

The Role of Adult Attachment Anxiety in the Relation between Cognitions
and Daily Pain in Fibromyalgia Patients

by

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ABSTRACT

An abundance of data has established the links between both pain-related cognitions and relationship attachment qualities in the experience of pain, including long-term functional health in chronic pain patients. However, relatively few studies have explored the dynamic relation between pain and pain-related cognitions within a day, and no studies have tested the moderating role of relationship attachment on the within-day cognition—pain association in chronic pain patients. The objectives of this study were to: 1) assess whether late morning pain flares predicted changes in afternoon positive and negative pain-related cognitive appraisals, and whether these changes in turn predicted end-of-day pain, and 2) explore whether adult attachment anxiety moderated the pain-cognition relation in individuals with chronic pain due to fibromyalgia. One hundred and seventy four partnered individuals with fibromyalgia completed initial assessments of demographics and attachment anxiety, and subsequently completed electronic assessments of pain intensity and positive and negative cognitive pain-related appraisals three times a day for three weeks. Multilevel structural equation modeling established that a latent negative cognitive appraisal factor (encompassing shared variance from catastrophizing, pain irritation, and self-criticism related to pain) mediated the link between late morning and end-of-day pain intensity, in line with the hypothesis. Analyses also provided some support for a mediating role for a positive cognitive appraisal factor (a composite of pain control, pain self-efficacy, and feeling pain without reacting) in the daily course of pain; the mediated effect for positive appraisals was weaker than the mediated effect of negative appraisals, but was sustained

in a model that included negative appraisals. Inconsistent with prediction, attachment anxiety did not moderate the within-day links between pain and cognitions. These findings establish the dynamic links within day between pain and pain-related cognitions, and highlight the potential impact of both negative and positive cognitions on daily pain regulation. They point to the value of broadening cognitive-behavioral treatment strategies for chronic pain patients to target not only negative but also positive cognitions.

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TABLE OF CONTENTS

	Page
LIST OF TABLES	vi
LIST OF FIGURES	vii
INTRODUCTION	1
The Role of Cognitions in Chronic Pain.....	1
A Brief Overview of Attachment.....	3
Attachment and Chronic Pain	8
Cognitive Appraisals.....	12
Attachment Anxiety and Negative and Positive Cognitive Pain-Related Appraisals	13
Model and Hypotheses.....	21
METHOD	22
Participants.....	22
Procedure	24
Measures	26
Attachment	26
Pain.....	27
Pain Cognitions.....	28
Data Analytic Strategy	28
RESULTS	33
Intraclass Correlations and Intercorrelations	33

	Page
Multilevel Confirmatory Factor Analysis.....	33
Mediation in Multilevel Structural Equation Model.....	34
Moderation in Multilevel Structural Equation Model	36
DISCUSSION	38
References.....	55
APPENDIX	
A Institutional Review Board Approval	64
B Measures	66

LIST OF TABLES

Table	Page
1. Sample Characteristics, Intraclass Correlations (ICCs), and Mean Levels of Key Study Group Variables Across Diary Days Based on Partnership and Study Inclusion Status	70
2. Means and Percentages of Key Group Variables Based on “Low” and “High” A-ANX Tertile Groups	71
3. Within-Person Intercorrelations	72
4. Between-Person Intercorrelations	73
5. Multilevel Structural Equation Mediation Model Examining the Role of Afternoon Negative and Positive Cognitions in Mediating the Relation between Morning and End-of-Day Pain.....	74
6. Multilevel Mediation Model Examining the Role of an Afternoon Negative and Positive Cognition Composite Variables in Mediating the Relation between Morning and End-of-Day Pain.....	75

LIST OF FIGURES

Figure	Page
1. Heuristic Mediated Moderation Model Demonstrating the Hypotheses to be Tested.	76
2. Model Depicting the Two-Factor Multilevel Confirmatory Factor Analysis to be Tested.....	77
3. Confirmatory Factor Analytic Structure for Endogenous Variables in the Measurement Model	78

The Role of Adult Attachment Anxiety in the Relation between Cognitions and Daily Pain in Fibromyalgia Patients

Fibromyalgia Syndrome (FMS) is a debilitating condition characterized by chronic, widespread and unpredictable pain, sleep disturbance, fatigue, and disability. The pathophysiology of FMS is not well understood and available treatments yield only moderate improvements in symptoms (Mease, 2005). Many FMS patients have a difficult time adjusting to their condition; compared to other chronic pain conditions, FMS patients show increased rates of depression and anxiety (Epstein et al., 1999). Thus, gaining a better understanding of factors that contribute to physical and psychosocial adjustment in this population can inform intervention efforts to help FMS patients experience high quality of life. An abundance of data emphasizes the importance of pain cognitions in the process of reacting to and adapting to pain, and recent work suggests that taking a social developmental perspective in thinking about these cognitions and their impact on adjustment to pain may be useful (e.g., Kratz, Davis, & Zautra, 2012). This investigation examined whether and how one important social developmental indicator, adult attachment anxiety, moderates the within-day relations between morning pain intensity and subsequent pain cognitions and evening pain intensity in FMS patients.

The Role of Cognitions in Chronic Pain

According to cognitive-behavioral theory, an individual's thoughts and beliefs about pain and his or her ability to cope play critical roles in both the experience of pain and adjustment to a chronic pain condition. Cognitive-behavioral theory posits that maladaptive patterns of thinking, feeling, and responding contribute to poor adjustment in

chronic pain patients, and changing these maladaptive thoughts can improve adjustment and functioning (Turk, 2002). A large body of cross-sectional research has demonstrated that patients who think about their pain in less adaptive ways show less favorable reactions to pain, worse overall adjustment to their condition, and worse subsequent physical and psychological functioning (Turner, Jensen & Romano, 2000; Turk, Meichenbaum & Genest, 1983). Cognitive-behavioral therapies (CBT) attempt to modify maladaptive beliefs regarding pain, such as those that catastrophize about pain (e.g., “My pain is so bad I can’t stand it anymore”) or emphasize low pain control (e.g., “My pain is completely out of my control”). CBT also targets the increased use of adaptive cognitive and behavioral coping strategies, such as problem solving and activity pacing. In fact, CBT is considered the gold standard treatment for chronic pain, improving physical and psychological functioning in patients with many different pain conditions compared to credible control conditions (Compas et al., 1998; Morley et al., 1999; NIH Technology Assessment Panel on Integration of Behavioral and Relaxation Approaches into the Treatment of Chronic Pain and Insomnia, 1996; Turner, 1996; Turner, Jensen, & Romano, 2000).

Though the majority of available data makes clear the importance of cognitions in adjustment to chronic pain in general, it only shows that dispositional cognitions- more stable, trait-like patterns of thinking- are related to pain and adjustment. Research on how situational, context-specific cognitions impact daily pain and adjustment has been much more limited. In general, findings from daily diary studies tend to support cognitive-behavioral theory that maladaptive thinking about pain and one’s ability to

manage it results in more pain and worse adjustment, whereas adaptive thoughts can help mitigate pain flares (see Footnote 1) and their effects on adjustment (e.g., Grant, Long, & Willms, 2002; Holtzman & Delongis, 2007; Keefe et al., 1997). These data suggest that a chronic pain patient's cognitive responses to a pain flare can impact the amount of pain the patient is feeling later in the day. Patients who appraise the pain negatively tend to show further increases in pain. For example, rheumatoid arthritis patients' morning pain catastrophizing has been shown to predict evening pain levels, controlling for morning pain levels (Holtzman & Delongis, 2007). Adaptive patterns of thinking in response to pain, however, have been linked with less same-day pain. For example, rheumatoid arthritis patients who reported increased appraisals of their ability to cope with the pain showed same-day and next-day decreases in pain intensity (Keefe et al., 1997).

A Brief Overview of Attachment

Individuals differ in their tendencies to respond to the stress of a pain flare in adaptive or maladaptive ways. Theorists posit that throughout development, life experiences, particularly those with caregivers, create unique patterns of viewing the world, relating to others, and reacting to stressors such as pain. Attachment theory is a well-validated framework by which to understand how these differences acquired through the course of development impact adaptation to challenges. "Working models" of attachment are mental representations individuals develop of the self, the world, and significant people in it (Bowlby, 1973; Bretherton, 1985) and shape how individuals meet adversity, including chronic pain (Meredith, Ownsworth, & Strong, 2008). This study examined the hypothesis that working models of attachment influence the ways patients

with chronic pain due to FMS view their daily pain episodes and their own ability to cope with the pain, which in turn influences their subsequent experience of pain.

Originally developed based on work with infants (Bowlby, 1969), attachment theory has become one of the leading psychological theoretical frameworks in the study of emotional regulation, personality development, and interpersonal relationships across the lifespan (Cassidy & Shaver, 2008). Bowlby (1969) proposed a hard-wired attachment behavioral system with a purpose of maintaining proximity to caregivers. Over time, as infants live in a particular social environment, their behavioral systems become tailored to specific relationship partners and guide their expectations. Thus, differences in the supportiveness and availability of infants' caregivers over time create individual differences in attachment style. Eventually these experiences form the basis of attachment working models, which continue to guide behavior, cognitions, emotions, encoding of future interactions and experiences with others, and the way individuals deal with challenges such as chronic pain (Mikulincer & Shaver, 2007). Theorists posit that as children transition to adulthood, their primary attachment partner shifts from a caregiver to a romantic relationship (Hazan & Shaver, 1987).

Individual differences in attachment style relate to individual differences in relating to others, responding to environmental stressors such as chronic pain, and thinking about self, relationships, and the world. Research supports two dimensions of attachment insecurity to describe these individual differences: avoidance (A-AVD) and anxiety (A-ANX). Attachment avoidance is characterized by discomfort with closeness, preference for emotional distance and self-reliance, and the use of deactivating strategies

to manage insecurity or distress (Mikulincer & Shaver, 2007). Those with an avoidant attachment style (i.e., high A-AVD and low A-ANX) are motivated by a goal to suppress pain and distress caused by frustration of bids for proximity to and support from cool, distant, or rejecting attachment figures (Cassidy & Kobak, 1988). Thus, these individuals attempt to deactivate the attachment system altogether by downplaying threats and emphasizing their self-reliance and self-efficacy (Bowlby, 1988; Kobak, Cole, Ferenz-Gillies, Fleming, & Gamble, 1993). Anxiously attached individuals (i.e., high A-ANX and low A-AVD), in contrast, are guided by an unfulfilled goal to encourage attachment figures to pay more attention to them and provide more reliable protection (Cassidy & Kobak, 1988; Mikulincer & Shaver, 2003). These individuals tend to keep their attachment system in a state of hyperactivation, constantly intensifying bids for attention until a satisfying sense of attachment security is obtained. Thus, the attachment anxiety dimension is characterized by a strong preference for protection and closeness, intense worries about partner availability and one's value to the partner, and the use of hyperactivating strategies to manage insecurity or distress. Individuals with high levels of A-AVD and/or A-ANX are said to be insecurely attached. People who are low on both dimensions are said to have a secure attachment style, which is defined by a long-term sense of attachment security, trust in partners, expectations of partner availability and responsiveness, comfort with closeness and interdependence, and the ability to cope with threats and stressors in a constructive manner. Securely attached individuals develop these positive working models of the self and the world gained from interactions with available and supportive attachment figures (Mikulincer & Shaver, 2003). Existing

evidence has established clear predictions for the unique patterns of cognitive appraisal in response to pain in securely attached and anxiously attached individuals, although not in avoidantly attached individuals (Meredith, et al., 2008; Mikulincer & Shaver, 2003); thus, this study focused exclusively on the attachment anxiety dimension of attachment.

In theory, the goal of the attachment system is to attain a sense of “felt security” (Sroufe & Waters, 1977). Bowlby (1969, 1973) suggested that the attachment system is activated by 1) environmental threats that endanger a person’s survival (encouraging one to seek protection from others), 2) “natural clues of danger” (i.e., stimuli that are not harmful alone, but may make a dangerous situation more likely, e.g., darkness, isolation), or 3) attachment-related threats such as loss of an attachment figure. When the attachment system is activated by a threat, the primary strategy of the attachment behavioral system is proximity seeking of the attachment partner for protection or support (Bowlby, 1969). In adulthood, proximity seeking might not require actual proximity to the attachment figure; it might also involve activation of mental representations of that person to establish “symbolic proximity” (Mikulincer & Shaver, 2004). Once an individual is able to establish a feeling of felt security, the attachment system is deactivated. From its origins, attachment theory was proposed to explain the source of individual differences in how people respond to threat, suggesting that attachment is a relevant model to apply to the threat of chronic pain.

Attachment theorists have documented that individuals tend to show unique patterns of cognitive appraisal in response to a threat like pain depending on their attachment style. In response to threat, secure individuals (low A-ANX and low A-AVD)

tend to engage in realistic threat appraisal and feel optimistic regarding threat management and potential outcomes compared to insecure people (Mikulincer & Shaver, 2003). Securely attached individuals are also likely to reappraise situations, construe events in a more benign way, reframe threats into challenges, maintain an optimistic sense of self-efficacy, and attribute undesirable events to controllable, temporary, or context-dependent causes (Shaver & Mikulincer, 2007). Secure individuals perceive distress as manageable, external obstacles as surmountable, and themselves as able to exert control over many threatening events. They also perceive that support will generally be available if needed, and that seeking support from others is an effective means to enhance problem solving. Securely attached people have developed an authentic sense of personal efficacy, resilience, and optimism that they are able to maintain even in situations where attachment figures or social support are absent or unavailable (Mikulincer & Shaver, 2004). Numerous studies, including prospective and longitudinal investigations, have linked attachment security with high self-assessed competence and/or efficacy across multiple life domains (Mikulincer & Shaver, 2007).

In contrast to individuals with lower levels of A-ANX, individuals with high levels of A-ANX view threats as congruent with their attachment goals to elicit attention and protection from attachment figures, and thus, they tend to sustain or exaggerate threats (Kobak et al., 1993). Anxiously attached individuals also hold pessimistic beliefs about their own ability to regulate distress and tend to attribute threats to uncontrollable causes and/or personal inadequacies (Mikulincer & Florian, 1998). This self-defeating appraisal process is sustained through cognitive biases evidenced by anxiously attached

people, including negative beliefs about themselves and the world. These biased beliefs include overgeneralizing memories of past attachment injuries that stem from unavailable or unreliable attachment figures by inappropriately applying them to new situations (Collins & Read, 1994; Mikulincer & Shaver, 2003; Shaver & Clark, 1994). Prospective and longitudinal studies have linked attachment anxiety with negative self-evaluations of competence (Mikulincer & Shaver, 2007). Anxiously attached individuals also tend to shift attention from external cues to internal indicators of distress, displaying hypervigilance to physiological components of emotions, heightened recall of threat-related experiences, and rumination on real or potential threats (Cassidy & Kobak, 1988; Main & Solomon, 1986; Mikulincer & Shaver, 2003). Empirical data have consistently found that attachment anxiety is related to distress-intensifying appraisals of stressful events (e.g., Berant, Mikulincer, & Florian, 2001; Mikulincer & Florian, 1998). For example, a prospective study of new parents found that parents' A-ANX as measured prior to the baby's birth predicted appraisals of parenting strain and self-esteem measured when the babies were about 6 weeks old (Alexander, Feeney, Hohaus, & Noller, 2001).

