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Acceptance, appraisals, and coping in relation to migraine headache: an evaluation of interrelationships using daily diary methods

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Abstract Acceptance and chronic pain is an emerging topic both for research and intervention. Initial studies have demonstrated that acceptance is correlated with higher quality of daily emotional, social, and physical functioning in chronic pain populations. The purpose of the present study was to clarify the nature of the relationship between acceptance, appraisals that are relevant to chronic pain (i.e., control and catastrophizing), and coping among migraine headache sufferers. Seventy four participants with migraine headaches completed self report measures assessing appraisal, coping strategies, acceptance, and pain related disability. Sixty three participants also completed a 28-day daily dairy assessing headache activity, catastrophizing, control, acceptance, and coping strategies. Hierarchical regression and multilevel modeling were used to examine the relations between these variables. Results indicated that higher levels of pain-related acceptance were associated with lower levels of catastrophizing and pain-related interference, and increased perceived control. Participants who endorsed higher levels of pain-related acceptance also reported engaging in a higher level of activity and indicated they used fewer coping strategies on a daily basis. Acceptance continues to show promise as a way of viewing pain that lessens the detrimental impact of certain types of thoughts (i.e., catastrophizing), and leads to increased participation in daily life.

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Introduction

Migraine headache is a commonly experienced phenomenon that is associated with high levels of subjective pain, as well as economic costs related to health care utilization, absence from work (Lipton et al. 2003; Lipton et al. 2001) and overall reduced work productivity (Ferrari 1998). Recent studies estimate the lifetime prevalence of migraine ranges from 11–29%, with 11% of the population categorized as active migraine headache sufferers at any given time (Arulmozhi et al. 2005; Russell et al. 1995; Stewart et al. 1992).

Negative life events and psychological stress are thought to play a significant role in the onset, maintenance, and/or exacerbation of headache disorders. For example, de Benedittis et al. (1990) reported that chronic primary headache sufferers (comprised of migraine, tension-type, and mixed headache sufferers) retrospectively recalled having experienced a higher number of stressors in the year prior to the onset of their chronic headache conditions. Similarly, Robbins (1994) reported that 62% of their migraine headache sample indicated that they developed migraine headaches during stress and 24% reported getting migraine headaches soon after a stressful period had passed. Prospective studies have also provided support for the relationship between stress and headache activity. In one prospective study exploring the relation between stress and headache, participants were asked to complete a brief headache diary for 6 months (Kohler and Haimerl 1990). Results indicated that participants had significantly more headache activity on days that were reported to be high stress.

The relationship between stress and headache has also been observed in laboratory research. Gannon et al. (1987) observed that eleven of sixteen migraine and muscle-contraction headache subjects (approximately 68%) reported that they developed a headache when they were exposed to a mental arithmetic stressor in the lab, while only two of the eight control subjects reported that they developed a headache (25%). Using comparable methodology, Haynes et al. (1990) induced headaches in 83% of headache sufferers (i.e., tension, mixed, migraine). Similarly, Martin and Seneviratne (1997) found that migraine and tension headache sufferers developed headaches in response to food deprivation (58% of headache sufferers) and difficult anagrams (93% of headache sufferers). Finally, although not formally assessed, we have found in our laboratory that headache sufferers, relative to non-headache sufferers, report more often that they developed headaches after exposure to the cold pressor task and mental arithmetic task (Chiros 2002; Hassinger et al. 1999).

Thus, based on the aforementioned cross sectional, prospective, and laboratory investigations, it appears that there is a reliable association between stress and headache. However, there also appears to be significant individual differences in the stress-headache relationship. For example, Holm et al. (1997) used a self-monitoring method to examine how daily stress and headache activity were related among headache sufferers. They reported that over 55% of the participants in their study had correlations between these two variables, but that significant individual differences were observed among participants.

Because stress is commonly experienced and correlated with headache activity, and because the magnitude of the correlation varies across individuals, it is important to evaluate how migraine headache sufferers differ in the way that they cope with stress. Lazarus and Folkman (1984) described coping as a voluntary process that has two interdependent elements: Appraisal (i.e., determining when a particular event constitutes a threat to well-being) and coping responses (i.e., cognitive and/or behavioral responses designed to mitigate the impact of the stressor). Lazarus and Folkman (1984) posited that there are two types of appraisals: primary appraisals and secondary appraisals. During the primary appraisal process, an individual evaluates the significance of an event based on the implications of that event for his or her well-being. During the secondary appraisal process, the individual evaluates his or her available resources to manage the event. Together, primary and secondary appraisals yield an evaluation of the overall stressfulness of a situation and lead to the use or nonuse of coping responses.

In the headache literature, relationships between appraisals and headache activity have been explored. Using survey methods, researchers found that migraine headache sufferers endorsed significantly higher levels of catastrophic appraisals relative to headache-free controls (Sorbi and Tellegen 1988). Using diary methods, Materazzo et al. (2000) found that migraine headache sufferers reported significantly higher levels of catastrophizing in their daily lives relative to headache free individuals. Similarly, Lefebvre et al. (1995) found that young adults with migraine headache and low back pain engaged in a higher level of catastrophizing than did those who only had migraine headaches or no pain condition. Finally, Hassinger et al. (1999) found that migraine headache sufferers reported a higher level of catastrophizing than did headache free individuals.

