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INDIVIDUAL DIFFERENCES, MOOD, AND COPING WITH CHRONIC PAIN IN RHEUMATOID ARTHRITIS: A DAILY PROCESS ANALYSIS

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This study examines individual differences in coping and associated health outcomes as they unfold across time. Twice daily for one week, 71 individuals with Rheumatoid Arthritis reported their pain, coping efforts, and negative mood via structured daily records. The five factor model of personality (neuroticism, extraversion, openness to experience, agreeableness, conscientiousness) and disease status were also assessed. Multi-level statistical models examining within and between person variability indicated significant temporal associations from coping to pain and bi-directional associations between mood and pain within days. Furthermore, findings suggest that coping use and coping effectiveness were moderated by personality. Implications for models of coping with chronic pain, as well as clinical applications, are discussed.

Keywords: Individual differences; Mood; Coping; Rheumatoid arthritis

Rheumatoid Arthritis (RA) is a chronic autoimmune disease that results in a variety of distressing and debilitating symptoms including stiffness, joint inflammation, fatigue, and mood changes. A primary symptom with which persons with RA cope is chronic, debilitating pain. Due to varying disease activity and progression, pain levels among those with RA can differ substantially both across time within a given patient and between patients (Grennan and Jayson, 1989). Chronic pain is typically associated with a multitude of secondary stressors such as sleep disruption, underemployment, interpersonal tensions, and difficulties with basic tasks of daily living (Taal *et al.*, 1993). These secondary problems simply compound the stress associated with chronic pain and make further demands upon coping resources.

Mood and Chronic Pain

A range of negative emotions including depression, anger, and anxiety are frequently experienced by people coping with a variety of chronic pain conditions, and higher

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levels of negative mood tend to be associated with higher levels of chronic pain (Craig, 1999; Robinson and Riley, 1999). Despite strong empirical support for the role of negative mood states characterized by anxiety, anger, and sadness in chronic pain, the nature of the temporal associations between mood and pain remains unclear and controversial. Much of the research to date has examined primarily long-term associations (i.e., months and years), and although some studies have found significant positive effects (Leino and Magni, 1993; Zautra *et al.*, 1995) others have failed to find such effects (Brown, 1990). Findings from studies examining temporal mood–pain associations across smaller time-frames (e.g., across days) have also been mixed (Keefe *et al.*, 1997; Affleck *et al.*, 1999). In one study that examined the bi-directional associations between mood and pain across days, increased depressed mood predicted increases in pain the following day, and higher levels of pain in turn predicted increased depressed, anxious, and angry mood the following day (Feldman *et al.*, 1999). In summary, although mood and pain seem to have potential bi-directional associations, little is known about the pain–mood nexus as it unfolds over the course of a day.

Coping and Chronic Pain

Much research to date has examined the role of coping in negative mood and functional disability outcomes among patients with chronic pain (Boothby *et al.*, 1999; DeGood, 2000). Less is known about how coping relates to pain *per se*. Cognitive reframing, distancing, emotional expression, and active problem solving are four ways of coping with pain that have been the focus of prior studies. Cognitive reframing (e.g., downward social comparisons, positive self-statements) appears to be an adaptive way of coping and has been associated with lower pain (Watkins *et al.*, 1999). With respect to distancing oneself from pain (e.g., distraction, diverting attention), some studies have shown attempts to ignore pain to be associated with lower pain (Watkins *et al.*, 1999), while others have failed to find significant associations (Affleck *et al.*, 1999). Similarly, emotional expression as a way of coping has been associated with lower pain in some studies (Kerns *et al.*, 1994), but has failed to predict pain outcomes in others (Affleck *et al.*, 1999). Despite the adaptive role of active problem solving in coping with a wide variety of stressors (Folkman *et al.*, 1986), Van Lankveld and colleagues (1994) found no significant relations between problem-focused coping and pain outcomes in their study of RA. In fact, a number of theorists (Lazarus and Folkman, 1984; Aldwin, 1994) have argued that problem-focused coping in the face of an uncontrollable stressor might actually be detrimental, as it may represent, at the very least, wasted effort that otherwise might have gone into more effective emotion-focused coping. To a great extent, RA pain represents such an uncontrollable stressor. In summary, evidence exists for a role of several ways of coping in pain outcomes, but the findings to date have been quite mixed. Further, as with studies of mood and pain, few studies have examined the temporal associations from coping to pain.

Person Factors in Mood, Coping, and Chronic Pain

Personality predicts appraisals, coping efforts, and health outcomes within a variety of stressful contexts (O'Brien and DeLongis, 1996). Specific contexts appear to pull for the

cognitive, affective, and behavioral responses that characterize specific personality traits (Shoda *et al.*, 1994). The role of personality in the context of chronic pain remains unresolved and controversial, especially given mixed findings and a lack of prospective studies (Weisberg and Keefe, 1999). More recent examination of the role of personality focuses upon ways in which personality traits may be associated with between person variability in vulnerability to, progression of, and adaptation to conditions associated with chronic pain.

The Big Five

There is a general consensus that five core traits represent the basic underlying dimensions of personality: Neuroticism, Extraversion, Openness to experience, Agreeableness, and Conscientiousness (Costa and McCrae, 1998; see Block, 1995 for an exception). *Neuroticism* (*N*) or trait negative affectivity refers to the degree to which an individual is prone to experience emotional distress. *Extraversion* (*E*) refers to the degree to which an individual is dominant, gregarious, outgoing, and fun-seeking. *Openness to Experience* (*O*) reflects the degree to which one is intellectually curious, creative, imaginative, and open-minded. *Agreeableness* (*A*) reflects the degree to which one seeks to avoid antagonism or conflict and is easygoing and cooperative. *Conscientiousness* (*C*) reflects the extent to which one tends to be organized, reliable, disciplined, and responsible. The associations between personality, coping, and mood in the context of chronic pain remains unclear and controversial as studies to date are small in number, researchers have rarely examined all five traits and existing findings are mixed.

The Current Study

Empirical evidence does provide some modest support for the role of coping, mood, and personality in pain outcomes among individuals with chronic pain. However, much of the existing research to date has utilized cross-sectional, aggregated, or repeated measures designs across months or years. Such approaches do not allow researchers to capture the moment by moment processes that determine the unfolding of health outcomes over time. Further understanding of these daily processes can potentially advance empirically derived theories of coping with chronic pain and clinical management of chronic pain. As a result, there have been calls in the literature for researchers to (1) utilize process models that allow examination of temporal associations among key psychosocial variables such as coping or mood and health outcomes, and (2) examine individual differences in the magnitude and direction of these associations (Tennen *et al.*, 2000).

