EMOTION REGULATION AND PAIN:
A DAILY PROCESS STUDY OF INDIVIDUALS WITH RHEUMATOID ARTHRITIS

by

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Abstract

Whereas the link between emotions and pain is well-established (e.g., Craig, 1999), the impact of managing emotions is uncertain. The current study used a daily process methodology to investigate the prospective relationship between daily emotion regulation and evening pain intensity. One hundred and seventeen individuals with rheumatoid arthritis took part in an initial background interview, followed by seven days of twice-daily telephone interviews, during which participants were asked about emotions and pain. Results of hierarchical linear modeling indicated that higher levels of daily emotion regulation were associated with significantly less evening pain. Further, maintaining or containing, as well as recovering (from), emotions were each independently associated with significantly less evening pain. Moreover, the current study addressed gaps in the literature by establishing these associations above and beyond the influence of baseline pain intensity and baseline morning emotions, as well as on a subsample of days when higher than average morning pain indicated the presence of undesirable emotions to be regulated. This prospective relationship between emotion regulation and pain intensity was largely driven by regulating depressive emotion, whereas, in previous research, regulating anxious emotion was found to be more influential (Pauqet, Kergoat, & Dubé, 2005). This novel finding underscores the importance of the additional controls applied in the current study. In sum, these findings highlight the importance of investigating the impact of dynamic emotion regulation on the day-to-day pain experiences of individuals with chronic pain and suggest potentially fruitful directions for future pain management interventions.

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Introduction

The inextricable link between mood and pain is a well-established phenomenon in the study of pain (Craig, 1999; Robinson & Riley, 1999). Results demonstrating this link have been obtained over both months and years (e.g., Zautra et al., 1995) as well as within and across days (e.g., Feldman, Downey, & Schaffer-Neitz, 1999; Newth & DeLongis, 2004).

Recently, however, there has been a call in the literature to examine whether the ability to manage (or regulate) moods and emotions also influences the pain experience (Keefe, Lumley, Anderson, Lynch, & Carson, 2001). Results of research investigating this question among individuals with a chronic pain condition have been equivocal (e.g., Hamilton, Zautra, & Reich, 2005, 2007; van Middendorp, Geenen, Sorbi, van Doornen, & Bijlsma, 2005; van Middendorp, Geenen, Sorbi, Hox, et al., 2005).

All of this previous work used one-time, self-report measures of emotion regulation, although, both research and theory suggest that emotions fluctuate considerably within and across days (Stone & Shiffman, 1994; Zautra, Affleck, Tennen, Reich, & Davis, 2005) and that emotion regulation is a dynamic process (Gross, 1998). Repeated and frequent assessments of emotion regulation are, therefore, best able to capture this process. In addition, emotion regulation is consistently defined as occurring both consciously and subconsciously (Diamond & Aspinwall, 2003)[1], thereby necessitating that emotion regulation not be assessed only via direct self-report.

A methodology that addresses these limitations is available, but has yet to be used to investigate the impact of emotion regulation on pain among individuals with a chronic pain condition (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000). Using this methodology, emotion is assessed at multiple points both within and across days, and emotion regulation is

[1] Recent research suggests that unconscious emotion regulation does indeed exist and that, at least as far as anger regulation is concerned, it has beneficial consequences (Mauss, Cook, & Gross, in press), unlike deliberate anger regulation which is associated with considerable psychological and physical costs (e.g., Gross, 2002; Suarez, 2006).

operationalized as maintaining or recovering desirable emotional states over the course of short time periods (i.e., less that one day).

Only one study that we know of has used this methodology to investigate the impact of emotion regulation on pain, albeit among elderly individuals who did not have a chronic pain condition (Paquet, Kergoat, & Dubé, 2005). This study found that emotion regulation was significantly associated with subsequent pain, although this work was not without limitations. First, given the strong associations between pain at the beginning of a short time period and pain at the end of it, as well as the known associations between emotions and pain, it is important to control for these factors in order to establish the independent influence of emotion regulation. Moreover, much of the emotion regulation literature takes an evolutionary perspective, according to which undesirable emotions and potential emotion regulation ensue following emotional cues (e.g., Gross, 1998). It is, therefore, important to determine whether the beneficial impact of emotion regulation on pain also operates when an emotional cue is present.

The current study implemented these controls and examined the prospective influence of emotion regulation on pain among a sample of individuals with rheumatoid arthritis (RA). It was expected that emotion regulation over the course of a day would be associated with significantly less pain at the end of it.

Method

Participants

A list of potential study participants was randomly selected from a database of RA patients registered with the Mary Pack Arthritis Society, a local organization that offers treatment and education to arthritis patients throughout the province of British Columbia, Canada. Individuals who were over the age of 18, living outside the Lower Mainland of British Columbia, and who had sought medical treatment for arthritis within the past two years, were mailed an initial contact letter describing the study and requesting their participation. Interested individuals were screened over the telephone to ensure that they had been diagnosed with RA, had experienced pain due to RA during the past month, and were able to read, write, and speak English. Individuals who contacted our research office regarding participation in the study were entered in a draw for C$1000.[2] In addition, upon completion of the initial background interview, all participants were mailed a small gift valued at C$10.

Initial contact letters were mailed to 800 individuals with arthritis. Of the 188 patients diagnosed with RA who expressed interest in the study, 28 declined to participate prior to additional eligibility screening.[3] Of the 160 who agreed to participate in a telephone screening interview, 120 (75%) met the inclusion criteria and completed both the background and daily interviews. Three of these 120 participants were dropped from the final analyses due to low compliance with daily interviews (i.e., less than 50% of daily interviews completed). Of the 20 respondents who were screened and did *not* meet criteria for the current study, 17 were excluded because they had not experienced RA pain in the past month and 3 were excluded because they

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[2] The initial draw was for C$300. Due to low response rate, the draw value was increased to C$1000 approximately half way through recruitment.

[3] Over the course of the recruitment phase of the study, 85 initial contact letters were returned due to an incorrect mailing address. We were also informed that six of the individuals on our mailing list were deceased, and that 14 had never been diagnosed with RA. We have no way of knowing why the remainder of patients did not respond (i.e., did not receive our letter, were not diagnosed with RA, were deceased, or were not interested in participating). Twenty-eight individuals declined to participate prior to additional eligibility screening due to: having been in too many studies (n = 1), being too ill (n = 3), being too busy (n = 9), or for an unspecified reason (n = 15).

had a medical condition other than RA. Of the 20 respondents who met the inclusion criteria but declined to participate, two indicated that they were too sick, two said that they were too busy or that it was a bad time, and the remaining 16 did not provide a reason.