Attachment and Chronic Pain

Several theorists have conceptualized pain as a stressor and a threat to one's safety and a cue of possible danger sufficient to activate the attachment system (Meredith et al., 2008; Thorn, 2004). Following from this conceptualization, individual differences in attachment are proposed as key influences on adaptation to chronic pain (Meredith et al., 2008), and existing evidence is consistent with this conceptualization. For example,

correlational research has linked insecure adult attachment to the prevalence of chronic pain in the general population (e.g., McWilliams & Bailey, 2010). In fact, insecure attachment has been associated with nearly twice the prevalence of chronic widespread pain as secure attachment in a community sample (Davies, Macfarlane, McBeth, Morriss, & Dickens, 2009). Some evidence in healthy individuals provides clues about how insecure attachment may influence the experience of pain. Among the healthy, attachment anxiety has been linked to lower pain thresholds to a laboratory-administered cold-pressor pain task (Meredith, Strong, & Feeney, 2006b). Attachment anxiety also predicted greater subjective pain in response to ischemic laboratory-induced pain (Wilson & Ruben, 2011). Moreover, when faced with pain in a laboratory setting, healthy, anxiously attached individuals tend to show less adaptive pain cognitions, including more catastrophizing, hypervigilance, and more pain-related fear and lower perceptions of control over pain and ability to decrease pain than secure individuals (McWilliams & Asmundson, 2007; Meredith, Strong, & Feeney, 2006b; Wilson & Ruben, 2011).

Among people who are experiencing chronic pain, the insecurely attached tend to fare worse than their securely attached counterparts as well. Insecure chronic pain patients show higher levels of psychological distress, depression, and anxiety than secure patients do (Ciechanowski, Sullivan, Jensen, Romano, & Summers, 2003; Mikulincer & Florian, 1998; Meredith, Strong, & Feeney, 2005; Meredith, Strong, & Feeney, 2006a; Meredith, Strong, & Feeney, 2006b). In addition, some data suggest that insecurely attached patients tend to cope with their condition in less adaptive ways, using more emotion-focused and fewer problem-focused strategies to cope than their securely

attached counterparts (Mikulincer & Florian, 1998). One study found that the links between pain affect (a two-item scale assessing pain intensity and suffering due to pain) and anxiety and depression were partially mediated by attachment anxiety (MacDonald & Kingsbury, 2006). Attachment anxiety has also been linked to a higher number of pain-related health care provider visits among chronic pain patients (Ciechanowski et al., 2003). These cross-sectional studies suggest that insecure attachment, particularly attachment anxiety, might be a risk factor for poorer psychological adaptation in the context of chronic pain.

Data on whether chronic pain patients differ in the physical aspects of adjustment (pain intensity and disability) by attachment style has been more inconsistent, with some studies finding more pain and disability among insecure patients relative to secure patients (e.g., McWilliams, Cox, & Enns, 2000) and some finding no relations between disability and attachment security (e.g., Ciechanowski et al., 2003). Past studies of the links between attachment style and coping among chronic pain patients have only evaluated self-report of typical, dispositional, trait-like responses to chronic pain. The unique ways that attachment affects each individual's coping response to episodes of pain are not captured by cross-sectional data. Thus, the question of how coping with daily pain flares varies by attachment style remains largely unexplored.

There is reason to expect that attachment may exert an effect on one's more situational reactions, like cognitive responses to fluctuations in pain day-to-day, that may not be apparent in dispositional, mean-level correlations of pain and attachment. Existing work has shown that situational and dispositional levels of pain cognitions are

not consistently related. For example, dispositional catastrophizing and situational catastrophizing reported during pain are uncorrelated in healthy individuals ($r = 0.01$), weakly correlated in patients with arthritis ($r = 0.22$), and moderately correlated in patients with temporomandibular joint disorders ($r = 0.45$; Campbell et al., 2010). Situational measures of catastrophizing predict experimental pain intensity better than dispositional measures in both healthy individuals and those with chronic pain (Campbell et al., 2010; Dixon, Thorn, & Ward, 2004; Edwards, Campbell, & Fillingim, 2005; Thorn et al., 2004). This investigation capitalized on the strengths of daily diary methodology to elaborate the processes linking attachment anxiety, situational pain cognitions, and subsequent pain intensity in individual patients over the course of a day.

How might attachment influence day-to-day physical adjustment of chronic pain patients? Meredith and colleagues (2008) have built upon attachment theory's positions on the role of attachment in reactions to threat by applying them to a theory of adaptation to chronic pain. The Attachment-Diathesis Model of Chronic Pain (ADMoCP) posits that insecure attachment style serves as a diathesis (vulnerability) that increases the likelihood of maladaptive responses to chronic pain. In this model, pain triggers attachment-related cognitive, behavioral, and emotional mechanisms. Different mechanisms are triggered depending on attachment style and these mechanisms have implications for both the experience of and adjustment to pain. According to this model, pain sensations activate attachment processes, which are then linked to unique patterns of cognitive appraisals of the pain (e.g., Is the pain a threat?), the self (e.g., Am I able to deal with this pain?), and the availability of social support (e.g., Will people respond to

my need for help?). These appraisals, in turn, relate to emotional states and the selection of coping strategies and support-seeking behavior. Ultimately, these appraisals and responses also predict adaptation to chronic pain, including the experience of pain, adjustment to pain, and well-being. Essentially, the ADMoCP proposes that attachment insecurity creates differences in pain patients' cognitive appraisals of their pain, which predicts differences in behavioral coping strategies, and ultimately adjustment.

Cognitive Appraisals

Cognitive appraisals are personal judgments about pain. The concept of cognitive appraisals was derived from stress and coping theories, which assert that the way in which an individual reacts to and copes with a stressor are determined by his or her perception of the stressor (Lazarus & Folkman, 1984). The importance the ADMoCP places on cognitive appraisals in the process of reacting to pain is consistent with cognitive-behavioral theories of pain, which conceptualize pain as the stressor (e.g., Thorn, 2004). Theorists posit that the experience of the stressor of pain triggers a cognitive process to determine whether the pain is a threat, and whether one has the resources to manage the pain (Cohen, Kessler, & Gordon, 1995; Cohen & Wills, 1985; Thorn & Dixon, 2007). One of the key assumptions of cognitive-behavioral models of pain is that pain and the affective, physiological, and behavioral reactions it can elicit change an individual's thinking about pain (Turk, 2002). Conversely, thoughts (e.g., appraisals) in response to pain can generate or change affective or physiological arousal (which can in turn influence behavior). The thoughts and emotions individuals experience before, during, and after a pain flare can exert a strong influence on their

experience of subsequent pain flares (Jensen, Turner, Romano, & Lawler, 1994).

Cognitive-behavioral theorists assert that in chronic pain patients, maladaptive appraisals of pain, personal efficacy, and control reinforce experiences of demoralization, inactivity, and overreaction to nociceptive stimulation in response to pain. Thus, these maladaptive appraisals influence behavior leading to increased psychological distress and physical disability (Jensen & Karoly, 1992). These appraisals relating to an individual's beliefs about the changeability of the pain or options for controlling the pain are considered central to adaptation to chronic pain (Grant, Long, & Willms, 2002). This study examined both maladaptive cognitions that may further increase pain and create poor adjustment and adaptive cognitions that may attenuate pain flares and promote better adjustment. It also examined individuals' appraisals focused on the pain itself and their abilities to cope with and change the pain.

Attachment Anxiety and Negative and Positive Cognitive Pain-Related Appraisals

Anxiously attached chronic pain patients tend to engage in more negative appraisals and thoughts about the pain than their secure counterparts. One of the most often-studied negative pain cognitions is catastrophizing, a type of automatic thought pattern that may occur in response to pain. Catastrophizing reflects a tendency to view pain as terrible and overwhelming. Though there has been some disagreement in the literature about whether catastrophizing should be considered an appraisal (some considering it a measure of coping instead), multiple researchers have asserted that catastrophizing can be considered an appraisal because catastrophizing scales measure the degree to which people worry and engage in negative thinking in response to pain

(e.g., Grant, Long, & Willms, 2002; Jensen & Karoly, 1991; Turner, 1991). The majority of research on the influence of catastrophizing on pain and adaptation to pain has been focused on dispositional catastrophizing. Trait-like measures of catastrophizing have been linked to a number of indicators of poor adjustment in chronic pain patients, including increased pain severity and psychological distress, and decreased physical functioning (Sullivan et al., 2001). Dispositional measures of catastrophizing have also been consistently linked with indicators of anxious attachment (Ciechanowski et al., 2003; McWilliams & Asmundson, 2007; Meredith et al., 2005, 2006a).

Some research has examined the relation between situational catastrophizing and pain in chronic pain patients. One study examined whether catastrophizing levels assessed immediately after the laboratory administration of a pain stimulus predicted pain intensity ratings in healthy individuals, individuals with temporomandibular joint (TMJ) disorders, and individuals with arthritis (Campbell et al., 2010). Findings indicated that higher levels of situational catastrophizing were linked with lower pain thresholds and higher pain ratings in all three subject groups. A few studies have reported similar associations between situational catastrophizing and pain intensity outside the laboratory using experience sampling methodology. In a 30-day study of women with chronic low back pain, days with higher ratings of catastrophizing were associated with increases in daily pain intensity ratings (Grant, Long, & Willms, 2002). Sturgeon and Zautra (2013) also found links between situational catastrophizing and pain intensity in rheumatoid arthritis patients such that pain flares predicted greater catastrophizing. Holtzman and Delongis (2007) examined relations between changes in pain and catastrophizing within

day by obtaining reports twice daily for a week in rheumatoid arthritis patients. They found that morning catastrophizing predicted evening pain controlling for morning pain. Increased pain also predicted increased catastrophizing, concurrently and later in the day.

Only a few studies have investigated how attachment relates to pain catastrophizing. In a study of healthy individuals conducted in the laboratory, attachment security moderated the effect of increased pain intensity on catastrophizing, such that less secure individuals were more likely to catastrophize in response to increased pain (Meredith et al., 2006b). Only one study has investigated the influence of attachment on situational catastrophizing and pain intensity in a chronic pain population. Kratz and colleagues (2012) examined the impact of attachment on daily measures of pain intensity, catastrophizing, and social coping in a sample of 210 women with fibromyalgia and/or osteoarthritis using electronic diaries. Across the 30 days of diaries, they found no mean differences in pain or catastrophizing between patients high and low in A-ANX. However, on days of increased pain, anxiously attached women showed greater increases in catastrophizing compared to non-anxious women. Kratz and colleagues' work demonstrated that attachment security plays a role in cognitive responses to increased pain on a day-to-day basis in chronic pain patients. However, this study was limited to examining the effects of one specific appraisal, catastrophizing, albeit an important one. Yet a number of other appraisals (i.e., about the pain and about the individual's abilities to manage, both positive and negative), are highlighted in dynamic models of pain coping and adjustment. This study aimed to build on the work of Kratz et al. (2012) by considering the moderating impact of anxious attachment on within-person daily changes

in more general negative and positive cognitive appraisals of not only the pain but also the individual's perception of available resources to manage the pain. It also assessed how these daily changes in appraisals predict changes in pain intensity throughout the day.

The moderating effect of anxious attachment on pain-related situational catastrophizing has garnered some empirical attention, but there is limited data on whether anxiously-attached individuals tend to think other negative pain-related thoughts in response to increased pain. However, data from the attachment literature reviewed above linking A-ANX to negative patterns of thought in response to stressors in general suggests that more anxious individuals may not only catastrophize more, but also may tend to react to pain with more negative appraisals of the pain in general compared to their less anxious counterparts (e.g., Mikulincer & Shaver, 2003). Some evidence suggests that appraisals regarding the experience of pain do involve thoughts about the self and others. For example, Gil and colleagues (1990), in a study of patients experiencing pain from sickle cell disease, rheumatoid arthritis, and chronic pain, conducted a factor analysis of situational negative thoughts in response to pain. They clustered these thoughts into three categories: negative self-statements, negative social cognitions, and self-blame. Patients who engaged in more negative self-statements and negative social cognitions reported more pain and psychological distress overall compared to patients who reported fewer negative thoughts. The results of this study suggest that certain types of negative thoughts in response to pain tend to cluster together and these clusters predict different pain intensity outcomes; thus, if an individual engages

in one type of negative thinking (e.g., catastrophizing), he/she is also likely to engage in other similar types of negative thought (e.g., irritation by pain and self-criticism related to pain). This study expanded the focus beyond catastrophizing alone to examine 1) the role of a more general style of negative thinking about pain (i.e., a latent variable estimated by items measuring catastrophizing, irritation by pain, and self-criticism) in response to a pain flare on the course of pain throughout the day, and 2) whether the link between pain and increases in negative thinking is moderated by attachment anxiety. Given data showing a tendency to engage in negative appraisals among anxiously attached individuals, I predicted that patients with high A-ANX would show a greater increase in negative pain-related cognitions in response to a pain flare compared to their low A-ANX counterparts, which would in turn predict a greater increase in pain intensity at the end of the day.

In response to the threat of increased pain, individuals may also respond with positive appraisals of their ability to react to the pain. Though less commonly studied compared to negative appraisals, positive cognitive appraisals have been shown to enhance the predictability of physical and psychological illness outcomes in a between-person analysis (Evers et al., 2001). Judgment of one's ability to cope with pain (i.e., pain coping self-efficacy) is one of the most studied positive appraisals. Appraising the self as equipped to cope with a stressor is necessary for successful adaptation (Cohen & Wills, 1985; Lazarus, Kanner, & Folkman, 1980). Self-efficacy predicts effort and participation in an activity; individuals are much more likely to engage in activities they believe they will be able to execute successfully (Strong, 1995; Turner, Jensen, & Romano, 2000).

Most data on pain self-efficacy in chronic pain patients is cross-sectional, using dispositional measures of the construct. Dispositional pain self-efficacy has been linked with less pain intensity (Arnstein, 2000), less pain and avoidance behavior (Asghari & Nicholas, 2001), greater functional status (Strong, 1995), and improved coping with pain (Turner, Jensen, & Romano, 2000). Trait-level arthritis self-efficacy predicted daily pain, pain control, self-efficacy, and mood over the course of 30 days in rheumatoid arthritis patients (Lefebvre et al., 1999). Meredith and colleagues (2006a) found relations between anxious attachment and low levels of dispositional pain self-efficacy and between secure attachment and high levels of dispositional pain self-efficacy.

A few studies have noted the positive influence of high coping efficacy on day-to-day pain intensity ratings in chronic pain patients using experience sampling methodology. One 30-day study of rheumatoid arthritis patients found that within-day increases in coping efficacy predicted same-day and next-day decreases in pain intensity (Keefe et al., 1997). An investigation of 30 temporomandibular disorder patients over one week, with four analyses per day found that pain self-efficacy predicted pain intensity when measured concurrently, but not at the next time point (Litt, Shafer, & Napolitano (2004). However, no research has examined the link between attachment anxiety and situational pain coping efficacy. An analysis conducted in our lab examining the effect of relationship satisfaction (which has consistently been correlated with attachment style [Feeney, 1999]) on outcomes in women with fibromyalgia, osteoarthritis, or both found that on days of higher pain, women with high levels of relationship satisfaction in their spousal relationships showed smaller increases in pain-

related coping difficulty than those with low levels of relationship satisfaction and those not in a relationship (Taylor, Davis, & Zautra, 2013). Additionally, the smaller pain-related changes in in pain coping difficulty experienced by happily-partnered versus the other patients helped to explain their smaller pain-related increases in disability. These findings suggest that insecurely attached individuals may show greater declines in positive self-thinking in response to pain flares, potentially leading to poorer adaptation.