The purpose of the current study was to address the role of personality in daily mood and coping processes in the context of chronic pain in order to examine the ways in which these variables interact in regards to chronic pain outcomes over time. Using both time invariant variables (i.e., personality traits, demographic variables, disease variables) and time variant variables (i.e., pain, mood, ways of coping) the following interrelated issues were addressed. First, what are the relations between mood and pain over time? Second, what are the relations of specific ways of coping to pain over time? Third, do the associations between mood, coping, and pain over time

vary between individuals? For example, do the associations between pain and mood over time vary according to personality traits or disease status? Does the use or effectiveness of coping strategies over time vary according to personality traits or disease status?

METHOD

Participants (Ps) were asked to indicate how they coped with one particular stressor: chronic pain due to RA. Ps reported their level of pain, negative mood, and coping efforts at multiple time points. They also provided information regarding demographic and disease variables, and completed a five-factor personality inventory (Trapnell, 1989; Trapnell and Wiggins, 1990).

Procedure

Ps were recruited via the British Columbia Rheumatoid Arthritis Registry and the Provincial Department of Vital Statistics. Eligible participants met the following criteria: (1) diagnosed with RA as defined by the American Rheumatism Association criteria (Arnett *et al.*, 1988), (2) nonhospitalized and utilized outpatient services during prior three years, (3) no major medical co-morbidity (e.g., major heart disease), and (4) spoke English. Of the 230 eligible Ps identified, 71 Ps agreed to participate.

Sample Characteristics

Age ranged from 24 to 76 years ($M = 55.31$; $SD = 13.30$). Seventy-six percent were female and 69% were currently married. Three percent reported grade school as the highest level of education obtained, 59% high school, and 38% college or university. Twenty nine percent were currently employed outside the home.

Questionnaire Measures

General Disease Status

Via questionnaire, Ps also reported their year of RA diagnosis, and general pain frequency, morning stiffness frequency and stiffness duration during the prior month. Functional disability (difficulties performing eight daily activities such as dressing oneself and getting in and out of bed) were assessed on a four point scale ranging from 0 (without any difficulty) to 3 (unable to do) (Pincus *et al.*, 1983).

Personality

Ps also completed a self-report measure (Trapnell, 1989; Trapnell and Wiggins, 1990) of the big five personality traits using adjectives found in previous studies to be prototypical markers of the five factors: Neuroticism (*N*), Extraversion (*E*), Openness to Experience (*O*), Agreeableness (*A*), Conscientiousness (*C*). Ps indicated the degree to which each of the 30 adjectives were descriptive of themselves on a seven point scale ranging from 1 (not true) to 7 (very true). The alphas ranged from 0.61 (*A*) to 0.76 (*N*) indicating acceptable reliabilities.

Diary Measures

Daily record keeping was limited to one week in order to minimize the burden placed on the sample. We relied upon paper rather than electronic diaries because the latter would have been inappropriate given the lack of comfort with electronic/computer technology evidenced in pilot testing, particularly by our older participants (DeLongis *et al.*, 2003). Ps were asked to complete the records around lunchtime, and again before going to bed each day. At each of the 14 timepoints, Ps reported their mood, coping, and pain since the last entry in the diary. Ps were encouraged to seal the records after completing each timepoint using stickers provided by the researchers. In this way, the period of cued recall was limited to no more than half a day. Ps were provided with a postage paid envelope to mail the researchers all 14 diaries at the end of the one week data collection period.

Pain

Ps indicated severity of pain on a 10 cm visual analog scale (VAS) with possible scores ranging from 0 mm (no pain) to 100 mm (severe pain; Huskisson, 1974; 1983).

Mood States

Three subscales assessing depressed, anxious, and hostile mood were drawn from the Affects Balance Scale (Derogatis, 1975) which has shown good internal consistency in prior research with reliability alpha coefficients ranging from 0.78 to 0.92 (Northouse and Swain, 1987). Ps indicated the degree to which 15 descriptors (e.g., nervous, resentful, sad, etc.) reflected how they felt on a scale ranging from 0 (never) to 4 (always). Given the high intercorrelations (*r*s 0.85 to 0.90) among the subscales, scores were combined to create a single overall index of negative mood.

Coping

Cognitive and behavioral coping efforts were assessed with a brief 27 item Ways of Coping inventory derived primarily from the Revised Ways of Coping (WOC-R; Folkman *et al.*, 1986). Three items reflecting active problem solving, distancing, positive reappraisal, downward social comparison, emotional expression/seeking support, confrontation, self-control, escape-avoidance, and accepting responsibility were included. Ps indicated the degree to which they had utilized each strategy specifically to cope with RA pain on a three point scale labeled 0 (not at all), 1 (some), and 2 (a lot). Due to low endorsement, items reflecting escape avoidance (e.g., ate, drank, or smoked to feel better), accepting responsibility (e.g., realized I had brought the problem upon myself), and one seeking support item ('sought professional help') were dropped. In the factor analysis of the remaining twenty coping items (Maximum Likelihood extraction with oblique rotation) two items failing to load higher than 0.3 on any factor were dropped.

Eighteen items were retained in the final factor analyses and yielded four factors (see Table I): cognitive reframing, distancing, emotional expression, and active problem solving. Both item loadings and alphas are comparable with empirically derived coping scales previously reported in the literature (Folkman *et al.*, 1986; Carver *et al.*,

TABLE I Coping scales, item loadings, and internal reliability estimates

	Factor loading
Scale 1: COGNITIVE REFRAMING (alpha[a] = 0.78 [0.63–0.86]; $n = 65$[b] [61–68])	
Reminded myself how much worse things could be.	0.73
I thought about someone I know who is in a worse situation.	0.73
Realized how, in some ways, I'm more fortunate than others.	0.72
Rediscovered what is important in life.	0.55
Changed or grew as a person in a good way.	0.45
Scale 2: STOIC DISTANCING (alpha = 0.80 [0.77–0.86]; $n = 66$ [63–69])	
Kept others from knowing how bad it was.	0.77
Tried to keep my pain to myself.	0.77
Didn't let it get to me; refused to think about it too much.	0.55
Went on as if nothing had happened.	0.55
Made light of the situation; refused to be upset.	0.54
Tried to keep my pain from interfering with other things too much.	0.50
Scale 3: EMOTIONAL EXPRESSION (alpha = 0.72 [0.62–0.82]; $n = 67$ [60–69])	
Talked to someone about how I was feeling.	0.73
Expressed anger.	0.61
I let my feelings out somehow.	0.58
Accepted sympathy and understanding from someone.	0.55
Scale 4: ACTIVE PROBLEM SOLVING (alpha = 0.79 [0.59–0.87]; $n = 65$ [62–68])	
Made a plan of action and followed it.	0.77
Concentrated on what I had to do – the next step.	0.72
I knew what I had to do so increased my efforts to make things work.	0.53

[a] The alphas for the coping scales were calculated at each of the 14 timepoints. A mean alpha for each coping scale was then computed from these 14 alpha estimates and is the value reported here. The range of alphas obtained for the 14 timepoints is reported in brackets.
[b] Alpha estimates for each timepoint include only those Ps with complete data for the particular coping scale in question. The average n is reported, with the range of the ns for the 14 timepoints reported in brackets.