Control is another type of appraisal that may play an important role in the experience of pain. Control appraisals involve the perception that one has the ability and resources to manage the experience of pain (Lazarus and Folkman 1984). For example, persons with chronic pain who also believe they can control their pain report higher levels of overall activity (Jensen and Karoly 1991) and lower levels of physical impairment (Keefe et al. 1987). Control appraisals have also been associated with adaptive functioning. Keefe et al. (1987) observed that increased perceived control during electrodiagnostic testing was associated with lower levels of pain-related psychological disability as well as higher levels of general psychological wellbeing. Buckelew and colleagues also found that chronic pain patients undergoing electrodiagnostic testing who perceived themselves as having higher control over their pain also endorsed lower levels of anxiety (Buckelew et al. 1992). A study of people with rheumatoid arthritis suggested that higher perceived control over their daily symptoms was associated with less mood disturbance (Affleck et al. 1999). Finally, in a study of patients in an ongoing multidisciplinary pain treatment program, higher perceived control was associated with less pain-disability among chronic pain patients (Jensen et al. 2001).

Taken together, the aforementioned studies suggest that persons who report higher levels of control tend to report lower levels of pain related disability and lower levels of negative emotionality. The relationship between control and pain has not been as extensively studied among headache sufferers. However, there are data indicating that control appraisals covary with important aspects of the headache experience. For example, in a diary study, Materazzo et al. (2000) found that migraine headache sufferers perceived themselves as having a lower ability to control and decrease their pain relative to headache free individuals (Materazzo et al. 2000). Similarly, Sorbi and Tellegen (1988) observed that migraine headache sufferers, relative to headache-free individuals, rated themselves lower on a measure of self-efficacy, which can be conceptualized as a form of control. Finally, tension headache

sufferers who rated themselves as having a high ability to control pain reported lower levels of headache pain intensity (Spinhoven and Linssen 1991).

Acceptance may be a unique type of appraisal that mediates the relationship between stressful events and headache pain. Acceptance has been conceptualized as the willingness to experience thoughts, feelings, and physical sensations without engaging in efforts to avoid them or allowing them to determine one's behavior (Bond and Bunce 2003). From a coping perspective, acceptance may be similar to the primary appraisal process, such that if an individual encounters a stressful event during primary appraisal and determines that he or she can accept the experience, coping efforts then need not be initiated. In terms of chronic pain, McCracken (1998) conceptualized acceptance as a willingness to experience continuing pain without needing to reduce, avoid, or otherwise change it. Thus, higher levels of pain acceptance should be associated with lower levels of pain-related coping behaviors.

Using survey methodology, McCracken and Eccleston (2003) studied 200 chronic pain patients and found that acceptance of pain was a significant predictor of perceived pain, depression, pain-related anxiety, disability, physical functioning, and vocational functioning. McCracken and Vowles (2008) surveyed 115 chronic pain patients attending a treatment program and found that pain-related acceptance predicted better outcomes. Chronic pain sufferers with higher levels of acceptance of pain have also been found to be more likely to report enhanced coping with pain (McCracken 1998; McCracken et al. 1999) and increased sense of vitality and overall health (McCracken and Velleman 2010). Finally, McCracken et al. (2004) reported that chronic pain sufferers who did not feel a need to control or avoid painful experiences were more likely to report experiencing less pain, less use of healthcare and medications, and less emotional distress.

A recently conducted meta-analytic study provides additional insight into the interrelationships between acceptance and pain outcomes (Leith et al. 2009). After completing an extensive search for relevant articles, Leith et al. (2009) located eight studies that investigated relationships between Acceptance and Commitment Therapy-relevant processes (acceptance, values, mindfulness) and pain-related outcomes (pain ratings, pain disability, negative emotional states, physical outcomes, pain medication use, and work status) among persons experiencing chronic pain. None of the studies used headache patients. Results indicated that acceptance ($Zr = -0.31$), mindfulness ($Zr = -0.43$), and values ($Zr = -0.34$) were inversely associated with pain-related experiences taken as a whole. Additionally, Acceptance and Commitment Therapy-related variables, taken as a whole, were inversely associated with negative psychological states ($Zr = -0.58$) and disability ($Zr = -0.44$). Because of the limited number of studies, Leith et al. (2009) could not partition out the specific relationships between acceptance and individual pain-related outcomes. However, the overall findings support the notion that acceptance is positively associated with improved psychological and behavioral functioning among chronic pain patients.

Although some researchers have considered acceptance as the willingness to give up attempts to control internal experiences (Hayes et al. 1999a, b; Hayes and Wilson 1994), at least one study has shown a positive correlation between acceptance and perceptions of control (Viane et al. 2003). These findings suggest that the traditional notion of acceptance as giving up the need to control may be inconsistent with the experiences of pain patients. That is, it may be that acceptance is viewed by these individuals as a means of controlling the negative sequelae that frequently accompany the pain experience. The inverse relationship between acceptance and pain-related outcomes in the Leith et al. (2009) meta-analysis tends to support this line of reasoning. Specifically, persons with higher levels of acceptance tend to have higher levels of functioning which, by definition, would indicate they have enhanced capacity for controlling their day-to-day activities. In a sense, it may be that acceptance involves discontinuing efforts to control aspects of the pain experience that are uncontrollable (e.g., the pain sensation itself, the unpredictability of pain) while simultaneously directing efforts toward changing behaviors that are controllable and linked to enhanced functioning (e.g., work, functional activity, not verbalizing pain complaints).

In summary, research suggests that appraisals of stressful events may be significantly related to headache activity. In particular, catastrophizing and control appraisals appear to be most consistently related to the experience of pain and stress. Preliminary studies also provide support for the idea that acceptance is associated with pain experiences and may covary with control appraisals. However, no published research has examined relationships among perceived control, catastrophizing, and acceptance among migraine headache sufferers.

This project aimed to evaluate relationships among acceptance, control, catastrophizing, pain symptoms, and coping among migraine headache sufferers using daily dairy methodology. It was hypothesized that among migraine headache sufferers: (a) pain acceptance would be inversely associated with catastrophizing, (b) pain acceptance would be positively associated with control appraisals, (c) pain acceptance would be inversely associated with headache interference with daily activities after controlling for pain intensity, and (d) pain acceptance would be inversely associated with use of multiple coping strategies.