Closely related to the concept of self-efficacy is that of locus of control, beliefs about whether certain life outcomes are due to one's own efforts (internal locus of control) or those of others (external locus of control; Bandura, 1986). A trait-level measure of perceived control over pain was related to lower reported pain levels over 75 days in a daily diary study of rheumatoid arthritis patients (Tennen, Affleck, Urrows, Higgins, & Mendola, 1992). Moreover, patients who endorse a high internal dispositional locus of control report less frequent pain and lower pain intensity, and improve more from multidisciplinary treatment than those with a low internal locus of control (Harkapaa, 1991; Harkapaa, Jarvikoski, Mellin, Hurri, & Luoma, 1991). The limited within-person data available from diary studies suggest a similar trend. For example, increases in rated control over pain were related to same-day reductions in pain intensity in a 30-day diary study of women with chronic low back pain (Grant, Long, & Willms, 2002). However, some within-day analyses of chronic pain patients have not found links between pain control and pain intensity (Litt, Shafer, Napolitano, 2004; Sorbi et al., 2006). Like dispositional measures of self-efficacy, dispositional measures of pain control seem to be inversely related to attachment anxiety. A laboratory assessment of

healthy individuals exposed to cold pressor pain, attachment anxiety was related to perceived diminished control over pain and diminished ability to decrease pain within-person (Meredith et al., 2006b). No studies have examined the relations between attachment anxiety and pain control appraisals in response to pain episodes in individuals with chronic pain.

Cognitive-behavioral theories of pain suggest that individuals engage in multiple appraisals in response to pain, including appraisals of the pain itself and one's ability to manage the pain (e.g., Thorn, 2004). These appraisals may be adaptive, promoting higher functional health despite pain, or maladaptive, promoting more limitations during pain episodes. Thus, a comprehensive investigation of situational pain appraisal processes should include adaptive and maladaptive appraisals of both the pain and one's ability to manage it. Gil and colleagues' (1990) factor analysis of negative cognitions in response to pain suggests that pain-related cognitions tend to cluster, such that if an individual appraises one domain negatively (e.g., self), they are likely to engage in other, similar negative appraisals in that domain in response to pain as well. Though there have been no similar studies specifically examining adaptive cognitions in response to pain, Grant and colleagues (2002) found common variance between morning pain control and self-efficacy in predicting end-of-day pain, such that when self-efficacy was added to the model, the effect of pain control was no longer significant. Thus, I hypothesized based on limited available evidence that positive and negative (adaptive and maladaptive) pain cognitions form distinct clusters by appraisal valence.

The current study examined the influence of negative pain appraisals, as previously discussed, and positive pain appraisals- a latent variable estimated by items measuring coping efficacy, pain control, and pain non-reactivity- on the course of pain throughout the day. This study is the first to explore the idea of clusters of adaptive and maladaptive appraisals as situational responses to pain that predict subsequent same-day pain. Given data showing that securely attached individuals tend to appraise the pain and themselves more adaptively and have higher self-efficacy in the face of stress, I hypothesized that low A-ANX individuals will report more of these positive appraisals in response to pain compared to high A-ANX individuals (e.g., Mikulincer & Shaver, 2003). The available data regarding situational positive appraisals suggests that increased positive appraisals are related to lower levels of same-day pain (e.g., Keefe et al., 1997). The current study tested the hypothesis that individuals with low levels of A-ANX will show smaller decreases in these positive appraisals in response to pain flares compared to their more anxiously attached counterparts, and these positive appraisals will ultimately predict the maintenance of pain intensity from the late morning through the end of the day.

Model and Hypotheses

This study tested a model specifying attachment anxiety as a moderator of the within-day relations between pain flares and positive and negative pain-related appraisals (see Figure 1) in a sample of individuals with FMS. Three aspects of the current study are unique relative to previous literature. First, it provides the unique opportunity to evaluate the within-day temporal ordering pain cognitions and pain intensity in a

population of FMS patients. Second, it assesses the impact of positive cognitions in addition to negative cognitions on daily pain. Third, it is the first to test the moderating effect of attachment anxiety on the links between pain intensity and cognitive appraisals of the pain. Like the study conducted by Kratz and colleagues (2012), this study applied the basic ideas of the ADMoCP to examine the within-day effects of attachment anxiety on cognitive responses to pain episodes, which in turn link to subsequent pain.

Attachment anxiety was expected to exacerbate the maladaptive effects of morning pain flares on afternoon cognitive appraisals, heightening afternoon maladaptive pain-related appraisals which in turn, were expected to promote subsequent elevations in pain at the end of day. The moderating effect of attachment anxiety on the relation between morning and evening pain was expected to be mediated by afternoon pain cognitions.

Method

Participants

Participants were recruited in the Phoenix metropolitan area from print and online advertisements, physician referrals, and fibromyalgia support groups to participate in a larger randomized clinical trial evaluating “mind-body” treatments for fibromyalgia. Inclusionary criteria included: 1) aged 18-72, 2) either a) self-reported pain in at least three of four major body areas lasting for at least three months or b) self-reported pain in two of four major body areas lasting for at least three months, a past-month fatigue rating of above 40 on a 0-100 scale with 0 being “no fatigue” and 100 being “fatigue as bad as it can be”, and a past-month sleep quality rating of less than 75 on a 0-100 scale with 0 being “lowest possible sleep quality” and 100 being “the best

sleep possible”. Participants also had to meet American College of Rheumatology diagnostic criteria for FMS using a tender point examination administered by a registered nurse (Okifuji, Turk, Sinclair, Starz, & Marcus, 1997; Wolfe et al., 1990). Exclusionary criteria included: 1) a diagnosed autoimmune disorder, 2) diagnosed neuropathic pain, 3) involvement in pain-related litigation, 4) major surgery scheduled within the study window of 4-5 months, 5) current participation in another research study or clinical trial for pain or depression, and 6) currently receiving counseling for pain or depression. For the current study, individuals without a romantic partner (i.e., did not complete a questionnaire regarding their attachment to a romantic partner) were also excluded from the analyses.

Table 1 depicts the demographic characteristics and descriptive statistics for key study variables for partnered individuals, who were included in the study ($N = 174$), and unpartnered individuals, who were excluded from the study ($N = 48$). Participants who met criteria for the current study were 174 partnered individuals between the ages of 19 and 72 ($M = 50.89$ years). The vast majority were female (87.4%), Caucasian (85.8%), and had completed at least some post-high school education (83.9%). A little over half of the included participants were married (59.2%). T-tests and χ^2 analyses presented in Table 1 demonstrate no differences between the groups of participants who were and were not included in the analyses on demographic and study variables with the exception of household income (partnered participants reported a significantly higher income, $p < .001$).

Notably, relatively low mean levels of A-ANX were present in this treatment-seeking FMS sample. A community sample of 21,838 individuals with romantic partners (81.5% female) reported a mean A-ANX score of 3.25 ($SD = 1.98$) and a mean A-AVD score of 2.47 ($SD = 1.31$) on the ECR-RS in regards to their partners (Fraley, Heffernan, Vicary, & Brumbaugh, 2011). Whereas the A-ANX mean in this community sample was higher and more variable than that of the FMS sample of the current study ($M = 2.37$, $SD = 1.30$), the A-AVD mean for this community sample was comparable to the FMS sample in this study ($M = 2.26$, $SD = 1.11$).

Table 2 presents group differences between the “low” and “high” A-ANX tertile groups. The “low” group was slightly older and had a greater household income than the “high” group. There were also significant group-level differences in catastrophizing, irritation by pain, and self-criticism, with the “high” A-ANX group reporting greater mean levels of these negative cognitions in the afternoon at a between-person level compared to the “low” A-ANX group. The “high” A-ANX group also reported marginally greater mean late morning and end-of-day pain and marginally fewer mean numbers of afternoon pain coping efficacy and pain control cognitions than the “low” A-ANX group between participants.

Procedure

All procedures were approved by the Institutional Review Board at Arizona State University (see Appendix A). The procedures utilized in this analysis were part of a larger randomized clinical trial investigating cognitive-behavioral and mindfulness group psychotherapy for FMS patients. Participants were first screened for eligibility by

telephone. After screening, participants were mailed an initial questionnaire assessing demographics and individual difference variables including personality, life orientation, and attachment. Participants were reimbursed \$20 for completing this questionnaire. A registered nurse then conducted a home visit in which the participant was consented and introduced to study procedures. Among other assessments, the nurse administered a tender point exam (Okifuji, Turk, Sinclair, Starz, & Marcus, 1997) to determine whether the participant met diagnostic criteria for FMS and was therefore eligible for the study. As part of their participation, participants also underwent a telephone interview about depression, trauma, and stressful life events, attended a laboratory session to assess emotion-modulated startle responses and pain reactivity, participated in the group intervention, and completed follow-up questionnaires regarding functional health, mental health, and social functioning. Data for the current study were drawn from the initial questionnaire and pre-intervention daily diary portion of the larger project.

Participants were provided with a mobile phone and trained by a research assistant to use the phone to complete electronic diaries four times a day for 21 days. An automated phone system called each of the participants each morning 20 minutes following his/her specified wake-up time for the morning interview, at 11:00 a.m. for the late-morning interview, at 4:00 p.m. for the afternoon interview, and at 7:00 p.m. for the end-of-day interview. The system asked participants questions verbally, and the participants responded by keying in the appropriate number key on the phone. If the participant missed the call, he or she could call the system within two and half hours to complete the call. Participants were encouraged to call laboratory staff immediately if a

problem occurred with the phone system. They were monitored and contacted if they were failing to complete diaries. Participants were compensated three dollars for each day with completed entries at all four time points.

Measures

All measures are included in Appendix B.

Attachment. Attachment was measured using the Experiences in Close Relationships- Relationship Structures (ECR-RS) scale (Fraley et al., 2011) in the initial questionnaire. The ECR-RS scale consists of nine questions, six for A-AVD and three for A-ANX. One item out of the 10 presented in Appendix B, “I don’t fully trust this person”, was not included in the computing of scale scores after Fraley and colleagues (2011) found that it loaded on both A-AVD and A-ANX and deleted it from their scale. A-ANX items were “I often worry that this person doesn’t really care for me,” “I’m afraid this person may abandon me,” and “I worry that this person won’t care about me as much as I care about him or her”. Participants were asked to rate the extent to which they agreed with each statement on a one to five scale with one indicating “Strongly Disagree” and five indicating “Strongly Agree”. Cronbach’s alpha for this scale for the included participants indicated high reliability ($\alpha = .93$).

It is important to note that although much of the earlier literature on attachment conceptualized attachment styles as discrete types (e.g., secure, preoccupied/anxious, dismissing/avoidant, fearful), taxometric analyses suggest that attachment patterns are better described as continuous variations along the two orthogonal dimensions of anxiety and avoidance (Diamond & Hicks, 2005; Fraley & Waller, 1998). Some have argued that

the dimensional approach to attachment style better reflects the actual distribution of interindividual differences in attachment and the continuous nature of contributors to attachment style (e.g., maternal sensitivity), and thus it is used in this investigation (Fraley & Waller, 1998).

Participants first answered the questions relating to a spouse or significant other, if applicable. They then filled out the same questions about their self-rated closest relationship besides a spouse or significant other. Participants were asked to indicate the type of relationship they have with this person. This procedure differs from the ECR-RS in that typically, the scale specifies the relation participants should consider when answering the attachment questions (e.g., mother, father, etc.). Thus, each participant had a continuous value of A-ANX for his or her relationship with a spouse or significant other (if applicable) and his or her self-determined next closest relationship. Only participants who rated their attachment style related to a spouse or significant other were included in the analyses, as the attachment literature considers the romantic relationship the primary attachment relationship in adulthood (Hazan & Shaver, 1987). Additionally, comparing romantic attachment style with close other attachment style would not be ideal given the unique qualities of romantic versus friend, family and other relationships.

Pain. Pain intensity was measured on a 101-point numerical rating scale (Jensen, Karoly, & Braver, 1986). Pain was assessed in the late morning, early afternoon, and at the end of the day. Late morning and end-of-day time points were chosen for analysis in order to establish within-day temporal precedence from late morning pain to afternoon pain cognitions to end-of-day pain. At the late morning and early afternoon time

points, participants were asked to report on their overall level of pain in the past two to three hours. At the end of day time point, participants were asked to report their overall level of pain that day. They were asked: “What was your overall level of pain?” They were instructed to “Enter a number between 0 and 100 that best describes your pain level. A zero would mean ‘no pain’ and a one hundred (100) would mean ‘pain as bad as it can be.’”

Pain Cognitions. Pain cognitions were measured at the early afternoon time point. Participants were instructed to report the degree to which they experienced specific cognitions in the past two to three hours on a five-point scale from 1 (not at all) to 5 (completely). Catastrophizing was measured using one item from the Pain Catastrophizing Scale (Sullivan, Bishop, & Pivik, 1995): “You felt your pain was so bad you couldn’t stand it anymore”. Irritation due to pain was measured by asking participants “How much were you irritated by your pain?” Self-criticism was measured by asking participants “How much have you told yourself that you shouldn’t be feeling the way you’re feeling?” Pain coping efficacy was measured with an item used in multiple analyses of coping with pain: “You coped effectively with your pain” (Affleck, Tennen, Urrows, & Higgins, 1992; Keefe et al., 1997; Stone & Neale, 1984). Perceived control over pain was measured using the following item: “You were able to control your pain” (Affleck, Tennen, & Apter, 2001). Reactivity to pain was measured by asking participants “How much were you able to feel your pain without having to react to it?”

Data Analytic Strategy

This study investigated the relations among pain and pain cognitions for individuals who vary in attachment anxiety in a model that takes temporal precedence into consideration. A series of models were estimated. Collectively the models examined relations of late morning pain to afternoon pain cognitions to end-of-day pain at the within-person level, testing whether these relations varied by attachment anxiety.

The following hypotheses were tested at the within-person level (Figure 1):

1. Hypothesis 1. On days when FMS patients report higher levels of pain in the late morning compared to their own mean late morning pain ratings (i.e., person-centered a.m. pain), they will report a) increased levels of negative cognitive appraisals and b) decreased levels of positive cognitive appraisals that afternoon.
2. Hypothesis 2a. On days when FMS patients report higher levels of negative cognitive appraisals in the afternoon compared to their own mean levels of afternoon negative cognitive appraisals (i.e., person-centered p.m. negative appraisals), they will report higher levels of pain that evening.
Hypothesis 2b. On days when FMS patients report lower levels of positive cognitive appraisals in the afternoon compared to their own mean levels of afternoon positive cognitive appraisals, they will report higher levels of pain that evening.
3. Hypothesis 3. Attachment anxiety will moderate the relationships between centered late morning pain and afternoon negative appraisals and positive appraisals, such that patients with higher versus lower levels of A-ANX will

show a) greater increases in negative appraisals and b) greater decreases in positive appraisals in response to increased centered late morning pain compared to patients with lower levels of A-ANX. Thus, ultimately, patients with higher levels of A-ANX will report greater evening pain after a late morning pain flare.

4. Hypothesis 4: The relation between the A-ANX x centered late morning pain interaction and end-of-day pain is expected to be partly mediated by centered end-of-day positive and negative appraisals.

