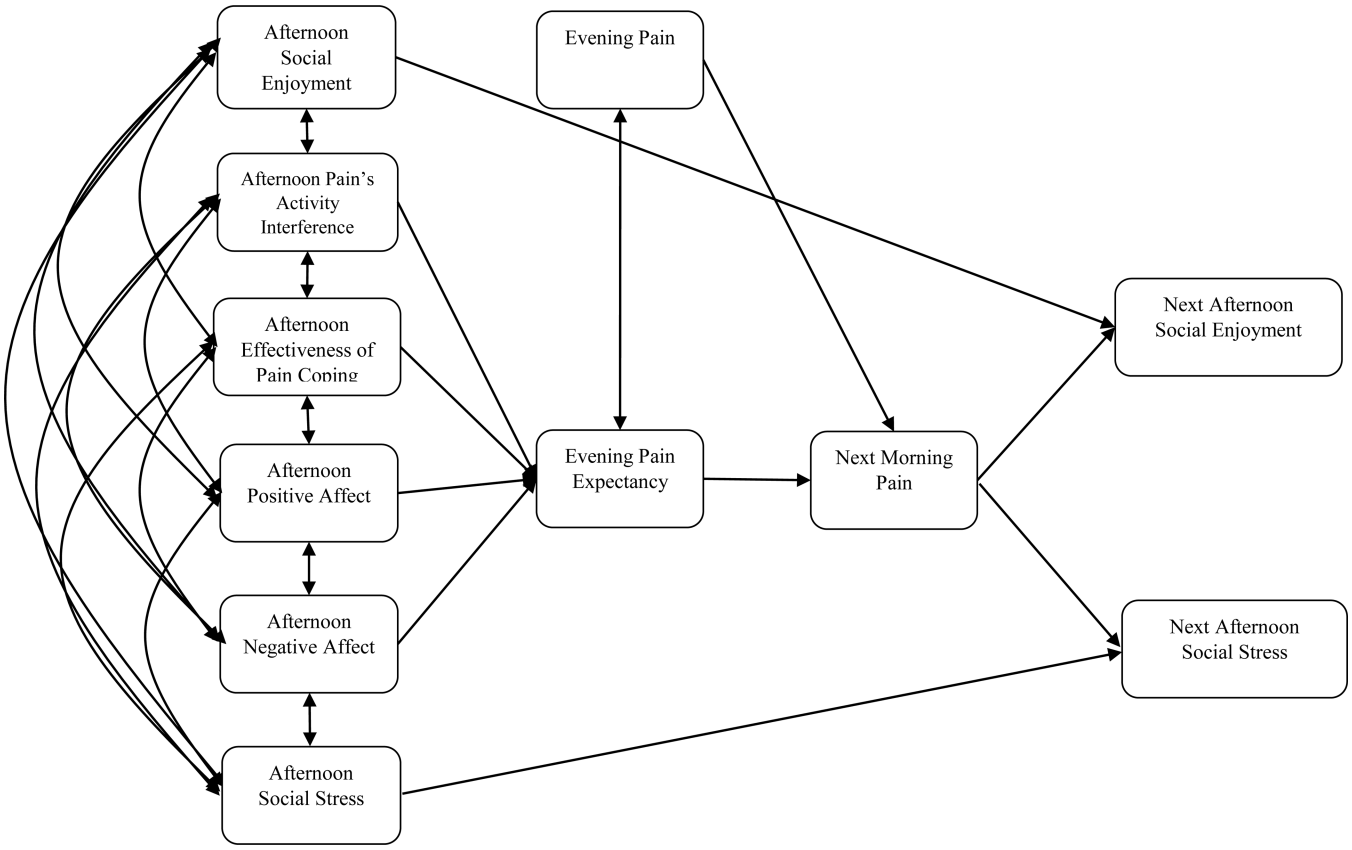

Figure 1. Hypothesized model of Study 2

Note. All the direct paths (e.g., paths from afternoon predictors to next morning pain intensity and next afternoon social enjoyment and stress) are not shown in this figure for visual parsimony. However, they were all specified in the actual model.