Method

Participants

Participants were recruited in the Minneapolis metropolitan area and nationally. Potential participants were recruited via local newspaper advertisements, local community bulletin boards, online community bulletin boards, and migraine support groups. Adults who responded to the advertisements and who reported (a) five or more headaches per month at a minimum pain intensity of 5, (b) pain primarily on one side of the head, (c) pulsating or throbbing sensation during headache, and (d) presence of photophobia, phonophobia, and/or nausea; were contacted and invited to be screened for participation in the study. Upon verbal consent, a diagnostic interview was conducted over the phone. Headache diagnoses were made according to the criteria of the International Headache Society (Headache Classification Subcommittee of the International Headache Society 1988). The diagnostic interview was administered by a trained graduate student. It was 15–20 min in length and based on the shortened version of the Structured Diagnostic Interview for Headaches (Andrew et al. 1992). A total of 110 possible participants were interviewed. Based on the responses to the structured diagnostic interview, 78 people met IHS criteria for migraine headache with or without aura. These 78 participants were enrolled in the study.

Of those who enrolled in the study, 74 people completed all three phases of the study (initial interview and questionnaire administration, 28 day daily diary, follow-up appointment for debriefing and questionnaire administration). The four participants who were dropped from the study failed to complete the second set of questionnaires. In exchange for their voluntary participation, participants received $25.00 at the end of the study. College students who were in courses that allowed extra credit for participation in the study were allowed to choose either extra credit or the $25.00 payment.

Participants were primarily female (86.5%), white (83.8%), and had some education beyond the high school level (83.7%). Age ranged from 18 to 66 ($M = 31.1$, SD = 13.2). Participants had been experiencing migraine headaches for an average of 15.48 years (SD = 13.99). A sizeable minority of the participants (39.2%) were receiving treatment at the time of entry into the study. In terms of headache activity, participants experienced an average of 15 headaches during the month of daily monitoring (SD = 6.58, range = 3-28).

Measures

Headache diagnostic system

The Structured Diagnostic Interview for Headache (Penzien 1991) was modified to include only the items necessary to obtain an International Headache Society diagnosis and brief headache history (Hassinger et al. 1999). Diagnoses were made using a computer program developed by Andrew et al. (1992). Preliminary validation studies of this method yielded approximately 94.9% agreement rates between International Headache Society diagnostic interviews and the computer software (Penzien et al. 1992). Data were entered into the computer program, which provides a summary of the participants' headache diagnoses and the criteria fulfilled in establishing the diagnoses.

Demographic Information

A screening questionnaire that was developed by the authors contained items that assessed basic demographic characteristics (age, gender, education, ethnicity, work status).

Pain Acceptance: Pain Willingness and Activity Engagement

Pain acceptance was measured using the Chronic Pain Acceptance Questionnaire (Geisser 1992; McCracken et al. 2004), which contains 20 items using a Likert-type scale format. This measure was developed with chronic pain patients waiting for enrollment in multidisciplinary pain treatment program. It has two subscales Activity Engagement (e.g., "There are many activities I can do when I feel pain.") and Pain Willingness (e.g., "It's OK to experience pain."). The measure's overall score can also be used as a general level of acceptance of chronic pain with higher scores indicating greater activity engagement and pain willingness. Respondents rate items on a 7-point scale from 0 (Never True) to 6 (Always True). The Chronic Pain Acceptance Questionnaire has adequate internal consistency ($\alpha = 0.78$–0.82) and has reliably predicted patient functioning in several studies (Geisser 1992; McCracken 1998; McCracken et al. 2004). The two subscales are moderately correlated ($r = 0.36$) (McCracken et al. 2004). In the present study the internal consistency was 0.75 for the Pain Willingness subscale and 0.84 for the Activity Engagement subscale. The two subscales were moderately correlated, $r = 0.29$. The mean scores for the two Chronic Pain Acceptance Quationnaire subscales were higher than those reported for chronic pain samples (e.g., McCracken et al. 2004; Morley et al. 2005).

General acceptance

The Acceptance and Action Questionnaire (Hayes et al. 2004) is a 49 self-report measure that assesses acceptance and experiential avoidance. This measure was developed

using both clinical (i.e., psychological service seeking) and nonclinical samples. Respondents endorse the degree to which statements are true or false for them on a 7-point scale from 1 (Never True) to 7 (Always True). Higher scores in the Acceptance and Action Questionnaire indicate greater acceptance and less experiential avoidance. It possesses adequate convergent and discriminant validity (Hayes et al. 2004). For the present study, the internal consistency was 0.88.

Pain catastrophizing

The pain catastrophizing scale (Sullivan et al. 1995) is a 13-item self-report measure designed to assess cognitive and affective catastrophizing responses to pain. This measure was developed using both acute and chronic pain experiences. Higher scores in the Pain Catastrophizing Scale indicate higher levels of catastrophizing. Although original factor analytic solutions suggested three factors (i.e., Rumination, Magnification, and Helplessness), the considerable overlap between the components suggest that they are all dimensions of one underlying construct (D'Eon et al. 2004). The measure has adequate criterion, concurrent, and discriminant validity (Osman et al. 2000; Sullivan et al. 1995). The total score was used in the present study, which had an internal consistency of 0.92.