The data analyses proceeded in a series of steps. First, a missing data distribution was generated and descriptive statistics (including intraclass correlations of diary variables) were calculated for all variables. Multilevel confirmatory factor analysis (MCFA) was then utilized to determine if the items used to assess afternoon cognitive appraisals reflect two latent factors as hypothesized, using MPlus version 7 (Figure 2; Muthen & Muthen, 1999-2012). Multilevel CFA accounts for the non-independence of observations in nested data by partitioning the between- and within-person variance and modeling each as unique sources of covariance (Hox & Maas, 2001). It was expected that these cognitive appraisals would load on two latent factors: negative appraisals and positive appraisals. Catastrophizing, irritation with pain, and self-criticism were expected to load on the negative appraisal factor. Pain control, pain coping efficacy, and reactivity to pain were expected to load on the positive appraisal factor. A two-factor structure was tested to assess the hypothesis that the negative appraisal cluster and the positive appraisal cluster of pain cognitions were best represented as two factors. Model fit was

evaluated according to the loadings and established fit guidelines for multiple fit indices including the comparative fit index, the root mean square error of approximation, and the within- and between-group standardized root mean square residuals (Hu & Bentler, 1999). The findings from this analysis are presented in the results section.

Next, MSEM (Preacher et al., 2010) was used to model the proposed mediated moderation relations, including the latent structure of the hypothesized cognitive appraisal styles from individual cognitions and accounting for variation both within and between participants by modeling both the within- and between-person variables simultaneously. All MSEM models were estimated using MPlus version 7 (Muthen & Muthen, 1999-2012). First, a non-moderated multilevel structural two-mediator model was estimated to test: 1) the relations between late morning pain and both afternoon negative pain- and positive self-appraisals (paths a_1 and a_2 in Figure 1); 2) the relations between afternoon negative pain- and positive self-appraisals and evening pain (paths b_1 and b_2 in Figure 1); and 3) the roles of the afternoon negative pain- and positive self-appraisals as statistical mediators of the relation between late morning pain and evening pain. The mediating (indirect) effects of each type of appraisal were calculated by taking the product of the coefficients of the paths between the predictor and the mediators (a paths) and the paths between the mediators and the outcome (b paths). Asymmetric confidence limits for the indirect effects of each mediator were computed using Rmediation (Tofighi & Mackinnon, 2011), which accounted for the correlations between the a and b paths (Kenny, Korchmaros, & Bolger, 2003).

To explore the possibility that the non-shared aspects of the positive and negative cognitions might also play a role in the daily pain process, the model described previously was re-run without the structural component. That is, the negative cognition items and the positive cognition items were each averaged to create a composite score for each afternoon of diaries. These composite scores were included in the model as measured rather than latent variables. Though the composite variables include measurement error whereas the latent variables do not, the value of exploring the relations between pain and the unique variance of the measured cognitions in addition to the common variance was prioritized. The within-person reliability for negative appraisals was Cronbach's $\alpha = .57$ and for positive appraisals was Cronbach's $\alpha = .59$. The between-person reliability for negative appraisals was Cronbach's $\alpha = .81$ and for positive appraisals was Cronbach's $\alpha = .78$.

Next, the moderating effects of attachment anxiety (a between-person, trait-level variable) were assessed. The following paths were estimated: 1) the interaction of late morning pain by A-ANX predicting positive and negative appraisals; and 2) afternoon appraisals predicting evening pain. In addition, the MSEM estimated the role of these interactions as mediators of the link between late morning and evening pain. To assess whether A-ANX significantly moderates the links between late morning pain and each type of appraisal, A-ANX was reconstructed from a continuous to a categorical variable, based on whether individuals scored in the highest tertile (i.e., "high" A-ANX group) or the lowest tertile (i.e., "low" A-ANX group) on the A-ANX measure in the current sample. A categorical variable was required to run the MSEM moderation model.

Selecting the upper and lower tertiles of the distribution created distinct groups with regard to these attachment dimensions. Each parameter in the model was freed to vary between the groups during estimation. The path coefficients from this analysis were compared using the Wald chi square difference test to determine whether the path coefficients vary significantly between the high and low A-ANX groups.

Results

Intraclass Correlations and Intercorrelations

Intraclass correlations of the diary variables range from $r = .35$ to $.70$ and are reported in Table 1. Intercorrelations for the within-person and between-person levels of the multilevel models are presented in Tables 3 and 4, respectively. As expected, daily increases in morning pain were associated with greater afternoon negative cognitions fewer afternoon positive cognitions at both within- and between-person levels.

Additionally, afternoon negative cognitions were positively related to evening pain and afternoon positive cognitions were negatively related to evening pain. Of note, the correlation between A-ANX and A-AVD ($r = .65$) was notably higher than that reported using this scale in a large community sample ($r = .44$) (Fraley et al., 2011). Because of this high correlation, I planned to control for A-AVD in the final model if A-ANX was found to be a moderator as hypothesized (Fraley et al., 2011).

Multilevel Confirmatory Factor Analysis

The first analysis utilized MCFA to determine whether the cognitive appraisals of pain assessed in the afternoon loaded on two latent variables as predicted: catastrophizing, irritation with pain, and self-criticism on a negative appraisal factor, and

pain control, pain coping efficacy, and reactivity to pain on a positive appraisal factor. Results of this analysis, presented in Figure 3, are consistent with a two-factor structure of pain cognitions into negative and positive factors. Fit indices indicated a good fit overall for this two-factor structure using Hu and Bentler (1999) and Hsu (2009) standards for RMSEA (RMSEA = 0.030), CFI (CFI = 0.969), and both the between-model and within-model SRMR (SRMR_{within} = 0.023, SRMR_{between} = 0.054). Factor loadings were generally higher at the between-person level (> 0.574) than the within-person level (all factor loadings > 0.347). Thus, this two-factor structure provides an adequate fit of the data at both between- and within-person levels of analysis.

Mediation in Multilevel Structural Equation Model

The next analysis utilized a non-moderated multilevel structural two-mediator model to estimate: 1) the relations between late morning pain and both afternoon negative and positive appraisals (paths a_1 and a_2 in Figure 1); 2) the relations between afternoon negative appraisals and positive appraisals and evening pain (paths b_1 and b_2 in Figure 1); and 3) the roles of the afternoon negative and positive appraisals as statistical mediators of the relation between late morning pain and evening pain. The results of these analyses are presented in Table 5. The findings indicate that as hypothesized, higher late morning pain predicts more negative appraisals, and fewer positive appraisals at the within-person level (see row 1 of Tables 5 and 6). As depicted in Figure 1, paths a_1 and a_2 are significant ($a_1: B = 0.013, p < .001, a_2: B = -0.010, p < .001$). The results of this analysis also showed that, consistent with hypotheses, increased negative cognitions in the afternoon predicted higher end-of-day pain at the within-person level ($b_1: B = 13.718, p <$

.001). However, inconsistent with hypotheses, decreased positive cognitions in the afternoon did not predict a higher level of end-of-day pain at the within-person level (b_2 : $B = -0.517, p >.05$). Negative cognitions significantly mediated the link between late morning pain and end-of-day pain (a_1b_1 : $B = 0.178, p <.001$). The asymmetric confidence interval for the a_1b_1 path was 0.131 to 0.230. There was a significant direct effect of late morning pain on end-of-day pain ($B = 0.24, p <.001$).

Though the hypotheses for this analysis were all at the within-person level, MSEM also simultaneously estimates the between-person level. Between-person level results for this analysis are presented in rows 2 and 4 of Table 5. Consistent with the within-person level results, paths a_1 and a_2 were also significant ($ps < .001$) at the between-person level. Neither the b_1 or b_2 paths were significant at the between-person level ($ps >.05$). Thus, no mediation between late morning and end-of-day pain was found at the between-person level for negative or positive cognitive appraisals.

The next analysis modeled negative and positive appraisals as measured variables (within-person composite scores of each of the three cognitions for each type of appraisals) rather than latent variables in order to assess the hypothesized pathways with the unique variance of each cognition included in the composites. The results are presented in Table 6. The findings suggest that, consistent with the previous model and as hypothesized, higher late morning pain predicts more negative appraisals and fewer positive appraisals at the within-person level (see rows 1 and 3 of Table 6). As depicted in Figure 1, paths a_1 and a_2 are significant (a_1 : $B = 0.012, p < .001$, a_2 : $B = -0.009, p < .001$). The results of this analysis also showed that, consistent with the structural model

and hypotheses, increased negative cognitions in the afternoon predicted higher end-of-day pain at the within-person level ($b_1: B = 7.470, p < .001$). In this model, as hypothesized, decreased positive cognitions in the afternoon predicted a higher level of end-of-day pain at the within-person level ($b_2: B = -3.352, p < .001$). Negative cognitions significantly mediated the link between late morning pain and end-of-day pain ($a_1b_1: B = .088, p < .001$). Positive cognitions also significantly mediated the link between late morning pain and end-of-day pain ($a_2b_2: B = .029, p < .001$). The asymmetric confidence interval for the a_1b_1 path was 0.069 to 0.112 and for the a_2b_2 path was 0.017 to 0.046. There was a significant direct effect of late morning pain on end-of-day pain ($B = 0.316, p < .001$). Consistent with the previous model with a structural component, the negative cognition indirect pathway was stronger than the positive cognition pathway: a contrast parameter created to compare the strength of the indirect paths of the negative cognitions and the positive cognitions was significant ($B = 0.058, SE B = 0.014, p < .001$).

The results of the estimation of the between-person level of analysis are presented in rows 2 and 4 of Table 6. Paths a_1 and a_2 in Figure 1 were significant ($ps < .001$) at the between-person level. Neither the b_1 or b_2 paths were significant at the between person level ($ps > .05$). The between-person level findings are consistent with those in the previous model incorporating a structural component.

Moderation in Multilevel Structural Equation Model

The final models explored whether A-ANX moderated the links between late morning pain and afternoon negative focused cognitions and late morning pain and afternoon positive cognitions (paths a_1 and a_2). These models also included the links

between afternoon cognitions and end-of-day pain. Moderation was first tested in the first model described in the previous section, modeling cognitions as latent variables. Because this model only showed a significant mediation of negative cognitions, only this pathway was tested for moderation. However, positive cognitions pathway was still included as a mediator in the model. Inconsistent with predictions, findings indicated that high and low anxious attachment groups did not differ in the relation between morning pain and afternoon negative appraisals. That is, A-ANX did not moderate the link between late-morning pain and afternoon negative cognitions (Wald test value = 1.067, $p = 0.30$). Altering the model to include cognitions as measured composites rather than latent variables (as in the second model described in the previous section) did not alter the findings; A-ANX did not moderate the link between late-morning pain and afternoon negative cognitions (Wald test value = 1.708, $p = .19$). Because positive cognitions were also found to be a significant mediator of the link between late-morning pain and end-of-day pain when modeled as a measured composite variable, A-ANX was also explored as a moderator of this pathway (a_2). Inconsistent with predictions, findings indicated that high and low anxious attachment groups did not differ in the relation between morning pain and afternoon positive appraisals. That is, A-ANX did not moderate the pathway between late-morning pain and afternoon positive cognitions (Wald test value = 0.581, $p = .45$).

To capitalize on the continuous nature of the A-ANX variable which is not possible in MSEM, I conducted a follow-up analysis using SAS PROC MIXED (SAS Institute, Cary, NC, USA) to assess moderation in a piece-wise fashion. Specifically, the

model assessed whether the continuous A-ANX variable moderated the link between late morning pain and the afternoon negative pain cognition composite variable. Consistent with the MSEM moderation analysis, A-ANX did not significantly moderate this link ($B = -0.0002$, $SE = 0.0005$, $p = .69$).

In summary, individuals who reported more of one type of appraisal (positive or negative) in the afternoon also reported higher levels of other, similar appraisals at that time, supporting an underlying unique latent structure to both negative and positive appraisals. On a day of greater morning pain, individuals reported greater levels of afternoon negative cognitions and fewer afternoon positive cognitions. This increase in negative afternoon pain cognitions predicted more end-of-day pain. Though the latent afternoon positive cognition variable was not found to mediate the link between late morning and end-of-day pain, modeling these cognitions as measured composite variable found that positive cognitions partially mediated the relation between late morning and end-of-day pain. Negative cognitions had a stronger influence on end-of-day pain than positive pain cognitions. Individuals with higher levels of A-ANX did not show a greater increase in negative cognitions or a greater decrease in positive cognitions in response to a day of high pain compared to those with lower levels of A-ANX.

Discussion

This study was the first to examine the dynamic process of pain in chronic pain patients as it unfolds throughout the day with a focus on: 1) the role of valence-specific clusters of negative and positive cognitive appraisals and 2) the impact of A-ANX on these appraisals. Both positive and negative cognitions were found to have a role in the

daily pain process. When FMS patients had a day of higher pain in the morning, they tended to think more maladaptively about the pain and their ability to cope in the afternoon, reporting more negative and fewer positive pain-related cognitions. These changes in both afternoon negative and positive cognitions uniquely predicted greater pain at the end of the day, partially mediating the link between late morning and end-of-day pain. Increases in negative cognitions were more strongly linked with end-of-day pain than were decreases in positive cognitions. I tested whether individuals reporting higher levels of attachment anxiety might be more prone to this maladaptive appraisal reaction (more negative and fewer positive appraisals) and found that A-ANX did not have an impact on the changes in cognitive appraisals in response to increased late morning pain.

The current study provides a major contribution to the literature on cognitive-behavioral theories of pain. It is the first to show links between late morning pain and subsequent afternoon pain-related cognitions as demonstrated in temporally-ordered, within-day assessments in chronic pain patients. Specifically, results showed that higher pain predicts less adaptive thinking about pain later in the day (more negative cognitions and fewer positive cognitions), and these maladaptive thinking patterns tend to lead to greater pain at the end of the day. These findings are consistent with assertions of cognitive-behavioral theories of pain that cognitions play a critical role in the pain experience in two key ways. First, the current study provides temporally-ordered support for the theories' position that the experience of pain can elicit change in an individual's thinking about pain, in the form of more negative and less positive appraisals of the pain

and individual's own capacity to cope with it (Cohen, Kessler, & Gordon, 1995; Cohen & Wills, 1985; Thorn & Dixon, 2007; Turk, 2002). This finding is consistent with within-day data linking increased morning pain with increased end-of-day maladaptive thinking in chronic pain patients (e.g., Holtzman & DeLongis, 2007).

Additionally, the finding that maladaptive thinking patterns predict greater pain later in the day supports a second key position of cognitive-behavioral theories of pain that maladaptive thinking about pain can lead to further increased pain (Turk, 2002). This finding is consistent with other within-person studies of chronic pain patients reporting that more negative thoughts (e.g., catastrophizing) and fewer positive thoughts (e.g., pain control and self-efficacy) predict greater pain concurrently and at future time points (Grant, Long, & Willms, 2002; Holtzman & DeLongis, 2007; Keefe et al., 1997; Sturgeon & Zautra, 2013). Above and beyond the temporally-ordered links between pain and cognitions, and cognitions and pain, this study was the first to demonstrate a within-day mediation of daily pain course by both negative and positive cognitions. This finding indicates a clear role for cognitions in the within-day fluctuations of pain in FMS patients. Thus, it also provides support for the intervention strategy of cognitive-behavioral therapy for pain, changing cognitions to decrease pain and improve adaptation to it. Though the design of this study did not enable the demonstration of causation between pain and cognitions, it suggests that cognitive restructuring in response to the increase in maladaptive thinking that occurs after a pain flare may disrupt a further pain increase through the day. Indeed, changes in both dispositional positive (including pain self-efficacy and pain control) and negative (including catastrophizing) cognitions have

been found to mediate long-term improvements in pain and physical functioning in response to CBT for pain in temporomandibular disorder patients (Turner, Holtzman, & Mancl, 2007). These findings also suggest that CBT therapists should educate chronic pain patients on the tendency for pain flares to precede maladaptive thinking patterns and to prepare them to utilize cognitive restructuring at those times. Though the current study did not find that cognitive restructuring techniques may be more effective for those with high A-ANX compared to low A-ANX, they may be particularly effective for individuals with a tendency to react to stressors with more negative appraisals due to personality, life orientation, or mental health concerns, for example.