The final sample consisted of 117 individuals diagnosed with RA. Participants were predominantly female (88%) and Caucasian (83%), ranging in age from 26 to 84 years ($M = 59$, $SD = 13.04$).[4] The number of years since being diagnosed with RA ranged from 1 to 54 ($M = 17$, $SD = 13.30$) and RA-related pain intensity ranged from 0 to 9 ($M = 4.82$, $SD = 1.99$) out of 10 in the week prior to the initial interview. The majority of participants had completed at least a high school education (80%). Twenty-six percent of participants were employed at the time of the study and the modal family income was between C$25 000 and C$49 999.

Procedure

Upon completion of the screening protocol, eligible participants took part in a structured background interview, which was conducted over the telephone and lasted approximately 30 minutes. Brief structured interviews were then administered twice daily for one week again, over the telephone. Daily interviews took place approximately six and twelve hours after participants woke up in the morning and lasted approximately 10 minutes each. The purpose of twice daily interviews was to allow for the examination of fluctuations among study variables within participants over the course of each day. At the beginning of each interview, participants were asked to find a place where they could talk privately. All interviews were conducted by trained female undergraduate and graduate research assistants. Participants were assigned the same interviewer for both the initial and the daily interviews. Interview sessions were tape recorded with the permission of participants. This allowed for later transcription of open ended questions

[4] The higher percentage of women than men in the current study is consistent with the greater prevalence of RA among women (i.e., the overall ratio is 3:1; Anderson, Bradley, Young, McDaniel, & Wise, 1985).

by interviewers as well as supervision of interviewers with regard to the standardized protocol. Participants also completed a brief mail-in questionnaire.

Data for the current study were drawn from a larger prospective study of psychosocial factors among individuals with rheumatoid arthritis and their spouses. Only those measures used in the current study will be discussed here.

Background Interview Measures

Demographics and Disease Status. Participants were asked to provide demographic (e.g., gender, age) and disease status information (e.g., years since diagnosis, fatigue, functional disability). Two key dimensions of *RA-related fatigue* (timing and intensity) were assessed (Belza, 1995). Patients were asked to indicate how often they had experienced fatigue due to their RA during the past week, using a scale from 1 (*never*) to 5 (*all the time*). Intensity of fatigue was assessed by asking patients to rate how fatigued they were during the past week on a scale from 0 (*no fatigue*) to 10 (*fatigue as bad as it could be*). These two measures were then combined to provide an overall fatigue rating with a significant inter-item correlation of .67. *Functional disability* was operationalized as difficulties performing eight daily activities (e.g., dressing oneself, getting in and out of bed, walking) on a scale from 1 (*without any difficulty*) to 4 (*unable to do*). These items were drawn from a modified version of the Health Assessment Questionnaire (MHAQ; Pincus, Summey, Soraci, Wallston, & Hummon, 1983) that is frequently used in the assessment of functional disability among patients with rheumatic diseases. The MHAQ has demonstrated good reliability and validity in past research (e.g., Pincus, et al.) and the inter-item correlation was good in the current study (α = .88).

Daily Interview Measures

During the first interview of the day, participants were asked to reflect on their experiences *so far that day.* During the second interview of the day, participants were asked to reflect on their experiences *since the last time they had spoken with the interviewer.* Most of the

measures used in the daily interviews were brief, modified versions of the original scales. This is common practice among daily process studies, as it reduces the otherwise prohibitive burden placed on participants and increases the number of constructs researchers can assess within a single study protocol (Bolger, Davis, & Rafaeli, 2003; Stone & Neale, 1984; Tennen, Affleck, Coyne, Larsen, & DeLongis, 2006).

Pain Intensity. Participants indicated the intensity of their RA-related pain on a numerical rating scale (NRS) ranging from 0 (*no pain*) to 10 (*pain as bad as it could be*). The NRS has demonstrated good validity in previous research, displaying positive and significant associations with other measures of pain intensity (Jensen, Karoly, & Braver, 1986; Paice & Cohen, 1997).

Emotions. Positive emotion was measured with the contentment subscale, and negative emotions were measured with the depression and anxiety subscales, of the Derogatis Affects Balance Scale (DABS: Derogatis, 1975). Participants were asked to indicate the extent to which each of a set of adjectives (e.g., hopeless, afraid, relaxed) described how they felt "so far today/since we last spoke" on a 5-point Likert scale (0 = *does not apply*, 1 = *not at all*, 2 = *a little*, 3 = *somewhat*, 4 = *a lot*). For all analyses, "0" and "1" responses were collapsed into a single category. The DABS has been found to have good internal consistency in previous research (e.g., Northouse & Swain, 1987) and, in this sample, the internal consistency (α) of each of the three subscales used was .94.

Emotion Regulation. Consistent with previous research (Carstensen et al., 2000; Paquet et al., 2005), emotion regulation was operationalized as maintaining or recovering desirable emotional states over the course of specific time periods. Desirable emotional states were empirically defined as more intense positive emotion or less intense negative emotions than the average intensity reported by each individual across the seven days of assessment. In order to obtain the emotion regulation variables, first, each individual's mean of positive, anxious, and depressive emotions across the seven day sampling period, was calculated, separately for

morning assessments and for evening assessments. Then, for each sampling occasion, positive emotion was classified and dummy coded as either above the individual's mean (1) or at or below it (0). Also, for each sampling occasion, anxious and depressive emotion were each dummy coded 1 if they were below the individual's mean and 0 if they were at the mean or above.

Maintaining positive emotion was operationalized as positive emotion that was above the participant's mean on both measurement occasions in the same day. *Recovering positive emotion* was operationalized as positive emotion that was at or below the individual's mean on the first sampling occasion of the day and above the mean in the evening. *Containing anxious or depressive emotion* was evidenced if either of these were below the participant's mean on both sampling occasions within the same day. *Recovering from anxious or depressive emotion* was assigned if either anxious or depressive emotion was at or above the individual's mean on the first sampling occasion and below the mean by the second sampling occasion. The emotion regulation types were dummy coded 1 if they were determined to have taken place over the course of a day and 0 if they had not.

In addition, six summary scores were calculated. G*lobal emotion regulation* ranged from 0 if none of anxious, depressive, or positive emotion had been regulated on a given day to 3 if all three emotions had been regulated. *Maintaining or containing* anxious, depressive, and positive emotion ranged from 0 if none had occurred to 3 if all had occurred. *Recovering from* anxious and depressive emotion and *recovering* positive emotion ranged from 0 to 3, depending on how many emotions recovery was associated with on a given day. *Regulating anxious*, *regulating depressive*, and *regulating positive emotion* were each assigned a score of 0 if neither maintaining or containing, nor recovering, had occurred on a given day and 1 if either had occurred. These summative scores permitted evaluation of the influence of emotion regulation in

general and for each emotion, as well as evaluation of containing or maintaining and recovering generally, and for each emotion.