Pain coping strategies

The coping strategies Questionnaire—Revised (Robinson et al. 1997) is a 27-item self-report measure that principally assesses the use of cognitive pain coping strategies. The Coping Strategies Questionnaire-Revised was originally developed on a sample of chronic low back pain sufferers (Rosenstiel and Keefe 1983). Respondents endorse the frequency with which they use each strategy on a seven-point Likert-type scale ranging from 0 (Never do it) to 6 (Always do it). Additionally, the Coping Strategies Questionnaire—Revised has participants rate coping strategy effectiveness (i.e., ability to control pain) on a 7-point scale ranging from 0 (No Control) to 6 (Complete Control) and a rating of ability to decrease pain with the strategies from 0 (Cannot Decrease it) to 6 (Can Decrease it Completely). The Coping Strategies Questionnaire—Revised yields six subscales; Diverting Attention, Reinterpreting Pain Sensations, Ignoring Pain Sensations, Coping Self-Statements, Praying/Hoping, and Catastrophizing. Higher scores on each of the subscales indicate that the respondent has endorsed higher levels of coping strategy frequency, greater effectiveness, and greater control. The Coping Strategies Questionnaire—Revised has been widely used in the pain coping literature and possesses satisfactory internal consistency and concurrent validity (Robinson et al. 1997). The internal consistency of the subscales in the present study ranged from 0.78 (Coping Self-Statements) to 0.91 (Ignoring Pain Sensations). This sample's means and standard deviations were comparable to other migraine headache samples (e.g., Haythornthwaite et al. 1998; Materazzo et al. 2000).

Chronic pain coping

The chronic pain coping inventory (Jensen et al. 1995) is a 56-item self-report measure designed to assess strategies used by patients to cope with chronic pain. It was developed using data from chronic pain patients receiving multidisciplinary pain treatment. The subscales are in each of three broad areas, illness-focused coping (Guarding, Resting, Asking for Assistance, Opioid Medication Use, Non-steroidal Medication Use), wellness-focused coping (Relaxation, Task Persistence, Exercise/Stretch, Coping Self-Statement), and other coping (Seeking Social Support). Respondents are asked to endorse the number of days in the past week they have used each strategy. Higher scores indicate that a particular coping strategy is used more frequently. Internal consistency is adequate, with subscales ranging from $\alpha = 0.74$ to $\alpha = 0.91$. Because this does not have catastrophizing as a subscale, it may be a more pure measure of coping. The Chronic Pain Coping Inventory has been found to be more predictive of pain related disability than the Coping Strategies Questionnaire—Revised (Tan et al. 2001). It also contains more items assessing behavioral responses to pain. For the present study, the Chronic Pain Coping Inventory—42 was used, as it is more abbreviated yet highly correlated with the original Chronic Pain Coping Inventory (Romano et al. 2003). The internal consistency in the present study ranged from 0.75 (Asking for Assistance) to 0.89 (Seeking Social Support).The means for the Chronic Pain Coping Inventory subscales were slightly lower in this study's sample compared to pain patients in chronic pain treatment studies (e.g., Tan et al. 2001).

Pain symptoms and pain interference

The West Haven Yale Multidimensional Pain Inventory (Kerns et al. 1985) is a 60-item self-report instrument that assesses chronic pain patients' pain severity, perception of pain interference, degree of support, perceived life control, and affective distress. Higher scores indicate higher levels of symptom reporting and more pain interference. The measure has adequate internal consistency ($\alpha = 0.74$–0.89) (Kerns et al. 1985). The West Haven Yale Multidimensional Pain Inventory has been demonstrated to have good reliability and validity with chronic pain patients (Kerns

et al. 1985). The internal consistency for subscales used in the present study ranged from 0.69 (Pain Severity) to 0.91 (Pain Interference).

Daily diary

A 28 item daily diary was developed for this study. The first five items measured headache activity (i.e., whether a headache occurred or not, whether the headache was migraine or not, pain level on a 0 -10 scale, stress level on a 0–10 scale, pain interference on a 0–10). These items are commonly used in headache research. The two acceptance constructs (pain willingness and activity engagement) were measured using six items taken from the Chronic Pain Acceptance Questionnaire (McCracken et al. 2004). Selection of items was based on face validity and factor analytic results (i.e., items with high factor loadings on relevant constructs). Each item was rated on a 0 ("not at all true") to 6 ("extremely true") Likert scale. Pain control was measured using the single control item that is contained on the Coping Strategies Questionnaire. The item read "How much control do you have over your pain" and was rated on a 7 point Likert scale that ranged from 0 ("no control") to 6 ("complete control").Finally, catastrophic appraisal was measured using three items taken from the Pain Catastrophizing Scale. Items were selected based on face validity and factor analytic studies (i.e., items that loaded highest on the relevant factor). These items were rated using a 7 point Likert scale that ranged from 0 ("not at all true") to 6 ("extremely true"). Internal consistency was calculated for the diary subscales with multiple items assessing a single construct. Results indicated that pain willingness ($\alpha = 0.84$), activity engagement ($\alpha = 0.84$), and catastrophizing ($\alpha = 0.90$) all had satisfactory internal consistency.

Fourteen items assessed coping strategies. The first eight coping items were taken from the Chronic Pain Coping Inventory—42 (Romano et al. 2003) with one item representing each of the eight subscales. These eight items were selected based on high loadings onto their respective subscales in a validation study (Hadjistavropoulos et al. 1999) as well as face validity. The remaining six items were taken from the Coping Strategies Questionnaire—Revised (Rosenstiel and Keefe 1983). Each item represented one of the six coping subscales found on the Coping Strategies Questionnaire-Revised (Robinson et al. 1997; Swartzman et al. 1994). Again, the selection of items was based on factor loadings. Each coping item was rated using a binary format (yes, no) which indicated whether the participant had used that particular strategy on that particular day. The coping items were summed to yield a measure of the number of coping strategies used on a given day.

Procedure

Potential participants who were interested in participating contacted the experimenter via telephone or email (their choice). The overall purpose and procedures of the study were provided to them. Willingness to undergo the brief phone screening for migraine headache was taken as informed consent for the phone portion of the study. Individuals who met criteria for migraine headache with or without aura were invited to participate in the study. Those who agreed to participate completed the study using one of two methods: paper and pencil version or internet version. Assignment to the paper and pencil or internet version of the study was based on participant preference and location (those residing a significant distance from the study site and/or could not meet with the researchers used the internet).