Although the results of the current study provide clear support for the unique relation between increased late morning pain and afternoon positive and negative cognitions, and for the link between afternoon negative cognitions and end-of-day pain, they only provide tentative support for the link between positive cognitions and end-of-day pain. Specifically, the model including pain cognition variables as latent variables did not find that positive pain cognitions significantly mediated the link between morning and evening pain (as negative pain cognitions did). In other words, whereas the common variance underlying negative cognitions mediated the link between late morning and end-of-day pain, late morning pain predicted the common variance underlying the positive cognitions measured, but this latent factor did not predict pain at the end of the day. To explore the possibility that the unique aspects of the positive cognitions in addition to the common aspects may predict end-of-day pain, a new model was estimated modeling the positive and negative cognitive variables as measured composites. Modeling positive

cognitions in this way did provide support for positive cognitions as a mediator of the link between late-morning and end-of-day pain. The latent and measured composite versions of the cognition variables are related, but different from one another. Whereas the latent variable captures the common variance among the indicators, the measured composite is a mean of the three cognitions measured, which includes the common variance, unique aspects of each cognition, and measurement error. These unique aspects of the cognitions pain control, pain self-efficacy, and non-reactivity to pain to the model when added to the common variance in the model were linked to end-of-day pain, mediating the link between late morning and end-of-day pain. Unfortunately, this analysis does not provide information about the content of the common and unique aspects of positive cognitions. Future studies should more fully examine what unique aspects of these positive cognitions are particularly important predicting daily pain. This work would help to further refine thinking about the underlying structure of pain cognitions and define clearer pathways for cognitive intervention.

Support, although preliminary, for two unique positive and negative cognitive appraisal factors that fluctuate in relation to within-day changes in pain is nonetheless an important new idea in the literature worthy of future exploration. The independence of these pathways suggests that a pain flare may impact the factors underlying negative and positive emotions in distinct ways, and in turn, these factors may further influence pain uniquely as well. The negative and positive cognitive appraisal factors were related at the within-person level ($r = .676$), thus sharing about 46% of the variance and suggesting they are related, yet distinct. Thus, those who tend to react with intense negative

thoughts in reaction to pain may be able to concurrently sustain their level of positive thoughts. This preliminary evidence for the unique role of a positive cognition composite mediating daily pain is consistent with limited available within-day findings that changes in positive cognitions have a unique relation with changes in pain beyond negative cognitions over the course of the day. For example, morning pain control and catastrophizing both significantly predict end-of-day pain when run in the same model in women with chronic back pain (Grant, Long, & Willms, 2002). A potential role for positive cognitive appraisals independent from negative appraisals implies that CBT may impact the daily pain process not only by teaching chronic pain patients to restructure and ultimately reduce negative cognitions in response to pain, but also by promoting their use of positive coping self-statements in the face of pain (Thorn & Dixon, 2007; Turner & Romano, 2001).

Unique benefits of positive cognitions on pain outcomes over and above negative cognitions have also been found in a between-person analysis of chronic illness cognitions. The negative cognitive appraisal scale (hopelessness) and two positive cognitive appraisal scales (acceptance and perceived benefits) in the Illness Cognition Questionnaire for Chronic Diseases were found to be largely independent in the pattern of outcomes they predicted (Evers et al., 2001). Hopelessness was related more strongly to unfavorable changes in physical and psychological health (e.g., disability, disease impact on quality of life, negative mood, and passive coping), whereas acceptance and perceived benefits were related more strongly to beneficial changes in physical and psychological health (e.g., positive mood, optimism, and active coping). If the same

pattern holds within-person, positive cognitions may play an independent role in pain alongside negative cognitions, but may play a unique and potentially more influential role in increasing more positive outcomes such as positive affect and coping. For example, increased daily pain coping efficacy has been found to predict increased same-day positive mood (in addition to decreased same-day pain and negative mood; Keefe et al., 1997). Future studies should expand the outcomes examined beyond pain to gain a better sense of how both positive and negative appraisals of pain affect overall adjustment to chronic pain.

A consistent finding from both models of mediating cognitive factors was that negative pain cognitions were more closely linked with changes in pain throughout the day than positive pain cognitions were. In other words, in the face of increased pain, an increase in negative cognitions better predicted end-of-day pain than did a decrease in positive cognitions. This was the first within-day analysis that allowed for a direct comparison of the strength of positive and negative cognition mediation pathways of daily pain. Some within-day studies with chronic pain patients have found significant links between catastrophizing (a negative appraisal) and pain but not between pain control or pain coping efficacy (positive appraisals) and pain (e.g., Litt, Shafer, & Napolitano, 2004; Sorbi et al., 2006). This finding suggests that if daily pain intensity is the primary intervention target, focusing CBT on restructuring and reducing negative pain cognitions will likely be the most effective strategy, especially if the intervention is time-limited. Future studies should continue to use models that allow for direct comparisons of the strength of the relations between positive and negative cognitive

appraisals of pain to help interventions streamline and prioritize the most effective methods within CBT.

One particularly unique aspect of this study was that it attempted to more accurately reflect individuals' real life experiences by modeling several different types of cognitions, versus a single cognition (e.g., catastrophizing). The current study measured both commonly-studied cognitions (e.g., catastrophizing, pain control, and pain self-efficacy) and rarely-studied cognitions (e.g., pain reactivity, pain irritation, and pain self-criticism) and explored whether more similar types of cognitions (positive or negative) might cluster together. The results supported the idea of a common factor for negative cognitions, fluctuating within-day and partially mediating the link between morning and end-of-day pain. They also provided preliminary support for a unique positive cognition common factor involved in the daily pain process. Evidence supporting these common latent factors underlying similar types of cognitions suggests that when one experiences an increase in one type of cognition, catastrophizing for example, one will likely also report more of other, similar negative pain cognitions. In other words, pain cognitions appear to be linked, such that a whole cluster may be activated by a single stimulus. These findings add to those of Gil and colleagues (1990), who reported the clustering of similar types of negative pain-related cognitions in response to a pain flare (as measured between-person, using retrospective self-report). Gil and colleagues also found that these clusters of negative cognitions related to greater levels of psychological distress, suggesting that intervening in these thinking patterns may impact psychological functioning in addition to pain. Future studies should explore the latent structure of a

greater number of positive and negative cognitions to confirm they map similarly onto two factors by valence. Further exploration of these within-day cognitive appraisal factors may fuel modifications of cognitive-behavioral theories of pain to better reflect the mechanisms of daily pain and cognitive processes, ultimately providing more clear pathways for cognitive interventions to decrease chronic pain and improve adaptation.

The focus of the current study was on within-person hypotheses. However, findings at the between-person level deserve comment. Specifically, the between-person analyses showed that individuals who reported a higher level of pain in the late morning tended to report higher levels of negative pain cognitions and fewer levels of positive pain cognitions in the afternoon, which was consistent with the links between these variables at the within-person level. However, the between analyses did not find a significant link between afternoon negative or positive pain cognitions and end-of-day pain, in contrast to the within-person analyses. Thus, neither afternoon negative nor afternoon positive cognitions mediated the link between late morning and end-of-day pain at the between-person level. Why did the between-person level findings not fully mirror those of the within-person level in the MSEM mediation analyses? These findings can be explained by the very high between-person correlation of late morning and end-of-day pain ($r = .96$; see Table 3). Because afternoon negative and positive pain cognitions were related to late morning pain slightly more than to end-of-day pain, it is likely that all the variance was accounted for in the a path, leaving very little unexplained variance to be accounted for by the b path. Nevertheless, all the variables are strongly related to one

another at the between-person level in the manner hypothesized at the within-person level.

Beyond establishing within-day links between pain and cognitions, the second major contribution of this study was its test of the moderating effect of attachment anxiety on relations between daily pain and cognitions. Inconsistent with the hypothesis, individuals with a higher level of attachment anxiety did not show a greater increase in negative pain cognitions or a greater decrease in positive pain cognitions in response to a pain flare than those with lower levels of attachment anxiety. There are a number of potential explanations for this result. First, the attachment characteristics of this sample may have influenced the findings. Participants in the current study reported a much lower level of A-ANX and were less variable on this measure ($M = 2.37$, $SD = 1.30$) compared to a large community sample rating their significant others on the ECR-RS ($M = 3.25$, $SD = 1.98$; Fraley et al., 2011). This community sample was comparable on gender distribution to our sample (81.5% female compared to 87.4% female in the current study); however, it was notably younger (mean age = 31.35 years compared to mean age = 50.89 years in the current study). The difference in mean age likely explained at least part of the difference in A-ANX scores, as age in adulthood has been inversely related to A-ANX (Mickelson, Kessler, & Shaver, 1997). Of note, the A-AVD mean and variability were similar between the two populations. Even with the age difference, these were unexpected findings given population studies showing correlations between attachment insecurity and chronic pain (e.g., McWilliams & Bailey, 2010). A lower level of A-ANX was also surprising given that this was a treatment-seeking sample

and A-ANX has been linked to a higher number of pain-related healthcare provider visits in chronic pain patients (Ciechanowski et al., 2003). The lower mean level of A-ANX compared to the community sample likely did not constrain the ability to detect a moderation effect as the mean is not approaching the minimum score on this scale. However, the lower amount of variability in A-ANX even compared to the A-ANX variability in a sample of over 20,000 may have limited model's ability to detect a moderation effect.

The methods used to assess attachment may also help to explain the non-significant A-ANX moderation pathway. Because this analysis was part of a larger study with primary goals not related to attachment, the ECR-RS was utilized to assess attachment in a significant other and close other relationship for brevity (Fraley et al., 2011). The ECR-RS, which includes nine items for each attachment figure (3 for A-ANX), was developed from the ECR-R, a 36-item (18 for A-ANX) assessment of romantic adult attachment, to account for the within-person variation in attachment between different attachment relationships (Fraley et al., 2011; Fraley, Waller, & Brennan, 2000). The ECR-R was developed using an item response theory analysis of all the self-report items of romantic attachment in the literature and is the best available self-report dimensional adult attachment measure using multiple items (Shaver & Fraley, 2010; Fraley et al., 2000). The ECR-RS was intended to be delivered in studies with theoretical reasons to reference specific attachment relationships, including but not limited to romantic partner, mother, father, and friend (Fraley et al., 2001). The hypotheses in the current study involved a general attachment orientation rather than a

specific attachment relationship, thus the ECR-R would have resulted in a better assessment of A-ANX as hypothesized. Additionally, the current study did not assess how long-term or committed the romantic relationships measured using the ECR-RS were. Given data suggesting that it can take about two years for a romantic relationship to develop into an attachment relationship, future studies should assess relationship commitment and duration to attempt to assure all romantic relationships assessed are true attachment relationships (Fraley & Davis, 1997).

Further work may improve upon the methods of this study to evaluate the ADMoCP by measuring cognitive appraisals that more clearly map onto the three types proposed in the model: appraisals of pain, self, and others in response to a pain stressor (Meredith et al., 2008). The current study included more primarily pain-focused (e.g., catastrophizing) and self-focused (e.g., pain coping efficacy) cognitive appraisals, but no other-focused appraisals (e.g., judgment of the social support available to help manage the pain). Perhaps the particular relevance of attachment anxiety to social evaluations would have revealed a stronger effect on these other-focused appraisals, which in turn might have a greater influence on pain compared to pain- and self-focused appraisals. Additional work including social cognitions would help further clarify other possible pathways by which attachment working models might influence cognitions and adaptation to chronic pain.

The finding that A-ANX did not moderate the link between late morning and end-of-day pain is inconsistent with the position of the ADMoCP that attachment anxiety acts as a diathesis to poor adjustment in chronic pain patients through the pathway of

maladaptive appraisals in response to pain (Meredith et al., 2008). An alternate plausible explanation for this finding is that A-ANX influences pain adaptation as proposed in the ADMoCP but primarily at a between-person level rather than within-person.

Specifically, individuals with incrementally greater overall levels of pain tend to use more negative and fewer positive cognitions, which in turn predict further increases in pain over a longer time frame. In the current study, pain flares significantly increased the maladaptive thinking (more negative and fewer positive cognitions) for both low and high A-ANX individuals; higher A-ANX did not predict a greater pain-related increase in this type of thinking. Perhaps a more general maladaptive thinking style, both when experiencing high and low pain, has a bigger, more cumulative effect on pain outcomes. The finding that individuals in the “high” A-ANX tertile group showed significantly greater levels of all the negative cognitive appraisals, marginally significant greater levels of late-morning and end-of-day pain, and marginally significant lower levels of pain coping efficacy and pain control compared to the “low” A-ANX tertile group (Table 2) seems to support the idea of greater mean levels of maladaptive thinking and pain for higher A-ANX individuals. A-ANX was also significantly positively correlated with all the negative cognitive appraisals at the between-person level (see Table 4).

The current study did not replicate the findings of Kratz and colleagues (2012) that in women with fibromyalgia and/or osteoarthritis, a day of increased pain predicted a greater increase in catastrophizing for anxiously attached participants compared to those who were not anxiously attached. Importantly, the current study measured a latent factor encompassing the common variance among multiple negative cognitions including

catastrophizing, rather than catastrophizing alone. I predicted that A-ANX would similarly moderate the link between daily pain and negative cognitive appraisals, but it did not. There are several potential explanations for the lack of A-ANX moderation explained above. First, Kratz and colleagues only included women, whereas this study also included men. However, arguing against this possibility, the analyses in the current study were re-run excluding the male participants (data not shown) without changes in the findings. Kratz and colleagues also used a discrete measure of attachment, the Relationship Questionnaire (Bartholomew & Horowitz, 1991), which requires that individuals read paragraphs describing the four discrete attachment styles (dismissing, secure, preoccupied, and fearful) and ranked them in order as to which they felt best described them. As previously mentioned, analyses since the Relationship Questionnaire was developed have supported a dimensional rather than categorical approach to attachment (Fraley & Waller, 1998). Finally, and perhaps most notably, participants in Kratz and colleagues' study only reported on their pain and cognitions at one time point each day, so the links between pain and catastrophizing were from concurrent rather than temporally-ordered measurements (as in the current study). Due to differences in methodology and modeling between these two studies, the current study was not able to provide a clean test for replication of the results of Kratz and colleagues' (2012) analysis. The inconsistent findings warrant additional research to more clearly determine whether A-ANX influences daily changes in cognitions in response to pain flares.

This study has some important limitations. First, because the data are correlational, no conclusions can be made about causal links between pain and

cognitions. The directional, within-day nature of the data do provide support for a theorized causal relation, however. Second, although the participants in this study accurately reflected the population of treatment-seeking FMS patients as a whole living in Phoenix, Arizona, the study population was still primarily female, Caucasian, and middle-aged, and thus may have more limited generalizability to FMS patients and other chronic pain patients who are male, more ethnically diverse, older or younger. Finally, all assessments were based on self-reports. Using more objective measures, such as dyadic diaries with attachment partners, independently observed interactions with attachment partner, and/or physiological indices during interactions in future studies would provide a more comprehensive model to further explore the links between pain and cognitions within FMS patients' daily experience (Holland, Fraley, & Roisman, 2012).