1989). *Cognitive reframing* represents efforts to perceive one's current situation positively via positive reappraisal and downward social comparison. *Distancing* represents attempts to avoid acknowledging, dwelling upon, or expressing the extent of the pain and its associated distress. *Emotional expression* represents efforts to express the pain-related distress and obtain interpersonal support. *Active problem solving* represents increased efforts to engage oneself cognitively and behaviorally in order to directly impact the pain and its effects.

Diary Completion

Analysis of all diaries indicated that 80% of the participants had analyzable data for coping, mood, and pain variables for at least 93% of the timepoints.[1] Specifically, of the 71 participants, approximately 63% ($n = 45$) were not missing pain, coping, or

[1] The following procedure was followed in regards to missing data for individual items at any particular timepoint within completed diaries. Indices for coping and mood scales were only calculated for each participant at each specific timepoint if they had reported on 50% or more of the items making up each particular index. For example, calculation of the negative mood index at a given timepoint required the participant to respond to at least 3 of each of the 5 mood items for depressed mood, anxious mood and angry mood respectively. Coping indices were only calculated for each participant at each specific timepoint if the same criteria were met (i.e., 50% or more of the items completed for each coping subscale at any given timepoint).

mood indices at any timepoint, while 13% ($n = 9$) were only missing the coping indices for one timepoint, and 4% ($n = 3$) were only missing pain variables for one timepoint. The remaining 20% ($n = 14$) of the sample were missing some (but not all variables) at more than 1 timepoint (e.g., $n = 6$ missing coping at 2 or 3 timepoints; $n = 4$ missing coping and pain at one or two timepoints). The statistical procedures described below can accommodate this level of missing data commonly found in repeated measures methodology while still maintaining reliable estimates of the effects.

RESULTS

Descriptives

Mean time since diagnosis of RA was 10.99 years ($SD = 9.89$). The means for disease status variables were as follows: general functional disability ($M = 0.79$, $SD = 0.55$), pain frequency ($M = 2.59$, $SD = 1.13$), AM stiffness ($M = 3.01$, $SD = 1.57$), and stiffness duration ($M = 1.96$, $SD = 1.21$). The means for personality and aggregated daily measures of mood, coping, and pain are reported in Table II.

Bivariates

Years since diagnosis was not significantly associated with disease variables or aggregated daily mood, coping, or pain, but was significantly associated with N ($r = -0.26$, $p = 0.03$). Age was significantly associated with lower average use of distancing only ($r = -0.40$, $p = 0.001$). Disease variables were all significantly positively correlated with one another (rs ranged from 0.31, $p = 0.01$ to 0.59, $p < 0.001$). Other than a significant positive association between E and general AM stiffness duration ($r = 0.28$, $p = 0.02$) none of the personality traits were significantly correlated with disease variables. The significant correlations among personality were as follows: O with E ($r = 0.38$, $p = 0.001$), O with A ($r = 0.28$, $p = 0.02$), and A with C ($r = 0.46$, $p < 0.001$). The correlations among aggregated mood, coping, and pain variables and personality are reported in Table II.

TABLE II Means, standard deviations, and correlations among aggregated daily variables and personality[a]

	M	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
AM pain severity	40.20	19.82	–						
PM pain severity	40.23	19.55	0.87***	–					
AM negative mood	0.63	0.64	0.45***	0.41***	–				
AM cognitive reframing	1.43	0.43	0.27*	0.17	0.50***	–			
AM distancing	1.74	0.44	0.09	0.06	0.17	0.22	–		
AM emot. expression	1.29	0.30	0.38**	0.32**	0.60***	0.47***	0.21	–	
AM problem solving	1.55	0.51	0.32**	0.40**	0.51***	0.50***	0.42***	0.45***	–
Neuroticism	3.63	1.07	0.16	0.20	0.44***	0.07	−0.06	0.35**	0.12
Extraversion	4.20	1.06	0.22	0.15	0.17	0.21	0.24*	0.33**	0.49***
Openness	4.87	1.00	0.05	0.09	−0.01	−0.19	0.08	0.11	0.14
Agreeableness	5.88	0.96	−0.06	−0.07	−0.20	−0.01	0.09	0.06	0.04
Conscientiousness	5.48	0.95	−0.06	−0.06	−0.41***	−0.23	0.12	−0.10	−0.14

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. $N = 71$, except for correlations with coping strategies ($N = 69$) due to missing data.
[a] Daily variables were aggregated for each participant across all timepoints.

Hierarchical Linear Models

Hierarchical Linear Modeling (HLM) was utilized in order to examine both time variant variables (mood, coping, and pain) and time invariant variables (personality and individual difference variables) within one comprehensive multi-level model (Bryk and Raudenbush, 1992; Snijders and Bosker, 1999). The purpose of the multi-level analyses was to examine (1) mood–pain associations, and (2) individual differences in the temporal associations among coping, mood, and pain accounted for by personality. Diary data were divided into morning (AM) timepoints and evening (PM) timepoints in order to examine within and between person differences in mood, coping, and pain over time. As demonstrated in the equations detailed below, the intercepts for each dependent variable were left free to vary (i.e., included a random component). In every multi-level model examined in the current paper, only significant main effects and interaction terms were maintained in the model while insignificant predictors were dropped to maximize stability and reliability of the findings (Kreft and De Leeuw, 1998). At Level 1 of the first HLM model, evening pain (PM Pain_{ij}) was modeled as a function of one's average evening pain across all diary days (β_{0j}), morning pain (β_{1j}; to capture residualized change in pain within days), a main effect for morning mood (β_{2j}), main effects for morning coping (β_{3j}, β_{4j}, β_{5j}, β_{6j}), the morning mood by morning pain interaction (β_{3j}), and that evening's deviation from the pain average (ε_{ij}):

$$\begin{aligned}\text{PM Pain}_{ij} = {} & \beta_{0j} + \beta_{1j}(\text{AM Pain}) + \beta_{2j}(\text{AM Mood}) \\ & + \beta_{3j}(\text{AM Cognitive Reframing}) + \beta_{4j}(\text{AM Stoic Distancing}) \\ & + \beta_{5j}(\text{AM Emotional Expression}) + \beta_{6j}(\text{AM Active Problem Solving}) \\ & + \beta_{7j}(\text{AM Pain by AM Mood}) + \varepsilon_{ij}\end{aligned}$$