Paper and pencil

Participants who completed the paper and pencil version of the study met with the researcher in a convenient location to read and sign the informed consent, the initial packet of questionnaires, and to receive the 28 day daily diary. Participants were given a written informed consent, with one copy to sign and one to keep for their records. After informed consent was signed, participants completed the questionnaires described in the methods section. Participants were then provided with the 28-day daily diaries. The diary was split into two 14-day packets, allowing participants to mail the first 14-days back to the researcher halfway through the study. Participants completed the daily diary once per day, within a few hours of going to bed. Upon completing all of the daily diaries, participants met with the researcher a second time. On this second occasion, participants again completed additional questionnaires that are not included in the present report. They were then debriefed and compensated for their participation. Participants were contacted each week by phone in order to promote compliance and to answer questions that arose during the completion of the diary. If a participant was not home at the time of the phone call, a message was left with encouragement to continue and a number that could be called if there were questions.

Internet

Participants assigned to the internet version of the study completed all study materials online. Survey Monkey was the tool used to deliver the surveys ("Survey Monkey," 2007). Survey Monkey is a company that operates in a secure server environment with standard Secure Socket Layer encryption. At the time of being invited to

participate in the study, participants reviewed the research protocol and details of informed consent with the researcher over the phone. Participants then provided the researcher an email address to use when sending links to the questionnaires and daily dairy. Participants received an email inviting them to participate in the study, when they clicked on the link that directed them to the study, the first page was the informed consent. Participants who agreed to participate clicked "I agree", which directed them to the first page of the initial questionnaires. A "I do not agree" link was also available at the bottom of the informed consent. If that link was clicked, potential participants would have been thanked for their interest, and removed from the study roster. All participants who were invited to participate did so. Email messages were sent to participants daily with a link to that day's diary.

Data reduction and analysis

Mean scores, standard deviations, internal consistency, and normality statistics for the self-report questionnaires were calculated. A set of initial analyses was conducted to determine if significant differences existed between internet and paper and pencil versions of the diary on demographic characteristics or other relevant measures, as well as local and nonlocal participants, and treatment status. Correlation analyses were then performed to examine the bivariate relationships between pain willingness and activity engagement and measures of appraisal, coping, and pain symptoms. Hierarchical regression analysis were used to examine the relation of acceptance with pain related disability after controlling for education, years since migraine onset, and pain severity. Education and years since onset of migraine headaches were entered in one block using a forward entry inclusion method. Pain severity was entered into the equation in the second block, and acceptance was entered in the final step. Hierarchical regression analysis were also conducted to determine the relation between acceptance, other types of appraisal (i.e., catastrophizing and control), and coping strategies. Hierarchical Linear Modeling software (Scientific Software International 2007) was used to explore these same relationships using daily diary data. Bryk and Raudenbush's approach was used for model building (1992; Raudenbush et al. 2004). Participants recorded daily pain levels on headache days, stressfulness of the headache, pain interference, use of various coping strategies from the Copins Strategies Questionnaire and the Chronic Pain Coping Inventory, level of perceived control, level of pain related acceptance (responding to several items from the Chronic Pain Acceptance Questionnaire, and level of catastrophizing. The daily diary data have a hierarchical structure of up to 28 responses nested within each of the 63 participants. In multilevel analysis for repeated measures designs, the Level 1 observations, and corresponding model equations, refer to within subjects repeated measures variables. The Level 2 observations and corresponding model equations refer to and model the between subjects variables (Hox 2002).

Model 1 was a within subjects model, designed to determine if daily level of catastrophizing was a function of daily levels of pain (pain level) and pain-related acceptance (pain willingness and activity engagement). Pain willingness and activity engagement were entered as separate predictors because prior studies indicate that the subscales are only moderately correlated and because each subscale had different magnitudes of correlation with catastrophizing when the questionnaire data were analyzed in this study (see Table 4). Day was entered for all models to account for daily fluctuations in these variables. The Level 1 and Level 2 models for the initial within-subjects analysis were:

$$\begin{aligned}\text{Level 1: Catastrophizing} &= \pi_0 + \pi_1(\text{Day}) + \pi_2(\text{Pain level}) + \\ &\quad \pi_3(\text{Pain willingness}) + \pi_4(\text{Activity engagement}) + e\\ \text{Level 2: } \pi_0 &= \beta_{00} + r_0\\ \pi_1 &= \beta_{10} + r_1\\ \pi_2 &= \beta_{20} + r_2\\ \pi_3 &= \beta_{30} + r_3\\ \pi_4 &= \beta_{40} + r_4\end{aligned}$$

In the first model, the level 1 equation is similar to a typical regression equation. The level 2 equation model can be constructed in multiple ways, depending on how one thinks about potential between person differences. This is a fairly basic level 2 construction that is allowing the slopes to vary randomly between participants on each of the level 1 variables. In other words, the level 2 equations define the level 1 predictors as the overall mean of that predictor (e.g., β_{40}) plus individual differences (e.g., r_4).