One advantage of this measure of emotion regulation is that it avoids relying on individuals' self-reports of their emotion regulation skills, thereby capturing not only changes in emotion that participants could consciously tell us about, but also automatic emotion regulation that may be unavailable for self-report. Also, by defining emotion regulation relative to the individual's own mean of each emotion in the morning and in the evening, only changes in emotion above and beyond the individual's normal daily changes in emotional state are considered.

Results

Overview

In this section, descriptive statistics are presented, followed by bivariate and multi-level regression analyses. The questions addressed using multi-level analyses were: 1) do the number of emotions regulated on any given day play a role in evening pain intensity, 2) do each of maintaining or containing, and recovering, have independent impacts on evening pain intensity, 3) does regulating each of anxious, depressive, and positive emotion play an independent role in evening pain intensity, and 4) are containing or maintaining and recovering (from) each of the emotions significantly and independently associated with evening pain intensity? Finally, these same questions were investigated in a subsample of days on which individuals experienced greater than average morning pain intensity. The purpose of these last analyses was to investigate whether emotion regulation influenced evening pain intensity, not only on an everyday basis, but also in the presence of a cue for undesirable emotion.

Daily Interview Completion and Descriptive Statistics

The completion rate for the daily interviews was high. Of a possible 1638 daily interviews, 98% (n = 1612) were completed. Of the 117 participants, 87% (n = 102) completed all 14 interviews, 8% (n = 9) were missing one interview, 3% (n = 4) were missing two interviews, 1% (n = 1) was missing four interviews, and 1% (n = 1) was missing five interviews.

Means and standard deviations were calculated for daily interview study variables, aggregated across all time points (see Table 1). Participants reported an average level of pain intensity of 4.21 (*SD* = 2.04) in the morning and 3.92 (*SD* = 2.03) in the evening. Average scores for anxiety and depression were 1.33 (*SD* = 0.42) and 1.25 (*SD* = 0.39) in the morning and 1.27 (*SD* = 0.41) and 1.22 (*SD* = 0.40) in the evening, respectively. Average scores for positive emotion were 2.74 (*SD* = 0.58) in the morning and 2.84 (*SD* = 0.58) in the evening. Paired t-tests comparing mean morning and evening levels of study variables revealed that pain intensity,

anxiety, and depression were all significantly higher in the morning, $t(800) = 5.57, p < .001$, $t(799) = 4.17, p < .001$, and $t(799) = 2.24, p < .05$, respectively. Positive emotion was significantly higher in the evening, $t(799) = -4.65, p < .001$.

Table 1. Means and Standard Deviations of Daily Interview Measures (N = 117)

Variable[a]	*Mean (SD)*
Pain Intensity (0-10)	
AM pain	4.21 (2.04)
PM pain	3.92 (2.03)
Anxiety (1-4)	
AM anxiety	1.33 (0.42)
PM anxiety	1.27 (0.41)
Depression (1-4)	
AM depression	1.25 (0.39)
PM depression	1.22 (0.40)
Positive Emotion (1-4)	
AM positive emotion	2.74 (0.58)
PM positive emotion	2.84 (0.58)

[a] Values for each variable were aggregated for each participant across all time points.

Frequencies were calculated for each type of emotion regulation (see Table 2). In terms of the summative emotion regulation scores, there were 171 (21%) days on which there was no emotion regulation, 229 (28%) days on which one emotion was regulated, 231 (28%) days on which two emotions were regulated, and 169 (21%) days on which three emotions were regulated. With respect to containing and maintaining emotions, there were 333 (41%) days on which no emotions were contained or maintained, 251 (31%) days on which one emotion was contained or maintained, 147 (18%) days on which two emotions were contained or maintained, and 69 (8%) days on which three emotions were contained or maintained. There were 470 (57%) days on which there was no recovery, 232 (28%) days on which there was recovery of one emotion, 80 (10%) days on which there was recovery of two emotions, and 18 (2%) days on which there was recovery of three emotions. Anxious emotion was regulated on 409 (50%) days, of which 242 were instances (30%) of containing anxious emotion and 167 were instances (20%) of recovering from anxious emotion. Depressive emotion was regulated on 382 (47%) days, with

256 instances (31%) of containing depressive emotion, and 126 instances (15%) of recovering from depressive emotion. Positive emotion was regulated on 407 (50%) days, composed of 254 days (31%) of maintaining positive emotion and 153 days (19%) of recovering positive emotion.[5]

Table 2. Emotion Regulation Frequencies (N = 819)

Type of Emotion Regulation	#	%
Global emotion regulation		
No emotions regulated	171	21
One emotion regulated	229	28
Two emotions regulated	231	28
Three emotions regulated	169	21
Containing or maintaining		
No emotions contained or maintained	333	41
One emotion contained or maintained	251	31
Two emotions contained or maintained	147	18
Three emotions contained or maintained	69	8
Recovering		
No recovering	470	57
Recovering of one emotion	232	28
Recovering of two emotions	80	10
Recovering of three emotions	18	2
Anxious emotion		
Regulating	409	50
Containing	242	30
Recovering from	167	20
Depressive emotion		
Regulating	382	47
Containing	256	31
Recovering from	126	15
Positive emotion		
Regulating	407	50
Maintaining	254	31
Recovering	153	19

[5] There were 819 person-days in the sample and 19 person-days on which emotion regulation data was missing.

Bivariate Analyses

Correlations were calculated among morning pain intensity, evening pain intensity, and the emotion regulation variables. Only morning pain intensity was significantly associated with evening pain intensity, $r = .92, p < .001$, highlighting the importance of controlling morning pain intensity in the multi-level regression analyses. The lack of significant association between evening pain intensity and all of the emotion regulation variables is noteworthy. However, Pearson product moment correlations cannot be interpreted in the context of daily diary data because they do not control for dependence in the data or for within- and between-person variance. Given this, we analyzed our data using multi-level modeling.

Multi-level Regression Analyses

Multi-level regression analyses were conducted using hierarchical linear modeling (HLM) software (v6.0; Raudenbush, Bryk, Cheong, & Congdon, 2004). One of the idiosyncrasies of daily diary studies is that there are necessarily at least two levels of data (days and individuals) one of which (days) is nested within the other (individuals). Data from daily diary studies is also characterized by dependence due to repeated sampling. Multi-level analyses conducted in HLM take these characteristics of the data into account and produce results that are unbiased by these features, as well as by missing data (Raudenbush et al., 2004; Schwartz & Stone, 1998).