After testing for any significant effects at Level 1 of the model, disease or demographic variables were then included at Level 2 to test between person differences in the evening pain intercept (i.e., the potential moderating effects of disease or demographic variables on pain within days) even after controlling for significant mood and coping variables. For these analyses the average daily evening pain intercept (β_{0j}) for any person (i) was tested as a function of the average intercept (mean pain) across persons (ϕ_{00}), the regression coefficient for each disease/demographic variable (ϕ_{01}, ϕ_{02}, ϕ_{03}, ϕ_{04}, ϕ_{05}) and a random component (ν_{0j}):

$$\begin{aligned}\beta_{oj}(\text{PM Pain Intercept}) = {} & \phi_{00} + \phi_{01}(\text{Functional Disability}_i) \\ & + \phi_{02}(\text{Years since Diagnosis}_i) \\ & + \phi_{03}(\text{General Pain Frequency}_i) \\ & + \phi_{04}(\text{Morning Stiffness Frequency}_i) \\ & + \phi_{05}(\text{Stiffness Duration}_i) + \nu_{0j}\end{aligned}$$

After testing for any significant effects between person differences due to disease/demographic variables, personality variables were also added at Level 2 of the model in order to test between person differences in the evening pain intercept (i.e., the potential moderating effects of personality on pain within days) even after controlling for significant demographic/disease, mood, and coping variables. For these analyses the

average daily evening pain intercept (β_{0j}) for any person (i) was tested as a function of the average intercept (mean pain) across persons (ϕ_{00}), the regression coefficients for N, E, O, A, and C (ϕ_{01}, ϕ_{02}, ϕ_{03}, ϕ_{04}, ϕ_{05}) and a random component (ν_{0j}):

$$\beta_{oj}(\text{PM Pain Intercept}) = \phi_{00} + \phi_{01}(N_i) + \phi_{02}(E_i) + \phi_{03}(O_i) + \phi_{04}(A_i) + \phi_{05}(C_i) + \nu_{0j}$$

Cross-level interactions between personality and mood or personality and coping in their relationship to pain within days were also tested. Specifically the role of personality in predicting between person differences in the mood to pain or coping to pain slopes were examined. All slopes were fixed to maximize power to detect significant effects (Kreft and De Leeuw, 1998). The equation below is an example of the personality traits modeled onto the cognitive reframing slope. The slopes for morning mood and all remaining coping slopes were modeled in the same manner:

$$\beta_{oj}(\text{AM Cognitive Reframing}) = \phi_{00} + \phi_{01}(N_i) + \phi_{02}(E_i) + \phi_{03}(O_i) + \phi_{04}(A_i) + \phi_{05}(C_i) + \nu_{0j}$$

In all analyses the five disease/demographic variables and the five personality variables were each modeled as a block onto the pain intercept or the mood and coping slopes. This was done to maintain a lower Type 1 error rate by minimizing the number of tests needed for cross-level interactions. To further reduce the probability of Type 1 error rate only those personality by pain, personality by mood, or personality by coping interactions that were significant at the family wise error rate of $p < 0.01$ were interpreted as significant.[2]

In regards to the direct effects of demographic, general disease status, and personality variables on PM pain, only general functional disability was positively associated with PM pain ($b = 0.15$, $t = 2.99$, $p = 0.003$). The remaining disease status variables (AM stiffness, AM stiffness duration, general pain frequency, years since diagnosis), age, gender, and personality were not significantly associated with PM pain. As a result all nonsignificant predictors were dropped from the pain intercept in the final model reported in Table III. As hypothesized, AM pain was significantly positively associated with PM pain ($b = 0.53$, $t = 13.21$, $p < 0.001$). There was no main effect for mood ($b = 0.07$, $t = 1.47$, $p = 0.14$) but follow-up analyses indicated that there was a significant interaction between AM pain and AM mood in predicting PM pain ($b = -0.09$, $t = -2.68$, $p = 0.008$), even after controlling for the significant main effect of AM pain. As shown in Fig. 1, mood moderated the relationship of AM pain to PM pain such that the positive associations between AM pain and PM pain were strongest under conditions of low mood.[3]

[2] For more detailed information regarding the linear equations and associated procedures used in the multilevel models, please contact the authors.

[3] A follow-up analysis was conducted in order to examine whether the temporal associations between pain and mood were bi-directional. HLM analyses revealed that AM pain was significantly associated with PM mood within days ($b = 0.06$, t (441) $= 2.20$, $p = 0.03$), even after controlling for the highly significant effect of AM mood ($b = 0.76$, t (441) $= 17.26$, $p < 0.001$).

TABLE III Hierarchical linear model (HLM) analyses: relations of AM mood, AM pain, AM coping, and personality traits to PM pain (standard model)

EFFECT[a,b]	*b*	*SE*
Functional disability status	0.15**	0.05
AM pain	0.53***	0.05
AM mood	0.07	0.05
AM cognitive reframing	−0.12*	0.05
AM stoic distancing	−0.05	0.04
AM emotional expression	0.01	0.04
AM active problem solving	0.20 ***	0.05
AM mood by AM pain	−0.09*	0.04
AM cognitive reframing by *E*	−0.14 **	0.04
AM emotional expression by *E*	0.10**	0.03

Note: $*p \leq 0.05$, $**p \leq 0.01$, $***p < 0.001$.
[a] All variables have been standardized; [b] AM pain, AM mood and all AM coping variables have been centered around the grand sample mean across the course of the study. In this "grand mean centered" analysis, "higher" and "lower" are relative to the grand mean sample.

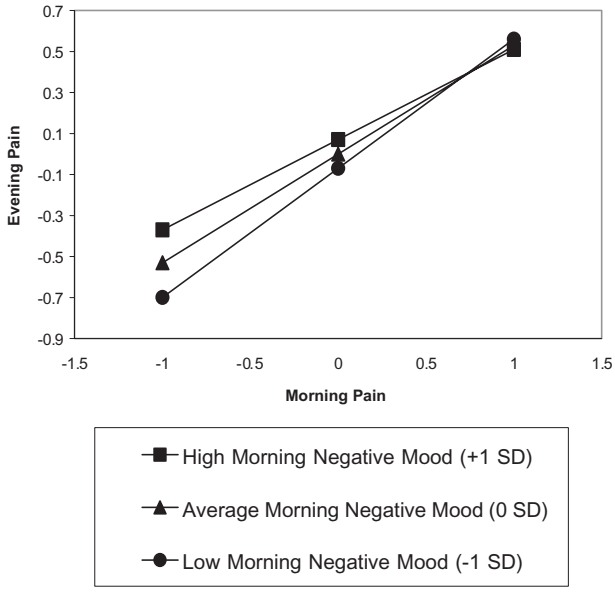

FIGURE 1 The relationship between morning negative mood and morning pain to evening pain (*Note*: All variables have been standardized).