Model 2 was a between subjects model, frequently referred to as an intercept-as-outcome model in the multilevel modeling literature (Raudenbush et al. 2004). This type of model allows for testing of between subjects differences in mean levels of the dependent variable, in this case, catastrophizing.

$$\begin{aligned}\text{Level 1: Catastrophizing} &= \pi_0 + \pi_1(\text{Day}) + e\\ \text{Level 2: } \pi_0 &= \beta_{00} + \beta_{01}(\text{Treatment}) + r_0\\ \pi_1 &= \beta_{10} + r_1\end{aligned}$$

Model 3 tested interaction effects, specifically, exploring the impact of treatment status on the strength of the relationship between pain willingness, activity engagement, and catastrophizing Treatment was explored as a

moderator because it often targets appraisals, acceptance, and coping responses.

$$\text{Level 1: Catastrophizing} = \pi_0 + \pi_1(\text{Day}) + \pi_2(\text{Pain level}) + \pi_3(\text{pain willingness}) + \pi_4(\text{Activity Engagement}) + e$$

$$\text{Level 2: } \pi_0 = \beta_{00} + \beta_{01}\ (\text{Treatment}) + r_0$$
$$\pi_1 = \beta_{10} + \beta_{11}\ (\text{Treatment}) + r_1$$
$$\pi_2 = \beta_{20} + \beta_{21}\ (\text{Treatment}) + r_2$$
$$\pi_3 = \beta_{30} + \beta_{31}\ (\text{Treatment}) + r_3$$
$$\pi_4 = \beta_{30} + \beta_{41}\ (\text{Treatment}) + r_4$$

Descriptive statistics were also used to summarize the diary data at the individual level.

Results

Demographic analyses

Participants were recruited both locally (Minneapolis/Saint Paul metropolitan area) and nationally for the present study, and multiple methods of participation (online versus paper and pencil) were utilized. Of the 47 local participants, 17 completed the internet version and 30 completed the paper and pencil version. Of the 27 nonlocal participants, all completed the internet version. Tables 1 and 2 summarize the demographic and headache characteristics of the participants.

No significant differences were observed between local and nonlocal participants on any demographic measure or headache measure. Similarly, no significant differences were observed between persons who completed paper and pencil surveys versus internet surveys. However, the participants using the internet missed, on average, one less day of self-monitoring relative to participants using the paper and pencil measures ($t(62) = 5.93$, $P = 0.03$). Participants who were receiving treatment were older ($F(1,70) = 46.35$, $P < 0.001$), and had experienced migraine headaches for a longer period of time ($F(1,68) = 37.50$, $P < 0.001$) than participants who were not in treatment. Because of this, treatment status was used as a covariate in subsequent hypothesis tests.

Questionnaire data

The descriptive statistics for the questionnaires are presented in Table 3. Intercorrelations among the self-report measures, daily diary items, and the two pain-related acceptance subscales are detailed in Table 4. Higher levels of pain willingness and activity engagement were associated with lower levels of catastrophizing, pain severity, and pain interference. Higher levels of pain willingness (but not activity engagement) were associated with general acceptance. Finally, higher levels of activity engagement (but not pain willingness) were associated with higher levels of control appraisals.

Table 1 Demographic characteristics of the sample

	N	%
Gender		
Male	10	13.5
Female	64	86.5
Marital status		
Single	39	52.7
Married	28	37.8
Divorced	5	6.8
Separated	1	1.4
Widowed	1	1.4
Race/Ethnicity		
White	62	83.8
Nonwhite	12	16.2
Education level		
Some high school	1	1.4
High school or equivalent	11	14.9
Some college	36	48.6
Associates	4	5.4
Bachelor's degree	10	13.5
Some graduate school	5	6.8
Graduate degree	7	9.5
Employment		
Full time	19	25.7
Part time[a]	24	32.4
Unemployed[b]	26	35.1
Disability	4	5.4
Retired	1	1.4

$N = 74$

[a] 17 Of those who were classified as part time workers were students

[b] 17 Of those who were classified as unemployed were students

Daily diary data

Among the 74 participants who completed the study and were included for possible data analysis, a total of 2,072 time points for diary entries were possible. Of those, 1,940 were completed, yielding a missing rate of 6.4 percent. Two participants completed fewer than 50% of the possible days and were excluded from data analysis. Nine additional participants were excluded, because they completed the daily diaries only on headache days. Thus, the final sample

Table 2 Headache characteristics of the sample

	N	%	*M*	SD	Range
Headache days per month			15.11	6.58	3–28
Migraine headache days per month			8.64	7.91	0–28
Average pain intensity			5.36	1.53	2.82–10
Migraine with aura	22	29.7			
Migraine without aura	52	70.3			
In treatment					
Yes		29	39.2		
No		45	60.8		
Age of onset			14.96	5.48	4–36
Years since onset			15.48	13.99	0–55

$N = 72$ for the daily diary variables. Headache days per month and pain intensity were taken from daily diary data, rather than initial self report at beginning of the study. The correlation between initial self-report of number of headache days and daily dairy reports of headache days was significant ($r = 0.63$, $P < 0.001$). The correlation between initial self-report of pain intensity and daily dairy reports of pain intensity was nonsignificant ($r = 0.13$, $P = 0.31$)

for statistical analysis of the diary data was 63 participants. Table 5 provides descriptive information for the diary data. There were no significant differences between persons who completed the diaries and were included in the analyses and those who were dropped from analyses on any demographic variable or self-report measure.

Hypothesis tests

The results of the multilevel models show that daily levels of catastrophizing were a function of daily pain willingness ($t = -6.68$, $P < 0.001$) and activity engagement ($t = -3.14$, $P < 0.001$) (Table 6). Specifically, increased levels of pain willingness and activity engagement were associated with lower levels of catastrophizing. Additionally, higher levels of daily pain were associated with higher levels of catastrophizing ($t = 12.98$, $P < 0.001$). Treatment status was not associated with catastrophizing alone or in combination with the other predictors.

Acceptance and Control. A similar analysis strategy was used to evaluate variables associated with control appraisals. The results of the multilevel models showed that daily levels of control were associated with day, pain level, and activity engagement (Table 7). Activity engagement and control appraisals were related as predicted. Increased levels of activity engagement were associated with increased levels of perceived control ($t = 7.39$, $P < 0.001$). Pain willingness did not relate to control appraisals. There was an effect for pain intensity, such that increased levels of pain were related to lower levels of perceived control ($t = -5.24$, $P < 0.001$). The effect for day suggests that control appraisals decreased across time ($t = -2.21$, $P < 0.05$). Treatment status did not yield between subject differences in initial levels of control nor differences in the strength of the relationship between pain level, acceptance, and control.