In multi-level regression analyses, within-person variation is modeled at Level 1 and between-person variation is modeled at Level 2, such that variation at both levels can be examined concurrently. In the Level 1 specification of within-person variation, separate regression slopes and intercepts are estimated for each person. In the Level 2 specification of between-person variation, the Level 1 regression parameters are used to estimate average parameter estimates across all subjects as well as the amount of variation around this average.

In the current study, variables derived from daily interviews (e.g., pain, emotion regulation) were entered at Level 1 and measures that were collected during the initial interview, for which there was a single value for each participant (e.g., gender, functional disability), were entered at Level 2. Random intercept models were specified for all analyses (i.e., intercepts for each dependent variable were left free to vary), such that findings can be generalized to the population of participants and days from which the sample and assessments respectively were drawn.[6] Continuous Level 1 predictor variables were centered on the mean of each individual's score over the course of the study in order to ease parameter estimation by reducing correlations among slopes and intercepts (Nezlek, 2001). Further, for each person-centered continuous Level 1 predictor variable, the within-person aggregate mean of the variable was entered at Level 2. This ensured that treatment of the intercepts as random factors did not bias the coefficients of the within-person factors (Schwartz & Stone, 1998). Slope coefficients in these models can be interpreted as the increase or decrease in the dependent variable, at average levels of the continuous variables and in the condition designated as 0 for the dichotomous variables that were included in each model (Raudenbush & Bryk, 2002).

First, in order to examine the proportion of between- and within-person variance in the dependent variable, the following null model was run for evening pain intensity:

$$\text{Level 1:} \quad Y_{ij}(\text{PM Pain}) = b_{0j} + r_{ij}$$

$$\text{Level 2:} \quad b_{0j} = \gamma_{00} + u_{0j}$$

This model specifies evening pain intensity (Y) at time point i for individual j as a function of b_{0j} and r_{ij}. Level 2 specifies that the Level 1 intercept (b_{0j}) is composed of the grand sample mean of evening pain intensity across all participants and all evening time points (γ_{00}), plus the between-person residual parameter (u_{0j}), which is the difference between the grand sample mean and an

[6] Both intercepts and slopes were initially modeled as random. However, in order to get models to converge, it was necessary to fix the slope coefficients (Nezlek, 2001).

individual's own mean across all evening time points. The within-person residual parameter (r_{ij}) represents the difference between an individual's own mean across all time points and their level of pain intensity on a particular evening. This null model indicated that participants varied significantly in their average level of evening pain across the study period, $\chi^2(116) = 2082.02$, $p < .001$. The intraclass correlation coefficient (ICC) was estimated based on this model, and revealed that 71% of the variance in evening pain intensity was attributable to differences between individuals, whereas, 29% of the variance was attributable to differences within individuals.

In order to determine which variables to include at Level 2 in the models, the exploratory analysis (Level 2) function of HLM was used. This provides a *t*-to-enter statistic for each potential Level 2 variable, based on which it is possible to determine which Level 2 variables will be significant in a given model (Raudenbush & Bryk, 2002). The demographic variables tested were: gender, age, ethnicity, and education. The disease status variables tested were: years since diagnosis, average fatigue in the week prior to the background interview, and functional disability. Besides these demographic and disease status variables, between-person differences in emotional lability were tested in order to determine whether they should be controlled in subsequent analyses. Emotional lability was operationalized as the within-person coefficient of variation for each of anxious, depressive, and positive emotion. Consistent with recommended multilevel model specification, only variables with a *t*-to-enter statistic greater than 1.96 or less than -1.96 were retained as control variables in the final models predicting evening pain intensity (Kreft & de Leeuw, 1998).

Does number of emotions regulated influence evening pain intensity? First, a model was specified predicting evening pain intensity from global emotion regulation.[7] Results indicated

[7] The control variables included in this model were average fatigue in the week prior to the background interview, functional disability, and lability of positive emotion.

that the number of emotions regulated over the course of a given day was significantly and negatively associated with evening pain intensity, $b = -0.31$, $t(795) = -6.15$, $p < .001$ (see Table 3, model 1). This replicated previous findings (Paquet et al., 2005).

Next, morning pain as well as morning anxious, depressive and positive emotion were added to the model such that the final model can be expressed as:

Level 1: $Y_{ij}(\text{PM Pain}) = b_{0j} + b_{1j}(\text{AM Pain}) + b_{2j}(\text{AM Anxiety}) + b_{3j}(\text{AM Depression}) + b_{4j}(\text{AM Positive Emotion}) + b_{5j}(\text{Global Emotion Regulation}) + r_{ij}$

Level 2: $b_{0j} = \gamma_{00} + \gamma_{01}(\text{Age}) + \gamma_{02}(\text{Within-Person Aggregate Mean of AM Pain}) + \gamma_{03}(\text{Within-Person Aggregate Mean of AM Anxiety}) + \gamma_{04}(\text{Within-Person Aggregate Mean of AM Depression}) + \gamma_{05}(\text{Within-Person Aggregate Mean of AM Positive Emotion}) + u_{0j}$

$b_{1j} = \gamma_{10}$

$b_{2j} = \gamma_{20}$

$b_{3j} = \gamma_{30}$

$b_{4j} = \gamma_{40}$

$b_{5j} = \gamma_{50}$

At Level 1, evening pain intensity on any given day (Y_{ij}(PM Pain)) was specified as a function of the individual's average evening pain intensity across all days (b_{0j}), the main effects of morning pain intensity (b_{1j}), morning anxious emotion (b_{2j}), morning depressive emotion (b_{3j}), morning positive emotion (b_{4j}), and number of emotions regulated (b_{5j}), as well as that day's deviation from the average (r_{ij}). At Level 2, the Level 1 intercept (b_0) for any person (j) was specified as a function of the average intercept (mean pain intensity) across persons (γ_{00}), age, average morning pain, average morning anxious emotion, average morning depressive emotion, and average morning positive emotion across the week, their respective regression coefficients, (γ_{01}, γ_{02}, γ_{03},

γ_{04}, γ_{05}), and a random component (u_{0i}). Results indicated that higher levels of emotions regulated on a given day were significantly associated with less evening pain, $b = -0.21$, $t(789) = -4.40$, $p < .001$, above and beyond the significant effect of morning pain intensity, $b = 0.33$, $t(789) = 5.82$, $p < .001$ (see Table 3, model 2).

Table 3. Associations of Global Emotion Regulation with Evening Pain Intensity

Model	*b*	*SE*
1. No controls at Level 1	-0.31*	0.05
2. Controlling baseline pain and emotions	-0.21*	0.05
3. High morning pain days only	-0.30*	0.07

Note. *$p < .001$.