Several of the AM coping strategies were also significantly associated with PM pain. AM cognitive reframing was negatively associated with PM pain ($b = -0.12$, $t = -2.74$, $p = 0.007$) indicating that higher levels were associated with lower pain. AM active problem solving was positively associated with PM pain ($b = 0.20$, $t = 4.42$, $p < 0.001$) indicating that higher levels were associated with higher pain. AM stoic distancing not significantly associated with PM pain ($b = -0.05$, $t = -1.25$, $p = 0.21$) and AM emotional expression was not significantly associated with PM pain ($b = 0.01$, $t = 0.25$, $p = 0.81$).

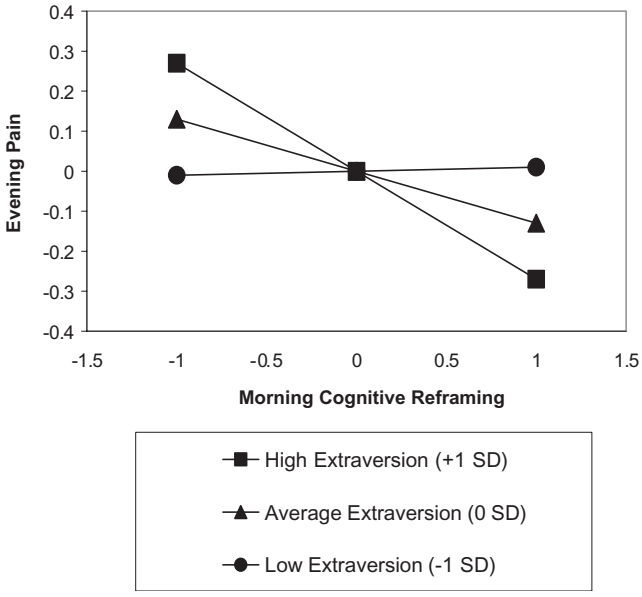

FIGURE 2 The relationship between morning cognitive reframing and extraversion to evening pain (*Note*: All variables have been standardized).

No significant cross-level interactions were found for *N* by coping or mood, *O* by coping or mood, *A* by coping or mood, or *C* by coping or mood. Analyses indicated that AM cognitive reframing and *E* interacted significantly in predicting PM pain ($b = -0.14$, $t = -3.38$, $p = 0.001$). This interaction is plotted in Fig. 2 and indicates that higher levels of cognitive reframing were associated with lower levels of pain but only for individuals higher on *E*. Emotional expression and *E* also interacted significantly in predicting PM pain ($b = 0.10$, $t = 2.58$, $p = 0.01$). This interaction is plotted in Fig. 3 and indicates that higher levels of emotional expression were associated with higher levels of pain for individuals higher on *E*, whereas higher levels of emotional expression were associated with lower levels of pain for individuals lower on *E*. In summary, the final multi-level model reported in Table III includes significant effects at all levels of the model and indicates the effects for mood, coping, and personality reviewed above remain significant even after controlling for all other significant variables in the model.[4]

A follow-up analysis was conducted in which the main effects of morning pain, morning mood, and morning coping were each individually centered. By individually centering the variables for each participant around their own personal mean each

[4] Follow-up analyses were conducted in order to determine whether effectiveness of coping was moderated by mood or pain at the time of coping efforts (i.e., morning coping by morning mood interactions and morning coping by morning pain interactions). All AM coping by AM mood interactions (including emotional expression by mood) were nonsignificant in their associations with PM pain after controlling for the main effects of AM pain, AM mood, and the main effects for the other ways of AM coping. All AM coping by AM pain interactions were also nonsignificant after controlling for the main effects of AM pain, AM mood, and the main effects for the other ways of AM coping.

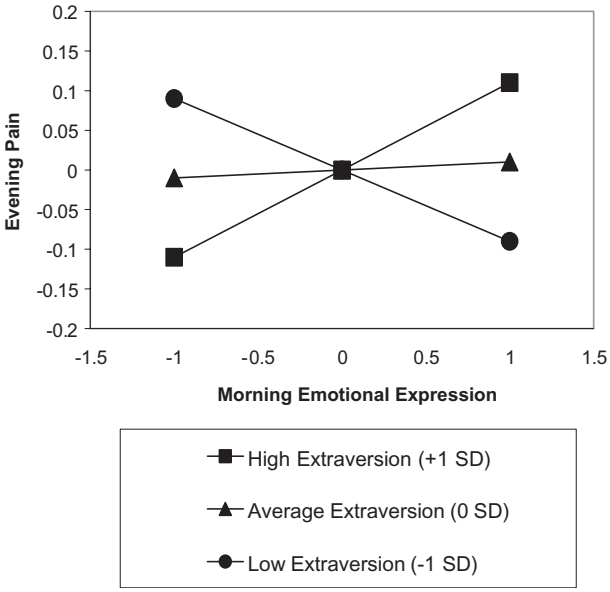

FIGURE 3 The relationship between morning emotional expression and extraversion to evening pain (*Note*: All variables have been standardized).

TABLE IV Hierarchical linear model (HLM) analyses: relations of AM mood, AM pain, and AM coping to PM pain (individually centered model)

EFFECT[a,b]	*b*	*SE*
Functional disability status	0.39***	0.09
AM pain	0.40***	0.06
AM mood	−0.01	0.07
AM cognitive reframing	−0.15*	0.06
AM stoic distancing	0.01	0.05
AM emotional expression	0.03	0.05
AM active problem solving	0.17**	0.06

Note: $*p \leq 0.05$, $**p < 0.01$, $***p < 0.001$.
[a] All variables have been standardized; [b] AM pain, AM mood, and all AM coping variables have been centered around each partcipant's individual mean. In this "individually centered" analysis, "higher" and "lower" are relative to each participant's own average during the course of the study and each individual acts as their own statistical control.

person acts as their own statistical control. Such a model allows examination of whether increases (or decreases) in pain, mood, or coping relative to one's personal average are associated with significant differences in pain as it unfolds across the course of a day. The findings for the individually centered model are reported in Table IV. The results demonstrate that increases (or decreases) in the use of cognitive reframing and active problem solving relative to one's typical use remain significantly associated with pain within days even after controlling for idiographic trends in mood, other ways of coping, and functional disability.