Acceptance and Pain Interference. The within subjects model indicated that pain interference was associated with decreased pain willingness ($t = -4.60$, $P < 0.001$) and activity engagement ($t = -3.66$, $P < 0.001$) (Table 8). Additionally, higher pain levels were associated with more pain interference ($t = 19.27$, $P < 0.001$). A significant effect for treatment status indicated that people who were in treatment had higher levels of pain interference ($t = 2.24$, $P < 0.05$). Treatment status also interacted significantly with pain level such that persons in treatment reported greater interference as their pain levels increased more than persons who were not in treatment ($t = 2.27$, $P < 0.05$).

Acceptance and Levels of Coping. As predicted, the within subjects model indicated that higher levels of pain willingness were associated with fewer coping strategies ($t = -4.77$, $P < 0.001$) (Table 9). Additionally, higher levels of pain were associated with more coping strategies ($t = 3.49$, $P < 0.001$). Finally, treatment status was associated with number of coping strategies such that people in treatment used more coping strategies that people not in treatment ($t = 3.23$, $P < 0.01$).

Discussion

Acceptance, catastrophizing, and control

Several findings in the present study extend our understanding of how acceptance relates to the two most commonly studied appraisals in chronic pain populations: catastrophizing and control. As expected, higher general

Table 3 Means and standard deviations of initial questionnaires

	M	SD
West Haven Yale multidimensional pain inventory		
Affective Distress	3.29	1.07
Pain Interference	3.18	1.25
Support	3.70	1.62
Pain Severity	3.11	1.09
Life Control	3.37	1.33
Negative Responses	1.29	1.37
Solicitous Responses	3.34	1.38
Distracting Responses	1.85	1.31
General Activities	2.68	0.93
Chronic Pain Acceptance Questionnaire		
Pain Willingness	25.86	7.99
Activity Engagement	39.42	10.79
Acceptance and Action Questionnaire	47.38	10.47
Coping Strategies Questionnaire—revised		
Distracting	3.06	1.56
Catastrophizing	2.36	1.29
Ignoring	2.58	1.29
Distancing	1.84	1.67
Coping self statement	4.03	1.22
Praying	3.35	1.89
Control	2.48	1.25
Chronic pain coping inventory		
Guarding	1.49	1.44
Resting	3.20	1.93
Asking for assistance	1.51	1.60
Relaxation	1.79	1.47
Task persistence	2.99	1.87
Exercise	1.89	1.83
Coping self statement	2.74	2.08
Seeking social support	2.37	2.01
Pain catastrophizing scale		
Rumination	8.62	3.96
Magnification	3.70	2.92
Helplessness	9.58	5.76
Total score	21.90	10.86

$N = 74$

Table 4 Pearson correlations among pain acceptance and initial questionnaires

	Pain willingness	Activity engagement
Initial questionnaires		
Appraisals		
Catastrophizing (PCS)	−0.493**	−0.200
Control (CSQ)	0.166	0.291*
Pain characteristics		
Pain severity (WHYMPI)	−0.388**	−0.280*
Pain interference (WHYMPI)	−0.510**	−0.555**
General activity (WHYMPI)	0.073	0.238
Affective distress (WHYMPI)	−0.134	−0.102
General acceptance (AAQ)	0.356*	0.225
Years since onset	−0.278*	−0.323*

PCS pain catastrophizing scale, *CSQ* Coping Strategies Questionnaire, *WHYMPI* West Haven Yale multidimensional pain inventory, *AAQ* Acceptance and Action Questionnaire. $N = 74$

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

Table 5 Daily diary descriptives

Measure	*M*	SD	Range
Headache days	15.22	6.71	5.00–28.00
Migraine days	8.44	8.01	0.00–28.00
Pain rating (overall, 0–10 scale)	5.36	1.61	2.82–10.00
Stress rating (of pain, 0–10 scale)	4.72	1.61	0.93–9.85
Daily interference (0–10 scale)	4.12	1.85	0.53–9.85
# Coping strategies used per day	4.60	2.36	0.23–9.92
Activity engagement (0–6 scale)	3.49	1.26	0.26–5.75
Pain willingness (0–6 scale)	3.62	1.27	0.09–5.87
Catastrophizing (0–6 scale)	2.112	1.09	0.18–3.01
Control (0–6 scale)	2.74	1.42	0.11–5.85
Variation in activity engagement	2.76	1.47	0.37–6.73
Variation in pain willingness	2.52	1.27	0.66–7.14

These data were averaged across all times for each participant and then averaged across participants to yield the final values. $N = 63$

levels of willingness to experience pain were associated with lower levels of catastrophizing. This relationship remained even when controlling for the effect of pain severity.

The only other study located in which catastrophizing and acceptance in chronic pain populations were evaluated yielded a similar pattern of findings. Viane et al. (2003) found that higher pain-related acceptance scores were associated with lower levels of catastrophizing. However, these researchers used a different measure of acceptance that was more focused on acceptance of chronic illness.