Are both types of emotion regulation (maintaining or containing and recovering) prospectively associated with evening pain intensity? In this model, evening pain intensity was predicted from recovering from anxious and depressive emotion and of positive emotion, as well as from containing anxious and depressive emotion and maintaining positive emotion.[8] Consistent with previous findings (Paquet et al., 2005), both maintaining or containing as well as recovering were significantly and negatively associated with evening pain, $b = -0.34$, $t(794) = -6.35$, $p < .001$ and $b = -0.24$, $t(794) = -3.52$, $p < .01$, respectively (see Table 4, model 1).

Next, morning pain and morning emotions were added to the model such that the final model can be expressed as:

Level 1: $Y_{ij}(\text{PM Pain}) = b_{0j} + b_{1j}(\text{AM Pain}) + b_{2j}(\text{AM Anxiety}) + b_{3j}(\text{AM Depression}) + b_{4j}(\text{AM Positive Emotion}) + b_{5j}(\text{Recovering}) + b_{6j}(\text{Containing/Maintaining}) + r_{ij}$

Level 2: $b_{0j} = \gamma_{00} + \gamma_{01}(\text{Age}) + \gamma_{02}(\text{Within-Person Aggregate Mean of AM Pain}) + \gamma_{03}(\text{Within-Person Aggregate Mean of AM Anxiety}) + \gamma_{04}(\text{Within-Person Aggregate Mean of AM Depression}) + \gamma_{05}(\text{Within-Person Aggregate Mean of AM Positive Emotion}) + u_{0j}$

[8] The control variables included in this model were average fatigue in the week prior to the background interview, functional disability, and lability of positive emotion.

$b_{1j} = \gamma_{10}$

$b_{2j} = \gamma_{20}$

$b_{3j} = \gamma_{30}$

$b_{4j} = \gamma_{40}$

$b_{5j} = \gamma_{50}$

$b_{6j} = \gamma_{60}$

At Level 1, evening pain intensity on any given day (Y_{ij}(PM Pain)) was specified as a function of the individual's average evening pain intensity across all days (b_{0j}), the main effects of morning pain intensity (b_{1j}), morning anxious emotion (b_{2j}), morning depressive emotion (b_{3j}), morning positive emotion (b_{4j}), the number of emotions for which recovery occurred (b_{5j}), the number of emotions that were contained or maintained (b_{6j}), and that day's deviation from the average (r_{ij}). At Level 2, the Level 1 intercept (b_0) for any person (j) was specified as a function of the average intercept (mean pain intensity) across persons (γ_{00}), age, average morning pain, average morning anxious emotion, average morning depressive emotion, average morning positive emotion across the week, their respective regression coefficients ($\gamma_{01}, \gamma_{02}, \gamma_{03}, \gamma_{04}, \gamma_{05}$), and a random component (u_{0i}). Results indicated that the greater the number of emotions that were contained or maintained, and the greater the number of emotions for which recovery occurred, were each significantly associated with lower evening pain, b = -0.22, $t(788)$ = -3.61, $p < .01$ and b = -0.21, $t(788)$ = -3.12, $p < .01$, above and beyond the significant effect of morning pain intensity, b= 0.33, $t(788)$ = 5.84, $p < .001$ (see Table 4, model 2).

Table 4. Associations of Maintaining or Containing, and Recovering, with Evening Pain Intensity

Model	*b*	*SE*
1. No controls at Level 1		
Maintaining or containing	-0.34***	0.05
Recovering	-0.24**	0.07
2. Controlling baseline pain and emotions		
Maintaining or containing	-0.22**	0.06
Recovering	-0.21**	0.07
3. High morning pain days only		
Maintaining or containing	-0.38***	0.09
Recovering	-0.23*	0.09

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

Does regulating different emotions (anxious, depressive, and positive) have an influence on evening pain intensity? In order to answer this question, a model was specified in which evening pain intensity was predicted from regulation of anxious, depressive, and positive emotion.[9] Consistent with previous research (Paquet et al., 2005), regulating anxious emotion was a significant predictor of evening pain intensity, b= -0.28, $t(793) = -2.04$, $p < .05$. In the current study, however, regulating depressive emotion over the course of a day was also significantly associated with less evening pain, b= -0.59, $t(793) = -4.39$, $p < .001$. Regulating positive emotion was not a significant predictor in this model (see Table 5, model 1).

Next, morning pain as well as morning anxious, depressive, and positive emotion were added to the model such that the final model can be expressed as:

Level 1: Y_{ij}(PM Pain) = b_{0j} + b_{1j}(AM Pain) + b_{2j}(AM Anxiety) + b_{3j}(AM Depression) + b_{4j}(AM Positive Emotion) + b_{5j}(Anxiety Regulation) + b_{6j}(Depression Regulation) + b_{7j}(Regulation of Positive Emotion) + r_{ij}

Level 2: $b_{0j} = \gamma_{00} + \gamma_{01}$(Age) + γ_{02}(Within-Person Aggregate Mean of AM Pain) + γ_{03}(Within-Person Aggregate Mean of AM Anxiety) + γ_{04}(Within-Person

[9] The control variables included in this model were average fatigue in the week prior to the background interview, functional disability, and lability of positive emotion.

Aggregate Mean of AM Depression) + γ_{05}(Within-Person Aggregate Mean of AM Positive Emotion) + u_{0j}

$b_{1j} = \gamma_{10}$

$b_{2j} = \gamma_{20}$

$b_{3j} = \gamma_{30}$

$b_{4j} = \gamma_{40}$

$b_{5j} = \gamma_{50}$

$b_{6j} = \gamma_{60}$

$b_{7j} = \gamma_{70}$

At Level 1, evening pain intensity on any given day (Y_{ij}(PM Pain)) was specified as a function of the individual's average evening pain intensity across all days (b_{0j}), the main effects of morning pain intensity (b_{1j}), morning anxious emotion (b_{2j}), morning depressive emotion (b_{3j}), morning positive emotion (b_{4j}), regulating anxious emotion (b_{5j}), regulating depressive emotion (b_{6j}), regulating positive emotion (b_{7j}) and that day's deviation from the average (r_{ij}). At Level 2, the Level 1 intercept (b_0) for any person (j) was specified as a function of the average intercept (mean pain intensity) across persons (γ_{00}), age, average morning pain, average morning anxious emotion, average morning depressive emotion, average morning positive emotion across the week, their respective regression coefficients ($\gamma_{01}, \gamma_{02}, \gamma_{03}, \gamma_{04}, \gamma_{05}$), and a random component (u_{0i}). Results indicated that after controlling for the significant effect of morning pain intensity, b = 0.33, $t(787) = 5.94$, $p < .001$, regulating depressive emotion remained the only significant predictor of evening pain intensity, b = -0.39, $t(787) = -3.25$, $p < .01$ (see Table 5, model 2).