This study also had some notable strengths. The sample was large and a large amount of data was collected from each participant. The multiple within-day reports of pain and cognitions reduced recall bias and produced reliable estimates of the within-day covariation between these variables over a three week time-period. Capturing three consecutive time points offered directional temporal precedence to elucidate the theorized influence of pain and cognitions on each other throughout the course of a day. Using multilevel modeling enabled us to separate and examine the unique between- and within-person relations between pain, cognitions, and attachment.

Because research applying attachment theory to the within-day changes in pain and cognitions has been limited thus far, there are a number of future directions to be

explored in this area. For example, future studies should explore the influence of dispositional third variables that are related to attachment anxiety, yet distinct from it (e.g., neuroticism) that may exert a more proximal effect on daily pain and pain cognitions (Mickelson, Kessler, & Shaver, 1997). Measuring the attachment style of the participants' attachment figures would also be informative as it has been linked to laboratory-induced pain levels in healthy individuals (Wilson & Ruben, 2011). Increasing research on the within-day variation of attachment processes suggests that measuring how these changes relate to daily changes in pain and cognitions would also be beneficial (Gillath, Hart, Nofle, & Stockton, 2009). Using a within-day measure of attachment as the moderator in the current study's model may provide a better test of the position of the ADMoCP that pain activates attachment processes, which in turn influence cognitive appraisals. However, further advances in statistical methods will be required to model a within-day variable as a moderator in an MSEM mediation model.

In conclusion, morning pain flares predict more negative thinking and less positive thinking about pain in the afternoon, and each of these changes appear to independently predict more pain at the end of the day. Increased negative thinking seems to be more detrimental to end-of-day pain than decreased positive thinking, however. By more clearly elucidating the role of cognitions in the daily pain process, the current study provides further support for the cognitive-behavioral model of pain and cognitive-behavioral therapeutic methods for pain. Further analysis of the potential independent roles of positive and negative cognitions and the relative importance of each type will allow further refinement and improvement of cognitive-behavioral theory and

intervention methods. Though attachment anxiety was not found to moderate the link between pain and cognitions as predicted, between-person group differences showing that individuals high in A-ANX report more negative pain cognitions overall suggest attachment is worthy of future study to more fully explore its influences on cognitions and the experience of chronic pain. Gaining a better understanding of the how attachment and cognitions influence pain severity could ultimately inform personalized cognitive intervention strategies for the same-day attenuation of a pain flare.

References

- Affleck, G., Tennen, H., & Apter, A. (2001). Optimism, pessimism, and daily life with chronic illness. In E. Chang (Ed.), *Optimism and pessimism: Implications for theory, research, and practice*. (pp. 147-168). Washington, DC: American Psychological Association Books.
- Affleck, G., Tennen, H., Urrows, S., & Higgins, P. (1992). Neuroticism and the pain-mood relation in rheumatoid arthritis: Insights from a daily prospective diary study. *Journal of Consulting and Clinical Psychology, 60*, 119-126.
- Alexander, R., Feeney, J., Hohaus, L., & Noller, P. (2001). Attachment style and coping resources as predictors of coping strategies in the transition to parenthood. *Personal Relationships, 8*(2), 137-152. doi: <http://dx.doi.org/10.1111/j.1475-6811.2001.tb00032.x>
- Arnstein, P. (2000). The mediation of disability by self efficacy in different samples of chronic pain patients. *Disability and Rehabilitation: An International, Multidisciplinary Journal, 22*(17), 794-801. doi: <http://dx.doi.org/10.1080/09638280050200296>
- Asghari, A., & Nicholas, M. K. (2001). Pain self-efficacy beliefs and pain behaviour. A prospective study. *Pain, 94*(1), 85-100.
- Averill, P. M., Novy, D. M., Nelson, D. V., & Berry, L. A. (1996). Correlates of depression in chronic pain patients: a comprehensive examination. *PAIN, 65*, 93-100.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall, Inc, Englewood Cliffs, NJ.
- Bartholomew, K., & Horowitz, L. M. (1991). Attachment styles among young adults: A test of a four-category model. *Journal of Personality and Social Psychology, 61*, 226-244. doi:10.1037/0022-3514.61.2.226
- Berant, E., Mikulincer, M., & Florian, V. (2001). The association of mothers' attachment style and their psychological reactions to the diagnosis of infant's congenital heart disease. *Journal of Social and Clinical Psychology, 20*(2), 208-232. doi: <http://dx.doi.org/10.1521/jscp.20.2.208.22264>
- Bowlby, J. (1969). *Attachment and loss: Attachment (Vol. 1)*: New York: Basic Books.
- Bowlby, J. (1973). *Attachment and loss: Separation: Anxiety and anger (Vol. 2)*: New York: Basic Books.

- Bowlby, J. (1988). *A Secure Base: Clinical Applications of Attachment Theory*. London: Routledge.
- Bretherton, I. (1985). Attachment theory: Retrospect and prospect. *Monographs of the Society for Research in Child Development*, 3-35.
- Campbell, C. M., Kronfli, T., Buenaver, L. F., Smith, M. T., Berna, C., Haythornthwaite, J. A., & Edwards, R. R. (2010). Situational versus dispositional measurement of catastrophizing: Associations with pain responses in multiple samples. *The Journal of Pain*, 11(5), 443-453. doi: <http://dx.doi.org/10.1016/j.jpain.2009.08.009>
- Cassidy, J., & Kobak, R. R. (1988). *Avoidance and its relation to other defensive processes*. In J. Belsky & T. Nezworski (Eds.), *Clinical implications of attachment* (pp. 300-323). Hillsdale, NJ: Erlbaum.
- Cassidy, J., & Shaver, P. R. (Eds.). (2008). *Handbook of attachment: Theory, research, and clinical applications (2nd ed.)*. New York: Guilford.
- Ciechanowski, P., Sullivan, M., Jensen, M., Romano, J., & Summers, H. (2003). The relationship of attachment style to depression, catastrophizing and health care utilization in patients with chronic pain. *Pain*, 104(3), 627-637. doi: [http://dx.doi.org/10.1016/S0304-3959\(03\)00120-9](http://dx.doi.org/10.1016/S0304-3959(03)00120-9)
- Cohen, S., Kessler, R. C., & Gordon, L. U. (1995). *Strategies for measuring stress in studies of psychiatric and physical disorders*. New York: Oxford.
- Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin*, 98(2), 310.
- Collins, N. L., & Read, S. J. (1994). Cognitive representations of attachment: The structure and function of working models. In K. E. P. Bartholomew, Daniel (Ed.), *Advances in personal relationships* (Vol. 5, pp. 53-90). London: Jessica Kingsley Publishers.
- Compas, B. E., Haaga, D. A., Keefe, F. J., Leitenberg, H., & Williams, D. A. (1998). Sampling of empirically supported psychological treatments from health psychology: Smoking, chronic pain, cancer, and bulimia nervosa. *Journal of Consulting and Clinical Psychology*, 66(1), 89.
- Davies, K. A., Macfarlane, G. J., McBeth, J., Morriss, R., & Dickens, C. (2009). Insecure attachment style is associated with chronic widespread pain. *Pain*, 143(3), 200-205. doi: <http://dx.doi.org/10.1016/j.pain.2009.02.013>

- Diamond, L. M., & Hicks, A. M. (2005). Attachment style, current relationship security, and negative emotions: The mediating role of physiological regulation. *Journal of Social and Personal Relationships*, 22, 499–518.
- Dixon, K. E., Thorn, B. E., & Ward, L. C. (2004). An evaluation of sex differences in psychological and physiological responses to experimentally-induced pain: A path analytic description. *Pain*, 112(1-2), 188-196. doi: <http://dx.doi.org/10.1016/j.pain.2004.08.017>
- Edwards, R. R., Campbell, C. M., & Fillingim, R. B. (2005). Catastrophizing and Experimental Pain Sensitivity: Only In Vivo Reports of Catastrophic Cognitions Correlate With Pain Responses. *The Journal of Pain*, 6(5), 338-339. doi: <http://dx.doi.org/10.1016/j.jpain.2005.02.013>
- Epstein, S. A., Kay, G., Clauw, D., Heaton, R., Klein, D., Krupp, L., . . . Zisook, S. (1999). Psychiatric disorders in patients with fibromyalgia: A multicenter investigation. *Psychosomatics: Journal of Consultation Liaison Psychiatry*, 40(1), 57-63. doi: [http://dx.doi.org/10.1016/S0033-3182\(99\)71272-7](http://dx.doi.org/10.1016/S0033-3182(99)71272-7)
- Evers, A. W. M., Kraaimaat, F. W., van Lankveld, W., Jongen, P. J. H., Jacobs, J. W. G., & Bijlsma, J. W. J. (2001). Beyond unfavorable thinking: The illness cognition questionnaire for chronic diseases. *Journal of Consulting and Clinical Psychology*, 69, 1026-1036.
- Feeney, J. A. (1999). Adult attachment, emotional control, and marital satisfaction. *Personal Relationships*, 6(2), 169-185.
- Fraley, R. C. & Davis, K. E. (1997). Attachment formation and transfer in young adults' close friendships and romantic relationships. *Personal Relationships*, 4, 131-144.
- Fraley, R. C., Heffernan, M. E., Vicary, A. M., & Brumbaugh, C. C. (2011). The experiences in close relationships—Relationship Structures Questionnaire: A method for assessing attachment orientations across relationships. *Psychological Assessment*, 23(3), 615.
- Fraley, R. C., & Waller, N. G. (1998). Adult attachment patterns: A test of the typological model. In J. A. Simpson & W. S. Rholes (Eds.), *Attachment theory and close relationships* (pp. 77-114). New York: Guilford Press.
- Fraley, R. C., Waller, N. G., & Brennan, K. A. (2000). An item response theory analysis of self-report measures of adult attachment. *Journal of Personality and Social Psychology*, 78(2), 350.
- Gil, K. M., Williams, D. A., Keefe, F. J., & Beckham, J. C. (1990). The relationship of negative thoughts to pain and psychological distress. *Behavior Therapy*, 21(3), 349-362. doi: [http://dx.doi.org/10.1016/S0005-7894\(05\)80336-3](http://dx.doi.org/10.1016/S0005-7894(05)80336-3)

- Gillath, O., Hart, J., Nofhle, E. E., & Stockdale, G. D. (2009). Development and validation of a state adult attachment measure (SAAM). *Journal of Research in Personality, 43*(3), 362-373.
- Grant, L. D., Long, B. C., & Willms, J. D. (2002). Women's adaptation to chronic back pain: Daily appraisals and coping strategies, personal characteristics and perceived spousal responses. *Journal of Health Psychology, 7*(5), 545-563.
- Härkäpä, K. (1991). Relationships of psychological distress and health locus of control beliefs with the use of cognitive and behavioral coping strategies in low back pain patients. *The Clinical Journal of Pain, 7*(4), 275-282.
- Härkäpää, K., Järvikoski, A., Mellin, G., Hurri, H., & Luoma, J. (1991). Health locus of control beliefs and psychological distress as predictors for treatment outcome in low-back pain patients: Results of a 3-month follow-up of a controlled intervention study. *Pain, 46*(1), 35-41. doi: [http://dx.doi.org/10.1016/0304-3959\(91\)90031-R](http://dx.doi.org/10.1016/0304-3959(91)90031-R)
- Hazan, C., & Shaver, P. (1987). Romantic love conceptualized as an attachment process. *Journal of Personality and Social Psychology, 52*(3), 511.
- Holland, A. S., Fraley, R. C., & Roisman, G. I. (2012). Attachment styles in dating couples: Predicting relationship functioning over time. *Personal Relationships, 19*, 234-246.
- Holtzman, S., & DeLongis, A. (2007). One day at a time: The impact of daily satisfaction with spouse responses on pain, negative affect and catastrophizing among individuals with rheumatoid arthritis. *Pain, 131*(1), 202-213.
- Hox, J. J., & Maas, C. J. (2001). The accuracy of multilevel structural equation modeling with pseudobalanced groups and small samples. *Structural Equation Modeling, 8*(2), 157-174.
- Hsu, H. (2009). Testing the effectiveness of various commonly used fit indices for detecting misspecifications in multilevel structural equation models (Doctoral dissertation, Texas A & M University, 2009). *ProQuest Dissertations and Theses*.
- Hu, L. t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55.
- Jensen, M. P., & Karoly, P. (1991). Control beliefs, coping efforts, and adjustment to chronic pain. *Journal of Consulting and Clinical Psychology, 59*(3), 431-438. doi: <http://dx.doi.org/10.1037/0022-006X.59.3.431>

- Jensen, M. P., & Karoly, P. (1992). Pain-specific beliefs, perceived symptom severity, and adjustment to chronic pain. *The Clinical Journal of Pain, 8*(2), 123-130.
- Jensen, M. P., Karoly, P., & Braver, S. (1986). The measurement of clinical pain intensity: a comparison of six methods. *Pain, 27*(1), 117-126.
- Jensen, M. P., Turner, J. A., Romano, J. M., & Lawler, B. K. (1994). Relationship of pain-specific beliefs to chronic pain adjustment. *Pain, 57*(3), 301-309. doi: [http://dx.doi.org/10.1016/0304-3959\(94\)90005-1](http://dx.doi.org/10.1016/0304-3959(94)90005-1)
- Keefe, F. J., Affleck, G., Lefebvre, J. C., Starr, K., Caldwell, D. S., & Tennen, H. (1997). Pain coping strategies and coping efficacy in rheumatoid arthritis: a daily process analysis. *Pain, 69*(1), 35-42.
- Kenny, D. A., Korchmaros, J. D., & Bolger, N. (2003). Lower level mediation in multilevel models. *Psychological Methods, 8*(2), 115.
- Kobak, R. R., Cole, H. E., Ferenz-Gillies, R., Fleming, W. S., & Gamble, W. (1993). Attachment and emotion regulation during mother-teen problem solving: A control theory analysis. *Child Development, 64*(1), 231-245.
- Kraaimaat, F. W., van Dam-Baggen, C. M. J., & Bijlsma, J. W. J. (1995). Depression, anxiety and social support in rheumatoid arthritic women without and with a spouse. *Psychological Health, 10*, 387-96.
- Kratz, A. L., Davis, M. C., & Zautra, A. J. (2012). Attachment predicts daily catastrophizing and social coping in women with pain. *Health Psychology, 31*(3), 278-285. doi: S1526-5900(09)00713-5[pii]10.1016/j.jpain.2009.08.009
- Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer Publishing Company.
- Lazarus, R. S., Kanner, A. D., & Folkman, S. (1980). Emotions: A cognitive-phenomenological analysis *Emotion: Theory, research, and experience* (Vol. 1: Theories of Emotions, pp. 189-217). New York: Academic Press, Inc.
- Lefebvre, J. C., Keefe, F. J., Affleck, G., Raezer, L. B., Starr, K., Caldwell, D. S., & Tennen, H. (1999). The relationship of arthritis self-efficacy to daily pain, daily mood, and daily pain coping in rheumatoid arthritis patients. *Pain, 80*(1-2), 425-435. doi: [http://dx.doi.org/10.1016/S0304-3959\(98\)00242-5](http://dx.doi.org/10.1016/S0304-3959(98)00242-5)
- Litt, M. D., Shafer, D. & Napolitano, C. (2004). Momentary mood and coping processes in TMD pain. *Health Psychology, 23*, 354-362.