TABLE V Hierarchical linear model (HLM) analyses: relations of AM mood, pain, and personality to AM coping use

EFFECT[b]	*AM*[a] *cognitive reframing*		*AM stoic distancing*		*AM emotional expression*		*AM active problem solving*	
	b	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*
Functional disability status	0.18*	0.08	ns		ns		ns	
AM[b] pain	ns		0.13*	0.06	ns		0.09#	0.05
AM mood	0.26***	0.07	0.20**	0.08	0.43***	0.08	0.22***	0.06
N	ns		ns		0.13*	0.07	ns	
E	0.23*	0.10	ns		0.20*	0.08	0.35***	0.08
O	−0.29**	0.09	ns		ns		ns	
A	ns		ns		ns		ns	
C	ns		0.17*	0.09	ns		ns	

Note: #$p < 0.10$, *$p \leq 0.05$, **$p < 0.01$, ***$p < 0.001$. [a] AM = AM time period; [b] All variables have been standardized.

Coping Use

Next, the role of mood, pain, demographics, disease status, and personality in the use of each coping strategy were examined. Results of the models predicting coping use are presented in Table V. Functional disability was maintained as a control variable in predicting cognitive reframing ($b = 0.18$, $t = 2.24$, $p = 0.03$), but no other disease status or demographic variables were significantly associated with use of coping (and so were dropped from the coping intercepts).

Cognitive Reframing

AM pain was not significantly associated with use of AM cognitive reframing and so was not included in the model. AM mood was positively associated with use of AM cognitive reframing ($b = 0.26$, $t = 3.67$, $p < 0.001$). *E* was positively associated with use of AM cognitive reframing ($b = 0.23$, $t = 2.36$, $p = 0.02$) and *O* was negatively associated with use of AM cognitive reframing ($b = -0.29$, $t = -3.13$, $p = 0.002$). *N*, *A*, and *C* were not significantly associated with use of AM cognitive reframing and were dropped from the model.

Distancing

AM pain was positively associated with use of AM stoic distancing ($b = 0.13$, $t = 2.04$, $p = 0.04$). AM mood was positively associated with use of AM stoic distancing ($b = 0.20$, $t = 2.63$, $p = 0.009$). *C* was positively associated with use of stoic distancing ($b = 0.17$, $t = 1.97$, $p = 0.05$). *N*, *E*, *O*, and A were not significantly associated with use of AM stoic distancing and were dropped from the model.

Emotional Expression

AM pain was not significantly associated with use of AM emotional expression and so was dropped from the model. AM mood was positively associated with use of AM emotional expression ($b = 0.43$, $t = 5.61$, $p < 0.001$). *E* was positively associated with use of AM emotional expression ($b = 0.20$, $t = 2.59$, $p = 0.01$). *N* was also positively associated

with use of AM emotional expression ($b = 0.13$, $t = 1.96$, $p = 0.05$). *O*, *A*, and *C* were not significantly associated with use of AM stoic distancing and were dropped from the model.

Active Problem Solving

There was a trend for AM pain to be positively associated with use of AM active problem solving ($b = 0.09$, $t = 1.69$, $p = 0.09$); therefore, this variable was maintained as a control variable in the current model. AM mood was positively associated with use of AM active problem solving ($b = 0.22$, $t = 3.65$, $p < 0.001$). *E* was positively associated with use of AM active problem solving ($b = 0.36$, $t = 4.32$, $p < 0.001$). *N*, *O*, *A*, and *C* were not significantly associated with use of AM active problem solving and were dropped from the model.

DISCUSSION

The central purpose of the current study was to examine temporal associations in mood, coping, and chronic pain as they unfold within the timeframe of a single day. As expected, both negative mood and coping efforts were associated with subsequent pain. Furthermore, how individuals responded to pain and the apparent effects of their ways of coping appear to vary according to several personality dimensions. The following is a general overview of the more detailed discussion that follows. First, we review the significant mood–pain nexus and contextual effects in this association (i.e., the magnitude and direction of the mood to pain relationhip was determined in part by morning pain levels). Second, we review the significant temporal associations between coping and subsequent pain. Even after controlling for the main effects and interaction between negative mood and pain, our findings suggest that cognitive reframing is an adaptive way of coping with pain, whereas higher use of active problem solving appears to be maladaptive. In comparison, there was no main effect for either emotional expression or stoic distancing on pain. Finally, we review the significant role of personality in moderating the use and effectiveness of coping strategies. The effectiveness of emotional expression and cognitive reframing were both significantly moderated by levels of *E* and several personality traits were also significant predictors of all four ways of coping.

The Mood–Pain Nexus: Main Effects and Contextual Effects

The significant positive association between negative mood and subsequent pain extends prior research (Feldman *et al.*, 1999). Our findings suggest that shifts in mood within days are associated with subsequent shifts in pain levels within days. Further, given associations between morning mood and evening pain, our findings suggest that the underlying mechanisms accounting for the temporal mood–pain nexus can occur within a matter of hours. The current findings also suggest that the positive associations between mood and subsequent pain vary according to initial pain levels (i.e., contextual effects). Those persons with RA experiencing higher levels of pain in the morning are likely to remain in higher pain throughout the day, regardless of their mood. Alternatively, for those with lower levels of pain in the morning, mood plays

a significant role in subsequent pain levels. For this latter group, higher negative mood is associated with increases in pain later in the day. This finding is consistent with theory and research that suggests mood/distress can play a causal role in pain experience via shared neurophysiological pathways and associated systems (Melzack, 1999).

Coping Effectiveness: Main effects

Stoic Distancing

Use of stoic distancing had no significant association with subsequent pain. This is consistent with prior research that has failed to find significant associations between diverting attention and health outcomes in the context of chronic pain (e.g., Van Lankveld *et al.*, 1994; Affleck *et al.*, 1999). It could be argued that measures of distancing or distraction need to be more specific in order to detect significant temporal associations with pain related outcomes as different types of distancing/distracting may vary in their associations with health processes and outcomes. For example, some individuals with RA may use distancing in such a way that they calmly allow any pain related intrusive thoughts to "come and go" without extensive attempts to suppress or block them. In comparison, others may use distancing while engaging in intense efforts to block or suppress any pain related thoughts. The latter group may be more prone to maladaptive pain outcomes via higher levels of distress or higher levels of pain related intrusions due to the paradoxical effects of thought suppression. It remains possible that different goals or approaches when using distancing may moderate the effectiveness of this way of coping and that under some conditions this way of coping may be significantly associated with pain within days. It is also possible that these more specific manifestations of distancing are significantly associated with personality, which could also help explain the lack of significant personality interactions with the more general assessment of this way of coping in the current study.

Cognitive Reframing

Higher use of cognitive reframing was associated with lower pain. This finding adds to the existing evidence that cognitions (e.g., catastrophizing; Geisser *et al.*, 1994) play a role in pain outcomes and suggests that the use of cognitive reframing is generally an adaptive way of coping with chronic pain due to RA. It appears that adaptive pain outcomes may be determined by the degree to which chronic pain patients avoid negative appraisals *and/or* engage in positive appraisals. The moderating influence of personality on the associations between cognitive reframing and pain is reviewed below.