Table 5. Associations of Regulating Anxious, Depressive, and Positive Emotion with Evening Pain Intensity

Model	*b*	*SE*
1. No controls at Level 1		
Regulating anxious emotion	-0.28*	0.14
Regulating depressive emotion	-0.59***	0.13
Regulating positive emotion	-0.34	0.10
2. Controlling baseline pain and emotions		
Regulating anxious emotion	-0.14	0.11
Regulating depressive emotion	-0.39**	0.12
Regulating positive emotion	-0.14	0.09
3. High morning pain days only		
Regulating anxious emotion	-0.25	0.17
Regulating depressive emotion	-0.39*	0.15
Regulating positive emotion	-0.27	0.15

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

Are containing or maintaining, and recovering (from), each of the emotions significantly and independently associated with evening pain intensity? First, consistent with previous research (Paquet et al., 2005), a model was specified in which containing anxious, recovering from anxious, containing depressive, recovering from depressive, maintaining positive, and recovering positive emotion were all included as predictors of evening pain intensity.[10] Containing anxious emotion, as well as containing and recovering from depressive emotion were significantly associated with evening pain intensity, b= -0.31, $t(790) = -2.13$, $p < .05$, $b = -0.63$, $t(790) = -4.40$, $p < .001$, and b= -0.49, $t(790) = -3.00$, $p < .01$, respectively (see Table 6, model 1).

Next, morning pain and morning emotions were added to the model such that the final model can be expressed as

Level 1: $Y_{ij}(\text{PM Pain}) = b_{0j} + b_{1j}(\text{AM Pain}) + b_{2j}(\text{AM Anxiety}) + b_{3j}(\text{Containing Anxiety}) + b_{4j}(\text{Recovering from Anxiety}) + b_{5j}(\text{AM Depression}) + b_{6j}(\text{Containing}$

[10] The control variables included in this model were average fatigue in the week prior to the background interview, functional disability, and lability of positive emotion.

Depression) + b_{7j}(Recovering from Depression) + b_{8j}(AM Positive Emotion) + b_{9j}(Maintaining Positive Emotion) + b_{10j}(Recovering Positive Emotion) + r_{ij}

Level 2: $b_{0j} = \gamma_{00} + \gamma_{01}$(Age) + γ_{02}(Within-Person Aggregate Mean of AM Pain) + γ_{03}(Within-Person Aggregate Mean of AM Anxiety) + γ_{04}(Within-Person Aggregate Mean of AM Depression) + γ_{05}(Within-Person Aggregate Mean of AM Positive Emotion) + u_{0j}

$b_{1j} = \gamma_{10}$

$b_{2j} = \gamma_{20}$

$b_{3j} = \gamma_{30}$

$b_{4j} = \gamma_{40}$

$b_{5j} = \gamma_{50}$

$b_{6j} = \gamma_{60}$

$b_{7j} = \gamma_{70}$

$b_{8j} = \gamma_{80}$

$b_{9j} = \gamma_{90}$

$b_{10j} = \gamma_{100}$

At Level 1, evening pain intensity on any given day (Y_{ij}(PM Pain)) was specified as a function of the individual's average evening pain intensity across all days (b_{0j}), the main effects of morning pain intensity (b_{1j}), morning anxious emotion (b_{2j}), containing anxious emotion (b_{3j}), recovering from anxious emotion (b_{4j}), morning depressive emotion (b_{5j}), containing depressive emotion (b_{6j}), recovering from depressive emotion (b_{7j}), morning positive emotion (b_{8j}), maintaining positive emotion (b_{9j}), recovering positive emotion (b_{10j}), and that day's deviation from the average (r_{ij}). At Level 2, the Level 1 intercept (b_0) for any person (j) was specified as a function of the average intercept (mean pain intensity) across persons (γ_{00}), age, average morning pain,

average morning anxious emotion, average morning depressive emotion, average morning positive emotion across the week, their respective regression coefficients ($\gamma_{01}, \gamma_{02}, \gamma_{03}, \gamma_{04}, \gamma_{05}$), and a random component (u_{0i}). Results indicated that, above and beyond the significant effect of morning pain intensity, $b = 0.33$, $t(784) = 5.90$, $p < .001$, only containing and recovering from depressive emotion were significantly associated with decreased evening pain intensity, $b = -0.37$, $t(784) = -2.62$, $p < .01$ and $b = -0.40$, $t(784) = -2.81$, $p < .01$, respectively. Containing anxious emotion ceased to be a significant predictor in this model (see Table 6, model 2).

Table 6. Associations of Containing or Maintaining, and Recovering (from) each of the Emotions with Evening Pain Intensity

Model	*b*	*SE*
1. No controls at Level 1		
Containing anxious emotion	-0.31*	0.14
Recovering from anxious emotion	-0.24	0.16
Containing depressive emotion	-0.63***	0.14
Recovering from depressive emotion	-0.49**	0.16
Maintaining positive emotion	-0.16	0.11
Recovering positive emotion	-0.07	0.13
2. Controlling baseline pain and emotions		
Containing anxious emotion	-0.20	0.12
Recovering from anxious emotion	-0.07	0.15
Containing depressive emotion	-0.37**	0.14
Recovering from depressive emotion	-0.40**	0.14
Maintaining positive emotion	-0.10	0.12
Recovering positive emotion	-0.18	0.12
3. High morning pain days only		
Containing anxious emotion	-0.41*	0.19
Recovering from anxious emotion	-0.11	0.22
Containing depressive emotion	-0.43*	0.20
Recovering from depressive emotion	-0.33#	0.17
Maintaining positive emotion	-0.29	0.19
Recovering positive emotion	-0.26	0.18

Note. #$p = .051$, *$p < .05$, **$p < .01$, ***$p < .001$.

Are results the same when a cue for undesirable emotion is present? The analyses conducted thus far are consistent with a lifespan developmental perspective of emotion regulation, which views emotion regulation as an everyday process. Research conducted from this perspective has generally been concerned with self-supported maintenance of desirable

emotional states and recovery from undesirable states in the context of normal daily situations (Diamond & Aspinwall, 2003; Paquet et al., 2005). In contrast, researchers who take an evolutionary approach to emotion regulation have been more inclined to use experimental designs in order to manipulate emotion to ensure that there is an undesirable emotional state available to be regulated (e.g., Gross & Levenson, 1997; Mauss, Cook, & Gross, in press). In order to take into account both of these approaches, the preceding questions were re-examined in a limited sample of days on which morning pain intensity was higher than the individual's own average across the seven sampling days. Because morning pain intensity was significantly associated with higher morning anxious emotion and depressive emotion as well as with lower morning positive emotion, $r(115) = .29, p < .01$, $r(115) = .36, p < .001$, and $r(115) = -.33, p < .001$, respectively, these cases represent instances during which an emotional cue was more likely to have been present with respect to which emotion regulation could have been employed. The advantage of the current blended approach is that it includes a control for undesirable emotional state, which is particularly relevant in the context of the fluctuating symptoms and associated emotions of rheumatoid arthritis (Smith & Wallston, 1992), as well as maintaining the ecological validity of assessing pain and emotions in the context of the participants' everyday lives.