- MacDonald, G., & Kingsbury, R. (2006). Does physical pain augment anxious attachment? *Journal of Social and Personal Relationships*, 23(2), 291-304. doi: <http://dx.doi.org/10.1177/0265407506062481>
- Main, M., & Solomon, J. (1986). Discovery of an insecure-disorganized/disoriented attachment pattern. *Affective development in infancy*. (pp. 95-124). Westport, CT: Ablex Publishing.
- McWilliams, L. A., & Asmundson, G. J. (2007). The relationship of adult attachment dimensions to pain-related fear, hypervigilance, and catastrophizing. *Pain*, 127(1), 27-34.
- McWilliams, L. A., & Bailey, S. J. (2010). Associations between adult attachment ratings and health conditions: Evidence from the National Comorbidity Survey Replication. *Health Psychology*, 29(4), 446-453. doi: <http://dx.doi.org/10.1037/a0020061>
- McWilliams, L. A., Cox, B. J., & Enns, M. W. (2000). Impact of adult attachment styles on pain and disability associated with arthritis in a nationally representative sample. *The Clinical Journal of Pain*, 16(4), 360-364.
- Mease, P. (2005). Fibromyalgia syndrome: review of clinical presentation, pathogenesis, outcome measures, and treatment. *Journal of Rheumatology Supplement*, 75, 6-21.
- Meredith, P., Ownsworth, T., & Strong, J. (2008). A review of the evidence linking adult attachment theory and chronic pain: Presenting a conceptual model. *Clinical Psychology Review*, 28(3), 407-429.
- Meredith, P. J., Strong, J., & Feeney, J. A. (2005). Evidence of a relationship between adult attachment variables and appraisals of chronic pain. *Pain Research & Management*, 10(4), 191-200.
- Meredith, P. J., Strong, J., & Feeney, J. A. (2006a). Adult attachment, anxiety and pain self-efficacy as predictors of pain intensity and disability. *Pain*, 123, 146-154.
- Meredith, P. J., Strong, J., & Feeney, J. A. (2006b). The relationship of adult attachment to emotion, catastrophizing, control, threshold and tolerance, in experimentally-induced pain. *Pain*, 120(1-2), 44-52. doi: <http://dx.doi.org/10.1016/j.pain.2005.10.008>
- Mickelson, K. D., Kessler, R. C., & Shaver, P. R. (1997). Adult attachment in a nationally representative sample. *Journal of Personality and Social Psychology*, 73, 1092-1106.

- Mikulincer, M., & Florian, V. (1998). The relationship between adult attachment styles and emotional and cognitive reactions to stressful events. In J. A. Simpson & W. S. Rholes (Eds.), *Attachment theory and close relationships* (pp. 143-165). New York: Guilford Press.
- Mikulincer, M., & Shaver, P. R. (2003). The attachment behavioral system in adulthood: Activation, psychodynamics, and interpersonal processes. *Advances in Experimental Social Psychology*, 35, 53-152.
- Mikulincer, M., & Shaver, P. R. (2004). Security-based self-representations in adulthood. In W. S. Rholes & J. A. Simpson (Eds.), *Adult attachment: Theory, research, and clinical implications* (pp. 159-195). New York: Guilford Press.
- Mikulincer, M., & Shaver, P. R. (2007). *Attachment in adulthood: Structure, dynamics, and change*. New York: Guilford Press.
- Morley, S., Eccleston, C., & Williams, A. (1999). Systematic review and meta-analysis of randomized controlled trials of cognitive behaviour therapy and behaviour therapy for chronic pain in adults, excluding headache. *Pain*, 80(1-2), 1-13. doi: [http://dx.doi.org/10.1016/S0304-3959\(98\)00255-3](http://dx.doi.org/10.1016/S0304-3959(98)00255-3)
- Muthén, L. K., & Muthén, B. O. (1999-2012). Mplus User's Guide. Los Angeles, CA: Muthén & Muthén.
- NIH Technology Assessment Panel on Integration of Behavioral and Relaxation Approaches into the Treatment of Chronic Pain and Insomnia (1996). Integration of behavioral and relaxation approaches into the treatment of chronic pain and insomnia. *Journal of the American Medical Association*, 276(4), 313-318.
- Okifuji, A., Turk, D., Sinclair, J., Starz, T., & Marcus, D. (1997). A standardized manual tender point survey. I. Development and determination of a threshold point for the identification of positive tender points in fibromyalgia syndrome. *The Journal of Rheumatology*, 24(2), 377-383.
- Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods*, 15(3), 209.
- Shaver, P. R., & Clark, C. L. (1994). The psychodynamics of adult romantic attachment. In J. M. Masling & R. F. Bornstein (Eds.), *Empirical perspectives on object relations theory*. (pp. 105-156). Washington, DC: American Psychological Association.
- Shaver, P. R. & Fraley, R. C. (2010). *Self-report measures of adult attachment*. Retrieved May 21, 2014, from R. Chris Fraley's University of Illinois at Urbana-Champaign Department of Psychology website: <http://internal.psychology.illinois.edu/~rcfraley/measures/measures.html>

- Shaver, P. R., & Mikulincer, M. (2007). Adult attachment theory and the regulation of emotion. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 446-465). New York: Guilford Press.
- Sorbi, M. J., Peters, M. L., Kruse, D. A., Maas, C. J. M., Kerssens, J. J., Verhaak, P. F. M., & Bensing, J. M. (2006) Electronic momentary assessment in chronic pain I: Psychological pain responses as predictors of pain intensity. *Clinical Journal of Pain*, 22, 55-66.
- Sroufe, L. A., & Waters, E. (1977). Attachment as an organizational construct. *Child Development*, 1184-1199.
- Stone, A. A., & Neale, J. M. (1984). New measure of daily coping: Development and preliminary results. *Journal of Personality and Social Psychology*, 46(4), 892.
- Strong, J. (1995). *Self-efficacy and the patient with chronic pain*. Paper presented at the Moving in on Pain Conference.
- Sturgeon, J. A., & Zautra, A. J. (2013). State and trait pain catastrophizing and emotional health in rheumatoid arthritis. *Annals of Behavioral Medicine*, 45(1), 69-77. doi: <http://dx.doi.org/10.1007/s12160-012-9408-z>
- Sullivan, M. J., Bishop, S. R., & Pivik, J. (1995). The pain catastrophizing scale: development and validation. *Psychological Assessment*, 7(4), 524.
- Sullivan, M. J. L., Thorn, B., Haythornthwaite, J. A., Keefe, F., Martin, M., Bradley, L. A., & Lefebvre, J. C. (2001). Theoretical perspectives on the relation between catastrophizing and pain. *The Clinical Journal of Pain*, 17(1), 52-64. doi: <http://dx.doi.org/10.1097/00002508-200103000-00008>
- Taylor, S. S., Davis, M. C., & Zautra, A. J. (2013). Relationship status and quality moderate daily pain-related changes in physical disability, affect, and cognitions in women with chronic pain. *Pain*, 154(1), 147-153. doi: <http://dx.doi.org/10.1016/j.pain.2012.10.004>
- Tennen, H., Affleck, G., Urrows, S., Higgins, P., & Mendola, R. (1992). Perceiving control, construing benefits, and daily processes in rheumatoid arthritis. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement*, 24(2), 186-203. doi: <http://dx.doi.org/10.1037/h0078709>
- Thorn, B. E. (2004). *Cognitive therapy for chronic pain: A step-by-step guide*. New York: Guilford Press.
- Thorn, B. E., Clements, K. L., Ward, L. C., Dixon, K. E., Kersh, B. C., Boothby, J. L., & Chaplin, W. F. (2004). Personality factors in the explanation of sex differences in

- pain catastrophizing and response to experimental pain. *The Clinical Journal of Pain*, 20(5), 275-282. doi: <http://dx.doi.org/10.1097/00002508-200409000-00001>
- Thorn, B. E., & Dixon, K. E. (2007). Coping with chronic pain: A stress-appraisal coping model. In E. Martz & H. Linveh (Eds.), *Coping with chronic illness and disability: Theoretical, empirical, and clinical aspects* (pp. 313-335). New York: Springer.
- Tofighi, D., & MacKinnon, D. P. (2011). RMediation: An R package for mediation analysis confidence intervals. *Behavior Research Methods*, 43(3), 692-700.
- Turk, D. C. (2002). *A cognitive-behavioral perspective on treatment of chronic pain patients*. New York: Guilford Press.
- Turk, D. C., Meichenbaum, D., & Genest, M. (1983). *Pain and behavioral medicine: A cognitive-behavioral perspective*. New York: Guilford Press.
- Turner, J. A. (1991). Coping and chronic pain. In M. R. Bond, J. E. Charlton & C. J. Woolf (Eds.), *Proceedings of the VIth World Congress on Pain* (pp. 219-227). Amsterdam: Elsevier.
- Turner, J. A. (1996). Educational and behavioral interventions for back pain in primary care. *Spine*, 21(24), 2851-2857.
- Turner, J. A., Holtzman, S., & Mancl, L. (2007). Mediators, moderators, and predictors of therapeutic change in cognitive-behavioral therapy for chronic pain. *Pain*, 127, 276-286.
- Turner, J. A., Jensen, M. P., & Romano, J. M. (2000). Do beliefs, coping, and catastrophizing independently predict functioning in patients with chronic pain? *Pain*, 85(1), 115-125.
- Turner, J. A. & Romano, J. M. (2001). Cognitive-behavioral therapy for chronic pain. In J. D. Loeser (Ed.), *Bonica's Management of Pain* (pp. 1751-1758). Philadelphia: Lippicott, Williams, & Wilkins.
- Ward, M. M. & Leigh, J. P. (1993). Marital status and the progression of functional disability in patients with rheumatoid arthritis. *Arthritis & Rheumatism*, 36, 581-588.
- Wilson, C. L. & Ruben, M. A. (2011) A pain in her arm: Romantic attachment orientations and the tourniquet task. *Personal Relationships*, 18, 242-265.
- Wolfe, F., Smythe, H. A., Yunus, M. B., Bennett, R. M., Bombardier, C., Goldenberg, D. L., . . . Clark, P. (1990). The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. *Arthritis & Rheumatism*, 33(2), 160-172.

APPENDIX A
INSTITUTIONAL REVIEW BOARD APPROVAL



Research Compliance Office
Office for Research & Sponsored Projects Administration
313 Sanson Hall
Tempe, AZ 85287-3505

Phone:
(480) 965-4788
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To: Mary Davis
PSYCHOLOGY

From: Carol Johnston, Chair
Bioscience Full Board

Date: 08/29/2008

Committee Action: Approval

IRB Action Date 08/05/2008

Approval Date 08/26/2008

IRB Protocol # 0807003098

Study Title Fibromyalgia: Interventions for pain and mood regulation

Expiration Date 08/25/2009

The above-referenced protocol has been APPROVED following Full Board Review by the Institutional Review Board.

This approval does not replace any departmental or other approvals that may be required. It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date noted above. Please allow sufficient time for continued approval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date.

Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Bioscience Full Board immediately. If necessary a member of the Committee will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Bioscience Full Board. The new procedure is not to be initiated until the IRB approval has been given.

APPENDIX B
MEASURES

Experiences in Close Relationships – Relationship Structures

Please answer the following 10 questions about your **spouse or romantic partner**. Indicate the extent to which you agree or disagree with each statement by circling a number for each item.

1. It helps to turn to this person in times of need.
strongly disagree 1 2 3 4 5 6 7 strongly agree

2. I usually discuss my problems and concerns with this person.
strongly disagree 1 2 3 4 5 6 7 strongly agree

3. I talk things over with this person.
strongly disagree 1 2 3 4 5 6 7 strongly agree

4. I find it easy to depend on this person.
strongly disagree 1 2 3 4 5 6 7 strongly agree

5. I don't feel comfortable opening up to this person.
strongly disagree 1 2 3 4 5 6 7 strongly agree

6. I prefer not to show this person how I feel deep down.
strongly disagree 1 2 3 4 5 6 7 strongly agree

7. I often worry that this person doesn't really care for me.
strongly disagree 1 2 3 4 5 6 7 strongly agree

8. I'm afraid that this person may abandon me.
strongly disagree 1 2 3 4 5 6 7 strongly agree

9. I worry that this person won't care about me as much as I care about him or her.
strongly disagree 1 2 3 4 5 6 7 strongly agree

10. I don't fully trust this person.
strongly disagree 1 2 3 4 5 6 7 strongly agree

Pain Cognitions

During these interviews I would like to ask you a series of questions about your experiences. All of the questions refer the past 2 to 3 hours.

Rate each of the following statements using a scale of 1 to 5, where:

- 1 is not at all
- 2, a little
- 3, some
- 4, quite a bit, or
- 5, completely

You felt your pain was so bad you couldn't stand it anymore.
Please enter an answer between 1 and 5 now.

You coped effectively with your pain.
Please enter an answer between 1 and 5 now.

You were able to control your pain.
Please enter an answer between 1 and 5 now.

How much were you able to feel your pain without having to react to it?
Please enter an answer between 1 and 5 now.

How much were you irritated by your pain?
Please enter your answer between 1 and 5 now.

How much have you told yourself that you shouldn't be feeling the way you're feeling.
Please enter an answer between 1 and 5 now.

Footnotes

¹The term “pain flare” is used in this instance and hereafter to denote pain above an individual’s average level of pain

Table 1

Sample characteristics, intraclass correlations (ICCs), and mean levels of key study group variables across diary days based on partnership and study inclusion status.