Emotional Expression

There was no significant main effect for emotional expression indicating that this way of coping in not generally associated with pain outcomes within days. However, the effectiveness of emotional expression as a way of coping was significantly moderated by personality indicating that this way of coping is an adaptive way of coping for at least some people. The moderating role of personality on the associations between emotional expression and pain is reviewed below.

Active Problem Solving

Use of problem solving was the only coping strategy associated with reports of higher subsequent pain. This finding is consistent with prior research and theory suggesting maladaptive effects for problem-focused coping in the context of uncontrollable stressors (for a review, see Aldwin, 1994). Active problem solving may have been a marker for overexertion in the current study. Learning to pull back appropriately from activity is an important component of adaption in the face of chronic pain, and training in "activity-rest cycles" is often included in empirically supported cognitive-behavioral pain treatment programs (Gatchel and Turk, 1996). Clinical observations also suggest that those coping with chronic pain are vulnerable to swinging between extremes of overexertion to excessive inactivity or avoidance. Such a pattern may lead to increased pain. Individuals endorsing active problem solving may have persisted in excessive activity when a period of therapeutic rest would have been more adaptive. Overexertion associated with active problem solving would presumably be maladaptive regardless of individual differences in personality, which may account for the lack of significant personality interactions.

Personality Moderators of Pain

Consistent with prior research (e.g., Miro and Raich, 1992), the big five dimensions of personality (*N*, *E*, *O*, *A*, and *C*) had no significant main effects on pain. We are unaware of other studies that have examined the role of all five personality traits in a process model of chronic pain. Additional studies are needed to clarify whether there are any conditions under which any of these traits are directly associated with pain as it unfolds over time.

Personality Moderators of Coping Use and Coping Effectiveness

As hypothesized, the current study found significant individual differences in (1) coping use and (2) coping effectiveness (i.e., the impact of coping on subsequent pain) and several personality traits were significant predictors of these differences.

Neuroticism

Levels of *N* were not significantly associated with effectiveness of the ways of coping examined in the current study. However, individuals higher on *N* tended to report higher levels of emotional expression than did those lower on *N*. This finding is consistent with prior research suggesting that *N* may play a significant role in pain-related distress rather than directly contributing to pain or to the use of coping strategies that are directly associated with subsequent pain (Harkins *et al.*, 1989).

Extraversion

Consistent with prior research (McCrae and Costa, 1986; Lee-Baggley *et al.*, 2002) individuals higher on *E* appear to be more "active copers" in that they were more likely to use a variety of ways of coping in the context of chronic pain compared to those lower on *E*. Being an active coper appears to have both benefits and costs depending upon the

coping strategy being used. First, individuals higher on *E* were more likely to use cognitive reframing and they were more likely to benefit from engaging in cognitive reframing in comparison to those lower on *E*. This could help explain why higher levels of *E* are often associated with higher levels of positive affect (Watson and Clark, 1997).

Second, higher levels of *E* were also associated with higher levels of emotional expression. However, greater use of emotional expression was maladaptive for individuals higher on *E* (associated with higher pain within days) but was adaptive for individuals lower on *E* (associated with lower pain within days). This pattern of findings extends prior research documenting the role of emotional expression *vs* suppression in pain outcomes (Kerns *et al.*, 1994). However, it suggests the impact of emotional expression on pain depends upon characteristics of the person expressing the emotion. Due to their dominant interpersonal style, individuals higher on *E* may be more likely to express their pain related emotions in an interpersonally aversive manner. The expression of pain-related distress among individuals higher on *E* may also disrupt adaptive processes that have been associated with higher levels of *E* (e.g., positive appraisals or positive mood; McCrae and Costa, 1986; Watson and Clark, 1997; David and Suls, 1999).

Finally, higher levels of *E* were also associated with higher active problem solving. Given the impact of chronic pain upon social relationships, those higher on *E* may be more motivated to use active problem solving in an attempt to prevent a loss of social resources. However, this strategy is likely to backfire given evidence that active problem solving was associated with higher pain within days in the current study. It is possible that due to their dominant social nature, those higher on *E* have more trouble than those lower on *E* engaging in necessary adjustments such as appropriately pacing their activities or accepting those things they cannot control. This may also help explain why individuals higher on *E* cope with chronic pain by using multiple coping strategies, making *E* both a liability and an asset in the context of chronic pain.

Openness to Experience

In contrast to the findings of McCrae and Costa (1986), higher levels of *O* were associated with lower levels of cognitive reframing within days. However, the use of cognitive reframing has been found to vary significantly across different types of stressors and levels of *O* interacts with type of stressor in predicting coping use (O'Brien and DeLongis, 1996). Those higher on *O* tend to be analytical, intellectual, and more comfortable with complexities (Costa and McCrae, 1992). As a result, cognitive reframing may represent unconvincing positive illusions for them when coping with the complexities of chronic pain. In comparison, individuals lower on *O* have been described as uncomfortable with complexities and conventional in their appraisals (Costa and McCrae, 1992). As a result, individuals lower on *O* may be more able to make concrete positive appraisals in the face of chronic pain, suggesting that higher levels of *O* may be a liability in the context of chronic pain when it comes to accessing the benefits of this way of coping.

Conscientiousness

Higher levels of *C* were associated with higher levels of stoic distancing. Given that high *C* individuals are characterized as hard-working and reliable, it is likely that

stoic distancing was utilized at higher rates by high *C* pain patients in an attempt to facilitate task directed efforts and minimize the interference of pain.

Agreeableness

A was the only trait that failed to show any significant associations with the stress and coping variables examined in the current study. Higher *A* has been associated with prosocial tendencies that promote intimacy and social cohesion (Graziano and Eisenberg, 1997) and lower levels of interpersonal confrontation (Hooker *et al*., 1994; O'Brien and DeLongis, 1996). Such findings suggest that *A* may be associated with interpersonal aspects of coping not assessed in the current study such as relationship-focused coping (attempts to cope in a way that maintains the integrity of relationships).

Limitations

Use of Paper Diaries

Stone and colleagues (Broderick, *et al*., 2003) have raised concerns regarding adherence rates in paper diary studies, arguing that participants often complete their diary entries later than self-report would otherwise suggest. In order to improve adherence and externally validate diary completion times, they have argued for the use of electronic diaries that time-stamp diary entries. While electronic diaries are, for many purposes, the method of choice, Green *et al*. (2003) have reported no significant differences in the relationships between stress and various outcomes regardless of whether participants use paper or electronic diaries. Green and colleagues argue that, given this, the problem with paper diaries may not be as serious as has been suggested.[5]

[5] There are a number of differences between our study design and that used by Stone and colleagues that may have improved adherence rates in our study. Most importantly, the study design used here placed far fewer demands on participants. Research on adherence to medical regimens has suggested that the single most important way to improve compliance among patients is to decrease the numbers of times per day that patients need to complete their regimen (Eisen *et al*., 1990). In a review of the literature, Greenberg (1984) found that adherence rates for twice daily regimens were 18% higher than thrice daily regimens. In our study, participants completed diary entries twice daily for 7 days, as opposed to thrice daily for 24 days as was done in the studies by Stone and colleagues. These researchers also found significant fatigue effects among their participants, with rates of compliance significantly higher during the first week of the study than in later weeks.