Applying this control resulted in a reduced data set composed of 116 participants and 380 days of data. In this sample, the descriptive statistics for the daily pain and emotion variables were identical to those in the full dataset except that average morning pain intensity was 4.22 ($SD = 2.05$) and average evening pain intensity was 3.93 ($SD = 2.03$). A paired t-test revealed that pain intensity was significantly higher in the morning than in the evening, $t(365) = 12.58, p < .001$.

Of the possible 380 sampling days during which various types of emotion regulation could have been exhibited, there were 96 (25%) days on which there was no emotion regulation,

105 (28%) days on which one emotion was regulated, 97 (26%) days on which two emotions were regulated, and 68 (18%) days on which three emotions were regulated. With respect to containing or maintaining emotions, there were 180 (48%) days on which no emotions were contained or maintained, 110 (29%) days on which one emotion was contained or maintained, 56 (15%) days on which two emotions were contained or maintained, and 20 (5%) days on which three emotions were contained or maintained. There were 202 (53%) days on which there was no recovery, 119 (31%) days on which there was recovery of one emotion, 33 (9%) days on which there was recovery of two emotions, and 12 (3%) days on which there was recovery of three emotions. Anxious emotion was regulated on 175 (46%) days, of which there were 97 instances (26%) of containing and 78 instances (21%) of recovering. Depressive emotion was regulated on 161 (42%) days, including 93 instances (25%) of containing and 68 instances (18%) of recovering. Finally, positive emotion was regulated on 167 (44%) days. There were 92 instances (24%) of maintaining positive emotion and 75 instances (20%) of recovering positive emotion (see Table 7).[11]

[11] There were 14 person-days on which emotion regulation variables were missing.

Table 7. Emotion Regulation Frequencies: High Morning Pain Days (N = 380)

Type of Emotion Regulation	#	%
Global emotion regulation		
No emotions regulated	96	25
One emotion regulated	105	28
Two emotions regulated	97	26
Three emotions regulated	68	18
Containing or maintaining		
No emotions contained or maintained	180	48
One emotion contained or maintained	110	29
Two emotions contained or maintained	56	15
Three emotions contained or maintained	20	5
Recovering		
Recovering of one emotion	202	53
Recovering of two emotions	119	31
Recovering of three emotions	33	9
Recovering of one emotion	12	3
Anxious emotion		
Regulating	175	46
Containing	97	26
Recovering from	78	21
Depressive emotion		
Regulating	161	42
Containing	93	25
Recovering from	68	18
Positive emotion		
Regulating	167	44
Maintaining	92	24
Recovering	75	20

As in the full dataset, bivariate correlations indicated that morning pain intensity was significantly associated with evening pain intensity, $r = .86, p < .001$, whereas, there were no significant associations between evening pain intensity and any of the emotion regulation variables. This is, again, noteworthy but not necessarily indicative of a lack of significant influence of emotion regulation on evening pain intensity.

The null model for this dataset indicated that participants varied significantly in their average level of evening pain across the study period, $\chi^2(115) = 1071.30, p < .001$. The intraclass correlation coefficient (ICC) was estimated based on this model, and revealed that 72% of the

variance in evening pain intensity was attributable to differences between individuals, whereas, 28% of the variance was attributable to differences within individuals.

Consistent with the results obtained in the full dataset, higher numbers of emotions regulated on a given day were significantly associated with decreased evening pain, $b = -0.30$, $t(355) = -4.61$, $p < .001$, above and beyond the significant influence of morning pain intensity, $b = 0.30$, $t(355) = 2.55$, $p < .05$ (Table 3, model 3).[12] Likewise, each of maintaining or containing as well as recovering was independently associated with decreased evening pain, $b = -0.38$, $t(354) = -4.22$, $p < .001$ and $b = -0.23$, $t(354) = -2.54$, $p < .05$, respectively, above and beyond the significant influence of both morning pain intensity and morning anxious emotion, $b = 0.30$, $t(354) = 2.51$, $p < .05$ and $b = -0.56$, $t(354) = -2.05$, $p < .05$, respectively (Table 4, model 3). Also, consistent with previous analyses controlling for morning pain and morning emotions in the full sample, regulating anxious emotion was not a significant predictor of evening pain intensity and regulating depressive emotion was significantly associated with decreased evening pain, $b = -0.39$, $t(353) = -2.55$, $p < .05$, in this subsample. Regulating positive emotion remained nonsignificant in this model. Results concerning the effects of regulating anxious, depressive, and positive emotion were above and beyond the significant influence of morning pain intensity, $b = 0.30$, $t(353) = 2.55$, $p < .05$ (Table 5, model 3). Finally, above and beyond the significant effects of morning pain intensity and morning anxious emotion, $b = 0.29$, $t(350) = 2.44$, $p < .05$ and $b = -0.65$, $t(350) = -2.02$, $p < .05$, respectively, and consistent with analyses in the full sample, containing depressive emotion was significantly associated with less evening pain, $b = -0.43$, $t(350) = -2.20$, $p < .05$. Recovering from depressive emotion dropped to a trend level of significance, $b = -0.33$, $t(350) = -1.95$, $p = .051$. Contrary to analyses using the full sample, containing anxious emotion was also significantly associated with decreased evening pain in the

[12] Age was the only significant demographic factor, disease factor, or emotional lability variable in this and all other models using the high morning pain subsample.

high morning pain subsample, $b = -0.41$, $t(350) = -2.22$, $p < .05$. None of recovering from anxious emotion, maintaining positive emotion, or recovering positive emotion was significantly associated with evening pain in this subsample (Table 6, model 3).

Conclusions

The purpose of the current study was to investigate the associations between daily emotion regulation and daily pain among individuals with chronic pain. Overall, emotion regulation had a prospective influence on pain intensity. This was the case for both number of emotions regulated over the course of the day, as well as for each of maintaining or containing, and recovering, independently. We also found that the influence of emotion regulation on subsequent pain was largely driven by regulating, specifically containing, depressive emotion.