		Partnered (Included) n = 174	Non-Partnered (Not Included) n = 48	
Demographics	ICCs	M (SD)/ %	M (SD)/ %	t or (X ²)
Age (years)	-	50.89 (10.84)	52.61 (11.70)	0.94
Female (%)	-	87.4	91.3	(0.43)
Income	-	\$20 - 30K	\$17 - 19K	-3.99***
Employed (%)	-	48.9	60.9	(2.07)
Caucasian (%)	-	78.7	80.4	(0.06)
Education	-	1-3 years college	1-3 years college	-1.22
A-AVD Non-Romantic Partner (1-5)	-	2.02 (0.88)	1.94 (0.90)	-0.47
A-ANX Non-Romantic Partner (1-5)	-	1.78 (1.08)	1.92 (1.18)	0.70
A-AVD Romantic Partner (1-5)	-	2.26 (1.11)	-	-
A-ANX Romantic Partner (1-5)	-	2.37 (1.30)	-	-
Diary Raw Scores				
Morning Pain (0-100)	.50	49.65 (17.75)	46.40 (17.04)	-1.13
Afternoon Catastrophizing (1-5)	.51	2.20 (0.85)	2.09 (0.81)	-0.8
Afternoon Irritated by pain (1-5)	.52	2.93 (0.99)	2.63 (1.01)	-1.85†
Afternoon Self-Criticism (1-5)	.70	2.25 (1.19)	2.19 (1.15)	-0.33
Afternoon Coping Efficacy (1-5)	.40	3.39 (0.76)	3.53 (0.79)	1.1
Afternoon Pain Control (1-5)	.46	3.03 (0.85)	3.18 (0.76)	1.14
Afternoon Pain Non-Reactivity (1-5)	.35	3.23 (0.69)	3.22 (0.75)	-0.04
Afternoon Negative Pain Cognition Composite (1-5)	.66	2.46 (0.87)	2.30 (0.86)	-1.12
Afternoon Positive Pain Cognition Composite (1-5)	.48	3.22 (0.64)	3.31 (0.66)	0.91
Evening Pain (0-100)	.55	54.95 (18.35)	50.90 (17.62)	-1.37

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2

Means and percentages of key group variables based on A-ANX "low" and "high" tertile groups

	"Low" A-ANX	"High" A-ANX	t or (χ^2)
	n = 65	n = 68	
Demographics	M (SD)/ %	M (SD)/ %	
Age (years)	52.38 (10.25)	48.50 (11.29)	2.08*
Female (%)	89.1	85.3	(0.42)
Income	\$40 - 50K	\$19 - 21K	4.21***
Employed (%)	47.6	47.1	(0.28)
Caucasian (%)	78.5	76.5	(0.08)
Education	1-3 years of college	1-3 years of college	1.09
A-AVD Romantic Partner (1-5)	1.48 (0.63)	3.10 (1.03)	-10.87***
Diary Raw Scores			
Morning Pain (0-100)	47.33 (18.21)	52.63 (16.49)	-1.76†
Afternoon Catastrophizing (1-5)	2.03 (0.84)	2.46 (0.87)	-2.89**
Afternoon Irritated by pain (1-5)	2.74 (1.08)	3.22 (0.93)	-2.77**
Afternoon Self-Criticism (1-5)	1.97 (1.11)	2.51 (1.25)	-2.62*
Afternoon Coping Efficacy (1-5)	3.51 (0.83)	3.26 (0.74)	1.82†
Afternoon Pain Control (1-5)	3.17 (0.88)	2.89 (0.88)	1.85†
Afternoon Pain Non-Reactivity (1-5)	3.29 (0.67)	3.25 (0.78)	0.36
Afternoon Negative Pain Cognition Composite (1-5)	2.48 (0.96)	2.78 (1.01)	-1.67†
Afternoon Positive Pain Cognition Composite (1-5)	3.19 (0.88)	3.08 (0.83)	0.76
Evening Pain (0-100)	52.63 (19.24)	58.41 (16.71)	-1.85†

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3
Within-person Intercorrelations

	Morning Pain	Catastrophizing	Irritated by pain	Self- Criticism	Coping Efficacy	Pain Control	Pain Non- Reactivity
Catastrophizing	.31						
Irritated by pain	.27	.45					
Self-Criticism	.13	.21	.30				
Coping Efficacy	-.20	-.34	-.34	-.13			
Pain Control	-.21	-.32	-.39	-.12	.54		
Pain Non- Reactivity	-.12	-.12	-.15	-.05	.27	.26	
Evening Pain	.45	.41	.39	.16	-.29	-.29	-.14

Table 4
Between-person Intercorrelations

	Morning Pain	Catastrophizing	Irritated by pain	Self- Criticism	Coping Efficacy	Pain Control	Pain Non- Reactivity	Evening Pain
Catastrophizing	.73***							
Irritated by pain	.62***	.72***						
Self-Criticism	.38***	.58***	.60***					
Coping Efficacy	-.60***	-.60***	-.60***	-.34***				
Pain Control	-.40***	-.41***	-.47***	-.20***	.75***			
Pain Non- Reactivity	-.23***	-.26***	-.28***	-.06	.61***	.43***		
Evening Pain	.96***	.73***	.62***	.35***	-.57***	-.36***	-.27***	
A-ANX	.11	.20***	.20***	.20***	-.09	-.11	.02	.10

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 5

Multilevel structural equation mediation model examining the role of afternoon negative and positive cognitions in mediating the relation between morning and end-of-day pain.

Negative cognitions	a ₁ path	b ₁ path	a ₁ b ₁ path	Correlation	Asymmetric
	<i>B (SE B)</i>	<i>B (SE B)</i>	<i>B (SE B)</i>	of a ₁ and b ₁	Confidence Interval
Within-person	0.013*** (0.001)	13.718*** (1.546)	0.178*** (0.028)	.080	[0.131, 0.230]
Between-person	0.034*** (0.003)	1.925 (1.275)	0.066 (0.043)	-.163	[-0.020, 0.149]
Positive cognitions	a ₂ path	b ₂ path	a ₂ b ₂ path	Correlation	Asymmetric
	<i>B (SE B)</i>	<i>B (SE B)</i>	<i>B (SE B)</i>	of a ₂ and b ₂	Confidence Interval
Within-person	-0.010*** (0.001)	-0.517 (1.180)	0.005 (0.012)	.155	[-0.018, 0.030]
Between-person	-0.024*** (0.003)	0.676 (0.947)	-0.016 (0.023)	-.099	[-0.064, 0.028]

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6

Multilevel mediation model examining the role of afternoon negative and positive cognition composite variables in mediating the relation between morning and end-of-day pain.

Negative cognitions	a ₁ path	b ₁ path	a ₁ b ₁ path	Correlation	Asymmetric
	<i>B (SE B)</i>	<i>B (SE B)</i>	<i>B (SE B)</i>	of a ₁ and b ₁	Confidence Interval
Within-person	0.012***(0.001)	7.470***(0.622)	0.088***(0.011)	.072	[0.069, 0.112]
Between-person	0.032***(0.003)	0.257(0.726)	0.008(0.023)	-.108	[-0.038, 0.053]
Positive cognitions	a ₂ path	b ₂ path	a ₂ b ₂ path	Correlation	Asymmetric
	<i>B (SE B)</i>	<i>B (SE B)</i>	<i>B (SE B)</i>	of a ₂ and b ₂	Confidence Interval
Within-person	-0.009***(0.001)	-3.352***(0.642)	0.029***(0.007)	.202	[0.017, 0.046]
Between-person	-0.017***(0.003)	-0.283(1.266)	0.005(0.022)	-.238	[-0.041, 0.045]

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

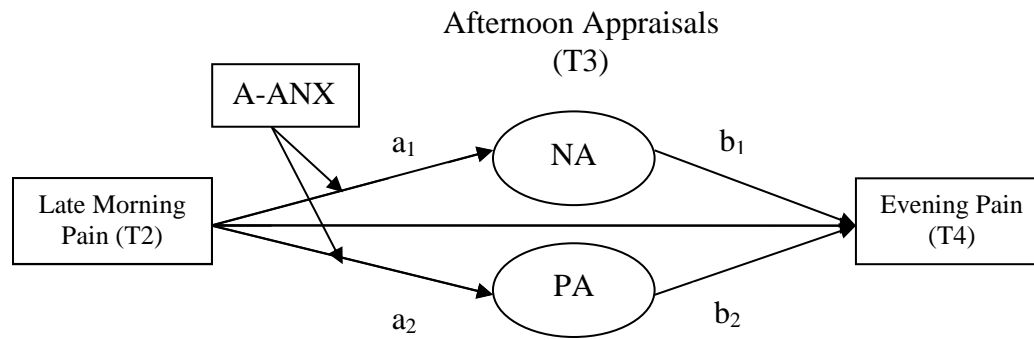


Figure 1. Heuristic mediated moderation model demonstrating the hypotheses to be tested.
 T2 = Time 2, 11:00 AM. T3 = Time 3, 4:00 PM. T4 = Time 4, 7:00 PM. A-ANX = Attachment Anxiety. NA = Negative related appraisals. PA = Positive related appraisals.

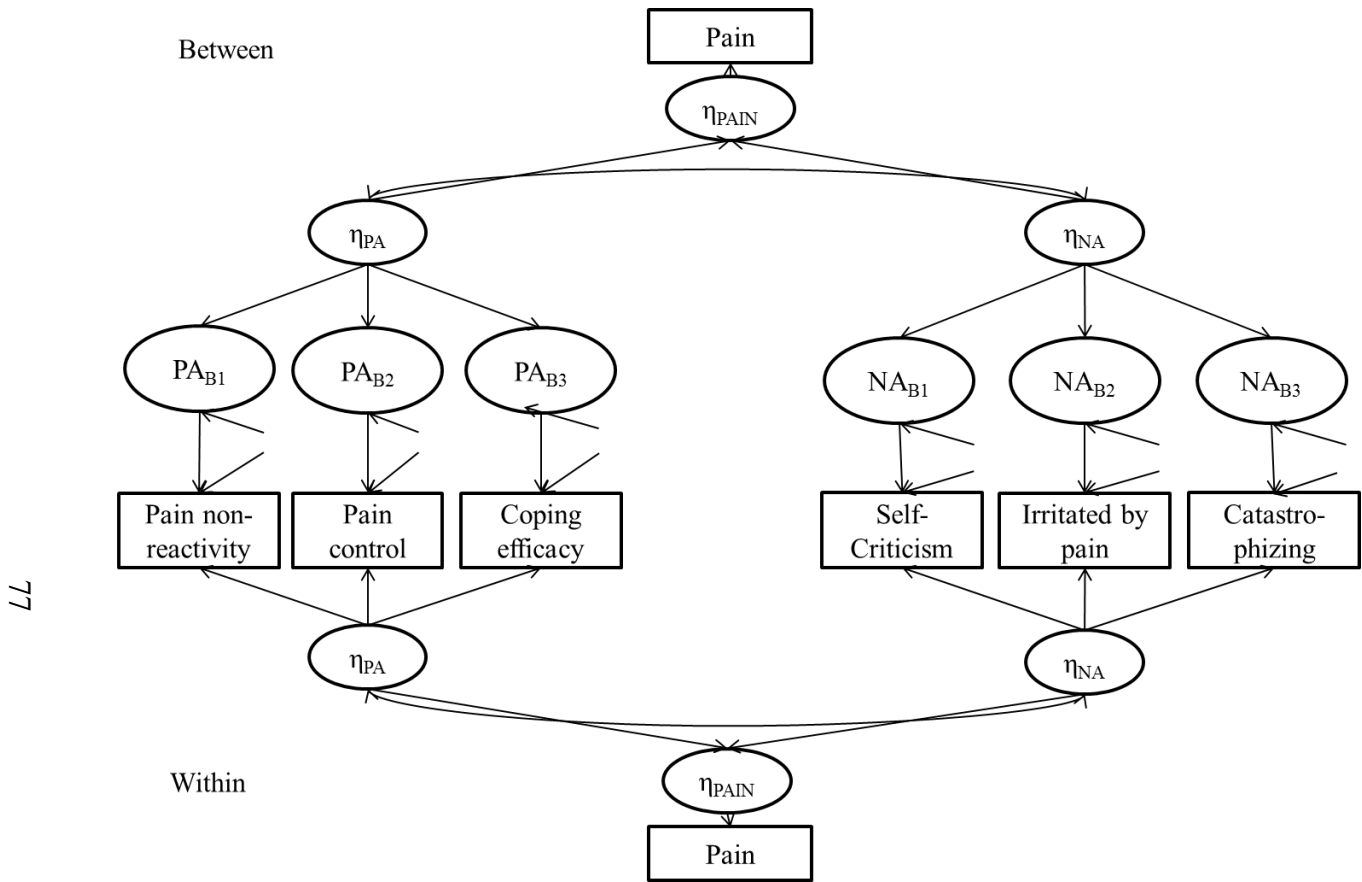


Figure 2. Model depicting the two-factor multilevel confirmatory factor analysis to be tested. All pathways with arrows will be estimated, though the factor structure and outcome are hypothesized at the within-level. The small arrows in the center of the model indicate residuals.

77

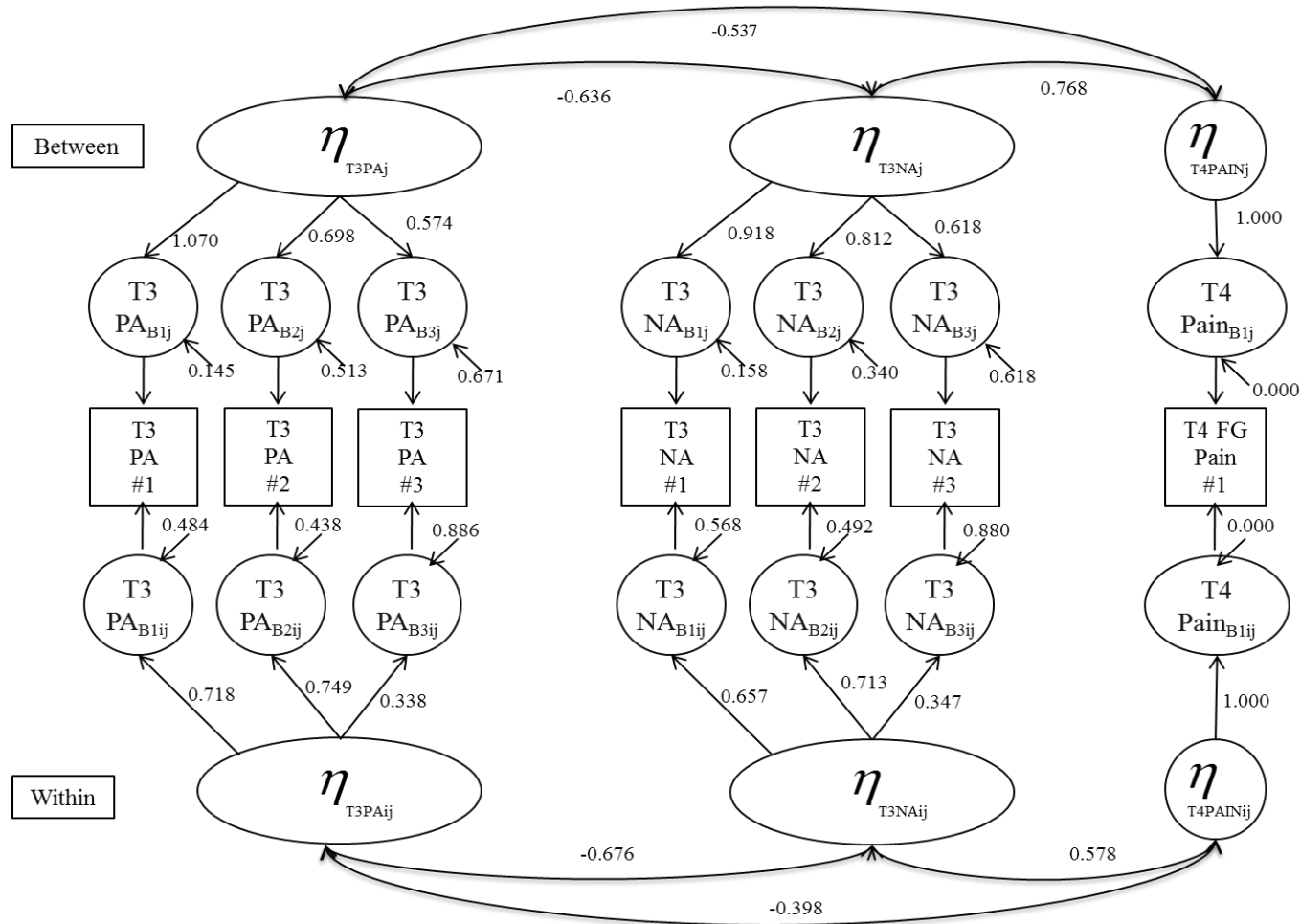


Figure 3. Confirmatory factor analytic structure for endogenous variables in the measurement model. All coefficients are unstandardized. T3 = Afternoon, T4 = End-of-day, PA = Positive appraisals, T3 PS #1 = Coping efficacy, T3 PS #2 = Pain control, T3 PS #3 = Feeling pain without reacting, NA = Negative appraisals, T3 NP #1 = Catastrophizing, T3 NP #2 = Irritation by pain, T3 NP #3 = Shouldn't be feeling pain. Note: Smaller diagonal arrows represent residual variances for indicated variables.