Another notable difference between the design of our study and theirs is in the time at which participants were asked to complete the diary entries. We used mealtime (lunch time) and bedtime to serve as memory prompts, or signals, to the participants to complete their diary entry. Previous research on medication adherence has found timing, and lack of interference with one's regular schedule, to be critical to increasing adherence (e.g., Dunbar-Jacob *et al*., 2000). Stone and colleagues' use of 10 a.m., 4 p.m., and 8 p.m. likely *increased* nonadherence because these times are not necessarily anchored to natural transition or "break" times for participants.

The precise timing of the diary entry was not critical to the research question being addressed in the present study, as it was in the Stone and colleagues' studies. Rather than being told that data needed to be entered within a 30-min window, participants in the current study were told to complete the diary entries *around* lunch time and *around* bedtime. Rather than decreasing adherence, our experience is that this greater flexibility serves to increase the ease of participating in the study and of completing the diary and therefore to *increase* adherence.

Generalizability

The sample included only individuals with chronic pain due to RA. Given that the effects of coping have been found to vary by disease status (e.g., Affleck *et al.*, 1999) it is possible that some of the current findings may not generalize to individuals with chronic pain that results from other types of conditions or diseases. In addition, the current sample was only mild to moderately impaired in regards to general functional disability. As a result, caution may be warranted in generalizing the findings to the special subset of individuals with more severe levels of disease than that captured in the current study. Finally, the current sample was predominantly women, which may suggest some caution in generalizing the current findings to men coping with chronic pain, especially given evidence of gender difference in pain research (for a review see Berkley and Holdcroft, 1999). Previous research has shown that women are more likely to report higher pain, more frequent pain, and pain of longer duration than men (Berkley and Holdcroft, 1999). Despite these cautions, both men and women with mild, moderate, and severe levels of disease were represented in the current sample. In addition, similar patterns of findings have been found in a variety of coping studies using a variety of chronic pain samples. Therefore, the current findings can most likely be generalized to many adults coping with chronic pain in their daily lives and particularly those coping with RA.

Day Confounds

It is also possible for days of the week to confound the findings of diary studies due to significant associations between coping, mood, or stress variables and days of the week. For example, Stone and colleagues (1993) found that people are most likely to report the highest levels of negative mood on Mondays (the "blue Monday" effect). To control for potentially confounding day effects, the start day for the diary portion of the study was staggered across participants. Therefore, it is unlikely that day effects could account for the pattern of findings in the current study.

Future Directions

We found significant effects for higher order factors of personality (the big five traits) in the mood–pain nexus, coping use, and coping effectiveness. Future research should examine lower order markers of personality that may also be moderators of mood, coping, and pain pathways. For example, McCrae and Costa (1992) reported that subfacets of *N* (e.g., anxiety) capture variance that is not necessarily captured entirely by the common trait marker of *N*. Furthermore, prior research suggests that these subfacets moderate the associations between pain and ways of coping. To illustrate,

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Further, rather than providing group instructions in completing the diaries, we provided individually tailored instructions at the end of a one-to-one interview that was designed to increase interviewer–participant rapport, and thus improve compliance. Finally, Stone and colleagues paid their participants $150; participants in our study were unpaid volunteers who were interested in participating in a study about RA. When participants are paid a relatively large sum of money to participate in a study "voluntarily", and many are unemployed, it may increase their motivation to merely *say* they completed their diaries on time, rather than to actually complete their diaries on time. In sum, it appears unlikely that the relatively high noncompliance rates reported in Stone and colleagues' studies would apply to our study given the differences in methodology.

the effectiveness of distraction among individuals with chronic pain has been found to vary according to individual differences in health anxiety (Hadjistavropoulos *et al.*, 2000). In this study, use of distraction was associated with higher affective pain ratings among high health anxious individuals in comparison to low health anxious individuals.

The current study did not include assessment of positive mood. To the best of our knowledge, negative mood *and* positive mood have not been examined in a process model that predicts pain within or across days while also controlling for the effects of coping and personality. This is an important direction for future research given that positive mood has been shown to have independent associations with pain over and beyond negative mood (e.g., Porter *et al.*, 2000).

The findings of the current study could also be extended by examining between and within-person differences in these pain related processes *across days* (rather than *within days* as done in the current study). It is possible that some significant associations between variables occur within a relatively short time frame and are no longer apparent over larger time lags. There are also likely to be temporal relationships among mood, coping, and pain variables that only become apparent when examining larger time lags such as across days. Therefore, future research should examine a broader set of empirically derived mood, coping, personality, and pain variables across a variety of time periods.

Clinical Implications

The current study extends understanding of coping with chronic pain and the mood–pain nexus. Patients with chronic pain vary significantly in how they cope with chronic pain in their daily lives and in the impact of their coping efforts. Importantly, several big five personality traits are useful markers of those at risk for engaging in maladaptive or ineffective coping as well as those most likely to benefit from adaptive ways of coping. These findings have several clinical implications. First, they provide support for the application of a biopsychosocial model in treating chronic pain patients, as they suggest the efficacy of cognitive modes of coping and the significant impact of pain related behavioral responses on daily pain experience. The within subject nature of these findings increases their clinical utility in that clinicians can be more confident that successful shifts in coping behavior on the part of patients can result in subsequent shifts in pain for those patients. Our findings suggest that these effects can occur fairly quickly, with morning coping efforts associated with evening pain levels. Finally, the findings also clearly indicate the need to tailor our interventions to the needs of the individual patient. Those higher on *E*, for example, face different challenges, cope differently to different effect, than do those lower on *E*. Unless such differences are taken into account in designing clinical interventions, treatment success is likely to be limited.

CONCLUSION

In closing, the current study provides evidence that the process of coping with chronic pain is a complex endeavor, and one that can vary day by day and from person to person. The findings provide support for transactional models of coping and biopsychosocial models of pain that incorporate state and trait affective, cognitive,

behavioral, and interpersonal variables in predicting health outcomes. Further use of process methodology in this context will continue to advance our understanding of day to day adjustment in the face of chronic pain. The current study demonstrates the utility of such an approach for stress, coping, and pain researchers. Pain outcomes in the context of chronic pain appear to be dynamic ever changing states that are determined by who we are, what we do to cope, and under what circumstances we find ourselves coping with chronic pain.

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