The overall finding that emotion regulation influences subsequent pain intensity is consistent with a previous finding that emotion regulation, assessed using a cross-sectional design with a self-report measure, was prospectively associated with perceived disease activity, including pain, at a one-and-a-half year follow-up among individuals with rheumatoid arthritis (van Middendorp, Geenen, Sorbi, van Doornen, et al., 2005). This, and the finding that each of maintaining and recovering desirable emotional states had independent influences on subsequent pain, was also consistent with another study which found, using the same empirically derived measures of emotion regulation that are used in the current study, that daily emotion regulation influenced subsequent pain among a sample of elderly individuals who had not been diagnosed with a chronic pain condition (Paquet et al., 2005). Generally, these findings support the neuromatrix theory of pain, which posits that regulation of emotional inputs affects the resultant pattern of pain outputs (Melzack, 1999).

The current study goes beyond the findings of previous research by controlling for baseline morning pain intensity as well as for baseline morning emotions *per se*. Morning pain intensity is significantly associated with evening pain intensity, and there is a well-established link between emotions and pain. So, it is crucial to determine that the associations of emotion regulation with subsequent pain are above and beyond the influence of these baseline factors. Another advantage of the current study is that it is the first that we know of to apply these

empirically derived measures of emotion regulation to the investigation of emotion regulation among a population of individuals experiencing chronic pain.

Our findings indicate that, even after controlling for baseline pain and emotions, as well as when the analyses were implemented on a subset of days on which a cue for undesirable emotions was present, overall emotion regulation, as well as each of maintaining and recovering desirable emotional states, were significantly associated with less subsequent pain. However, our additional controls lead to novel findings when emotion regulation is disaggregated by emotion, as well as when it is disaggregated by emotion and type of regulation. In the first instance, when we implemented our analyses without the controls, both regulating anxious emotion and regulating depressive emotion were significantly associated with decreased evening pain intensity. However, both when we controlled for baseline morning pain and emotions, as well as when we conducted the analyses on the subsample of days when morning pain was higher than average, only regulating depressive emotion was significantly associated with subsequent pain intensity. This is inconsistent with previous research which found that, without implementing our additional controls, regulating anxious emotion was the only significant predictor of subsequent pain within the same day (Pauqet et al., 2005). A possible explanation for these equivocal results can be found in the generally stronger association between pain and anxiety conditions than between pain and depression (McWilliams, Goodwin, & Cox, 2004). In the current study, controlling for morning pain in the full dataset and conducting the analyses on high morning pain days only may have resulted in controlling for more of the variance associated with anxious emotion than with depressive emotion, thereby, making it more likely for the influence of regulating depressive emotion to emerge as significant. This highlights the importance of the two pain controls that we implemented and suggests that, for individuals with a chronic pain condition, pain management efforts might most usefully focus on regulating depressive, rather than anxious or positive, emotions.

Previous research also led us to expect that, when emotion regulation was disaggregated by both emotion and type of regulation, both containing and recovering from anxious emotion, as well as recovering positive emotion, would be significantly associated with decreased evening pain (Paquet et al., 2005). In our first model, without the additional controls, we found a significant influence of containing anxious emotion, but we also found independent influences of containing and recovering from depressive emotion. In model 2, which included the morning pain and morning emotions controls, only containing and recovering from depressive emotion remained significant. In the analyses conducted on the subsample of days when participants had higher than their own average morning pain, containing anxious and containing depressive emotion were each significantly associated with decreased evening pain. Tentatively, we suggest that the differences between what we found and what was expected based on previous research may have had to do with the differences between the two samples. Lifespan research suggests that anxiety, but not depression, decreases with age (Alexopoulos, 1990) and that older adults are relatively happy (Diener & Diener, 1996) and satisfied with life (Herzog & Rodgers, 1981). Therefore, the dysregulation of anxious and positive emotion may have a greater influence among older adults for whom greater regulation is the norm.

Although some important improvements are made in the current study, as compared to previous research on the topic of emotion regulation and pain, the current study is not without its limitations. On the one hand, the measure we used captures dynamic and subconscious aspects of emotions regulation that one-time, self-reports of emotion regulation do not. On the other hand, some instances of emotion regulation may have been missed. For example, one can imagine a day on which an event occurred that resulted in a participant having substantially higher than average negative emotions or substantially lower than average positive emotion. One can also imagine that, on one of those days, the participant might have somewhat regulated their emotions but still have higher than average negative emotions or lower than average positive emotions.

The current measure of emotion regulation would not have counted those days as days on which emotion was regulated, although, as is clear from the example, it was. The consequence of this limitation is that nonsignificant results may not reflect a true lack of influence of emotion regulation on pain intensity, but rather the inability of the measure to fully capture emotion regulation when it occurred. One way of addressing this limitation in future research would be to ask participants whether anything important had happened since their previous interview, the valence of the event, and how serious the event was for them. In future research a trait measure of self-perceived emotion regulation as well as daily self-report measures of emotion regulation could be added to research protocols in order to examine the independent influences of between and within-individual differences in emotion regulation as well as the extent to which self-report and empirically derived daily measures of emotion regulation concur.

Another useful direction for future research might be to consider the temporal aspect of affect regulation in order to determine whether the impact of mood regulation on pain is similar to that of emotion regulation. This consideration arises out of the different timeframes and methodologies associated with the two approaches to emotion regulation that have informed this study. One branch of emotion regulation research takes its departure from an evolutionary perspective (e.g., Gross, 1998), which views emotions as momentary and tends to conduct experiments in which emotions and emotion regulation are manipulated (e.g., Gross & Levenson, 1997; Mauss et al., in press). In contrast, the lifespan developmental perspective does not make as fine a temporal distinction between moods and emotions and tends to examine everyday experiences of emotion, including regulation (e.g., Carstensen et al., 2000; Paquet et al., 2005). The advantage of the first approach is methodological rigor, whereas, the advantage of the second is ecological validity. The methodology of the current study is more closely aligned with the second approach. Therefore, it might be useful in future research to measure emotion regulation in close temporal proximity to emotional cue events, using, for example, event-

triggered sampling (Bolger et al., 2003). This would simultaneously preserve the ecological validity associated with the lifespan developmental approach, as well as more accurately measure emotion regulation as it is defined by the evolutionary approach.

In sum, the current study responds to recent calls in the literature to go beyond investigations of the effects of static emotions on pain, to examining the influence of dynamic emotion regulation (e.g., Keefe et al., 2001). This approach is consistent with the dynamic model of affect which asserts that emotions are not static and that their influence on physical and psychological outcomes fluctuates across short timeframes (Zautra, Smith, Affleck, & Tennen, 2001). Results of the current study indicate that both maintaining desirable emotional states and recovering from undesirable emotional states have important influences on the amount of daily pain experienced by individuals with chronic pain. This seems to be particularly the case for depressive emotion. A key implication of this research for psychosocial pain management interventions is that it may be most important to teach individuals with chronic pain conditions how to manage their depressive emotions, especially how to avoid experiencing them in the first place.

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Appendix