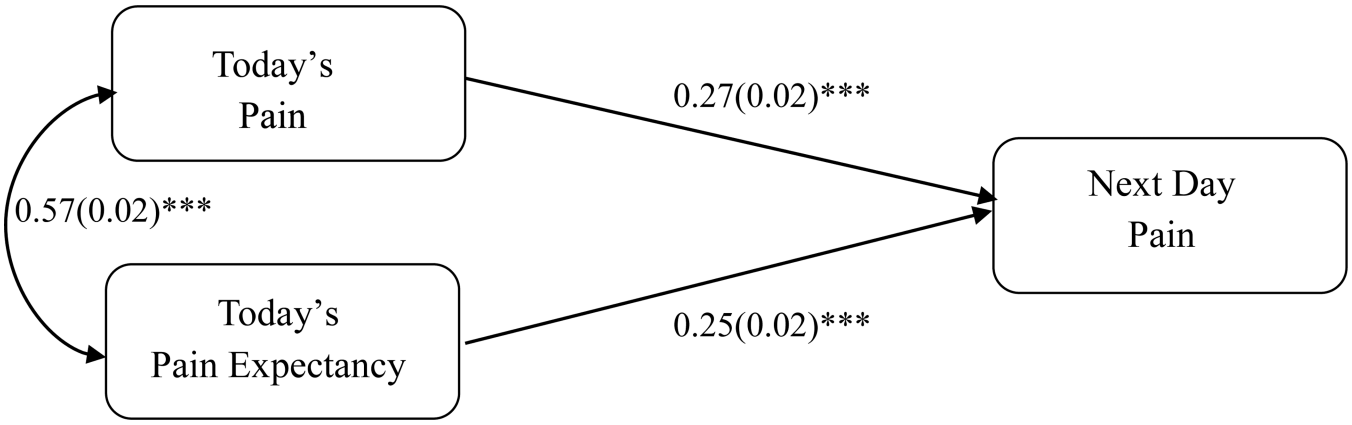

Figure 2. Summary of Study 1 findings

Note. Path estimates are standardized regression coefficients and values in the bracket are standard errors. * $p < .05$, ** $p < .01$, *** $p < .001$;