The relationship found between acceptance and catastrophizing merits further consideration of the manner in which these two concepts relate. McCracken and Eccleston (2003) have discussed this relationship at length, emphasizing the differences between the two. Catastrophizing is an automatic, negative, and unrealistic interpretation of a situation, in this case pain, with a focus on feared outcomes (McCracken and Eccleston 2003), whereas acceptance involves a more deliberate choice to come into contact with pain and discontinue the struggle to control it or eliminate it, rather focusing on moving forward with living one's values (e.g., spending time with family, engaging in meaningful work) (Hayes et al. 2004). McCracken and

Table 6 Daily catastrophizing as a function of daily pain level and daily pain-related acceptance

	Coefficient	SE	*t*
Model 1: Within subjects factors			
Day	−0.00	0.01	−0.20
Pain level	1.10	0.09	12.98***
Pain willingness	−0.33	0.05	−6.68***
Activity engagement	−0.12	0.04	−3.14**
Model 2: Between subjects effects			
Treatment status	−0.05	0.04	−1.29
Model 3: Moderating effects			
Treatment status			
On day	−0.02	0.03	−0.76
On pain level	0.09	0.18	0.48
On pain willingness	0.13	0.11	1.22
On activity engagement	−0.08	0.09	−0.92

$N = 63$

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

Table 7 Daily levels of control as a function of daily pain level and daily pain-related acceptance

	Coefficient	SE	*t*
Model 1: Within subjects factors			
Day	−0.01	0.01	−2.21*
Pain level	−0.09	0.02	−5.24***
Pain willingness	0.01	0.02	0.26
Activity engagement	0.13	0.02	7.39***
Model 2: Between subjects effects			
Treatment status	0.00	0.01	0.19
Model 3: Moderating effects			
Treatment status			
On day	0.01	0.01	0.51
On pain level	−0.03	0.04	−0.83
On pain willingness	−0.04	0.04	−0.86
On activity engagement	−0.02	0.03	−0.56

$N = 63$

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

Table 8 Daily levels of interference as a function of daily pain level and daily pain-related acceptance

	Coefficient	SE	*t*
Model 1: Within subjects factors			
Day	0.01	0.01	1.65
Pain level	0.78	0.04	19.27***
Pain willingness	−0.10	0.02	−4.60***
Activity engagement	−0.08	0.02	−3.66***
Model 2: Between subjects effects			
Treatment status	1.36	0.61	2.24*
Model 3: Moderating effects			
Treatment status			
On day	−0.01	0.01	−1.03
On pain level	0.19	0.08	2.27*
On pain willingness	0.04	0.04	0.90
On activity engagement	0.01	0.06	0.11

$N = 63$

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

Table 9 Pain-related acceptance and number of coping strategies

	Coefficient	SE	*t*
Model 1: Within subjects factors			
Day	0.01	0.01	0.75
Pain level	0.13	0.04	3.49***
Pain willingness	−0.14	0.03	−4.77***
Activity engagement	0.02	0.03	0.66
Model 2: Between subjects effects			
Treatment status	1.98	0.61	3.23**
Model 3: Moderating effects			
Treatment status			
On day	0.00	0.02	0.13
On pain level	0.07	0.07	1.04
On pain willingness	0.03	0.06	0.61
On activity engagement	−0.02	0.05	−0.36

$N = 63$

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

Eccleston (2003) suggest that acceptance of pain may be a way to reduce frequency and/or impact of catastrophizing.

Within the acceptance and commitment therapy framework, from which these research questions for the present study came, cultivating acceptance is distinct from overt efforts to control internal experiences such as pain (Hayes and Wilson 1994). However, control of the *behavioral expression* of pain is viable and would be encouraged. Thus, it is likely that catastrophizing thoughts would still remain in people who have high levels of acceptance but that the degree of *belief* in the catastrophic thoughts would be diminished as well as the expression of pain. Additionally, the *functional relationships* between catastrophic thoughts and avoidance responses would be diminished.

Higher levels of activity engagement were associated with higher levels of perceived control. Other researchers have found a positive association between pain-related acceptance and control (Geisser 1992; Viane et al. 2003). On the surface, this appears to run counter to one of the tenets of acceptance and commitment therapy wherein it is

argued that acceptance is analogous to giving up attempts to control persistently problematic internal experiences. However, the present results suggest that acceptance of headache pain may be experienced as a means through which a person may feel as though he or she has increased control over the influence that headache pain plays in one's life, or the extent to which it interferes with pursuit of important life goals. This investigation used only a single measure of control and while it has high face validity, it does not provide information about the many potentially important facets of control (e.g., control as prediction, behavioral control, emotional control, cognitive control, objective control, etc.) that may have different relationships with acceptance. These fine-grained distinctions about control perceptions in relation to acceptance merit further investigation.

Acceptance and coping

As hypothesized, migraine headache sufferers who endorsed higher daily levels of acceptance reported they engaged in fewer daily coping strategies. In Lazarus and Folkman's (1984) model of primary and secondary appraisal, perceptions that an event is not threatening or that one has the resources to respond to an event, would be associated with a reduced probability of initiating a coping response. Thus, the current finding provides support that acceptance may function as a type of primary or secondary appraisal. Further exploration of the interrelationships between acceptance, appraisal, and coping is needed to disentangle these interrelated constructs.

Acceptance and pain interference

As hypothesized, higher levels of pain-related acceptance were associated with lower levels of pain-related interference even after variance associated with pain severity was partitioned out. Thus, it appears that acceptance can be activated regardless of pain level. Further, it can be the case that acceptance can exert beneficial effects independent from severity of symptoms.

Several limitations of the present study warrant mention. All of these data were obtained using self-report measures. Thus, method variance may have inflated the magnitude of relationships among measures. Given that chronic pain conditions frequently impact those around the person with chronic pain (i.e., friends, family, coworkers), it would be helpful to consider future research that evaluates the impact of a persons headache condition on interpersonal relationships. Finally, this was a self-selected sample, limited to people who responded to advertisements for research. Thus, it is not possible to know the extent to which these findings generalize to the parent population of all headache sufferers. Further evaluation of these interrelationships with a patient sample would also clarify how well these findings extend to persons experiencing the most severe and debilitating headaches.

In closing, this study further strengthens the evidence base that acceptance is a construct that has relevance in the experience of migraine pain. Acceptance continues to show promise as a way of viewing pain that lessens the detrimental impact of certain types of thoughts (i.e., catastrophizing), and leads to increased participation in daily life.

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