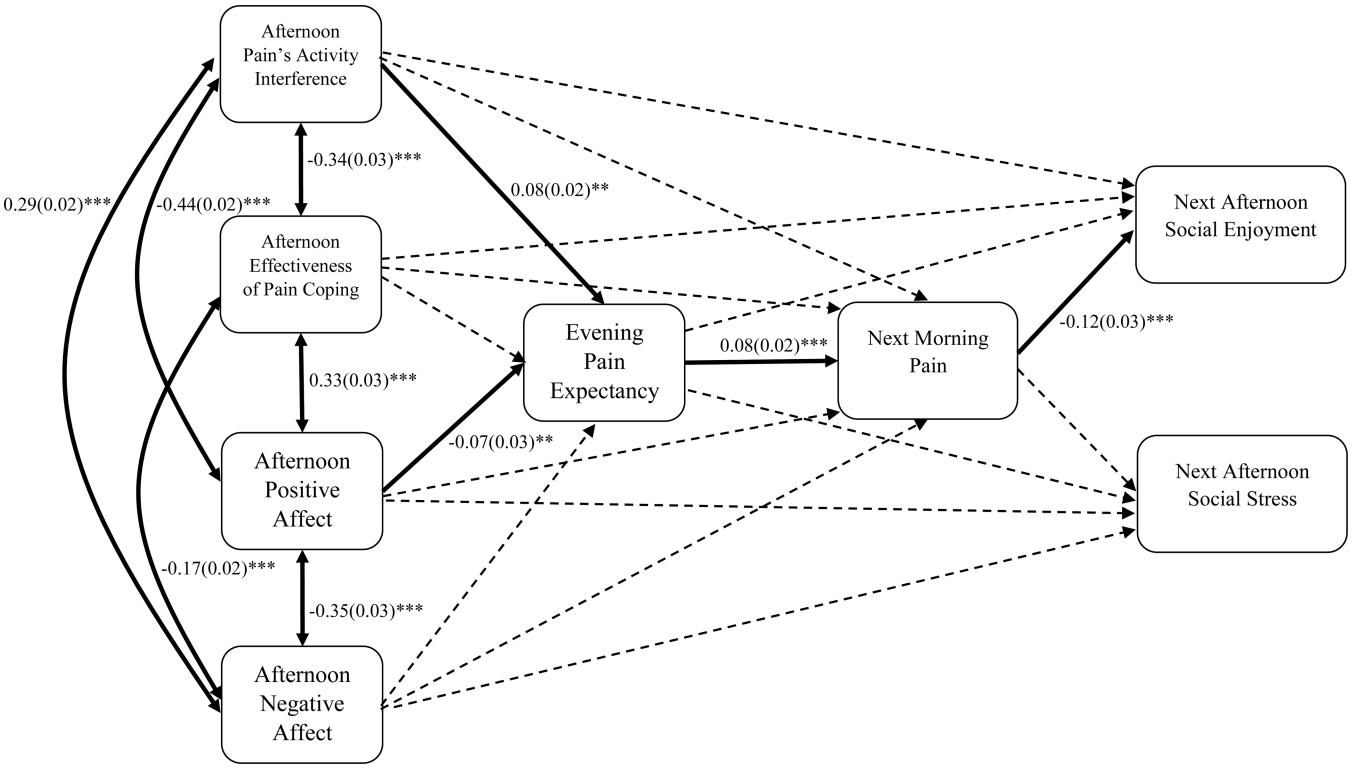

Figure 3. Summary of Study 2 findings

Note. The dashed lines represent non-significant paths. Only significant path estimates were shown here. Path estimates are standardized regression coefficients and values in the bracket are standard errors. Covariates (i.e., afternoon social enjoyment and stress, evening pain intensity) are not shown in this figure for visual parsimony but were included in the actual model.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 1

Sample Characteristics in Study 1 and Study 2

	Mean or % (SD)	
Variables	**Study 1**	**Study 2**
Age (years)	55.31(13.23)	51.25 (11.02)
Gender		
Male	30.3	11.2
Female	69.7	87.0
Education		
Less than high school	5.1	2.2
Completed high school	11.7	13.0
Post high school	13.9	13.4
1–3 years of college	29.0	33.2
4 years of college	17.3	17.5
Post graduate	21.6	17.0
Marital Status		
Never married	6.5	8.1
Married/partnered	63.6	55.3
Widowed	6.1	5.8
Divorced	19.9	27.4
Separated	2.6	1.4
Employment		
Employed	35.9	50.7
Not working	62.3	47.1
Race/Ethnicity		
Caucasian	88.7	78.0
Black/African American	3.0	2.7
Asian	0	1.3
Hispanic	9.1	14.3
Native American	2.2	4.0
Native Hawaiian/Pacific Islander	0.4	0.9
Other	0.4	3.6
Income		
Under $3,000–$20,999	20.8	25.6
$21,000–$39,999	24.2	22.0
$40,000–$59,999	19.9	17.9
$60,000–$99,999	19.9	19.7
$100,000 and over	10.4	8.1

Table 2

Mean, Standard Deviations, Skewness, Kurtosis, ICC, and Reliabilities of Study Variables

Variables	M	SD	Skewness	Kurtosis	ICC	α
Study 1						
Pain	35.18	18.35	0.21	−0.65	0.62	n/a
Pain Expectancy	30.9	19.5	0.29	−0.52	0.75	n/a
Study 2						
Afternoon Positive Affect	2.58	0.66	0.36	0.52	0.53	.66
Afternoon Negative Affect	1.67	0.67	1.35	1.30	0.61	.86
Afternoon Effectiveness of Pain Coping	3.42	0.77	−0.09	0.19	0.42	n/a
Afternoon Pain's Activity Interference	2.69	0.79	−0.17	−0.36	0.41	n/a
Evening Pain	54.07	18.23	−0.29	−0.39	0.53	n/a
Evening Pain Expectancy	43.50	21.95	0.02	−0.58	0.65	n/a
Next Day Morning Pain	48.60	18.15	−0.16	−0.24	0.50	n/a
Next Day Afternoon Social Enjoyment	3.49	1.09	−0.36	−0.54	0.27	n/a
Next Day Afternoon Social Stress	1.78	1.05	1.34	1.23	0.39	n/a

Note. α = Within-person reliability. α was calculated for variables that are composite of more than two items. n/a = Not Applicable.

Table 3

Intercorrelations of Within-Person Variables across All Days

Measures	1	2	3	4	5	6	7	8	9	10	11
Study 1											
1 Pain	-										
2 Pain Expectancy	0.57**	-									
Study 2											
3 Afternoon Pain's Activity Interference			-								
4 Afternoon Pain Coping Efficacy			−.34**	-							
5 Afternoon Positive Affect			−.44**	.34**	-						
6 Afternoon Negative Affect			.29**	−.17**	−.35**	-					
7 Evening Pain Expectancy			.12**	−.09**	−.12**	.05**	-				
8 Evening Pain			.40**	−.26**	−.29**	.18**	.23**	-			
9 Next Morning Pain			.09**	−.06**	−.06**	.01	.12**	.16**	-		
10 Next Afternoon Social Enjoyment			−.06*	.04	.04	−.06*	−.08**	−.05*	−.13**	-	
11 Next Afternoon Social Stress			.01	.01	−.02	.03	.03	−.02	.02	−.30**	-

Note. Study 1, N = 231; Study 2, N = 220;

* p <.05;

** p <.01.