The Clinical Journal of Pain Publish Ahead of Print
DOI:10.1097/AJP.0000000000000580

Mindfulness and Chronic Headache/Migraine: Mechanisms Explored through the Fear-Avoidance Model of Chronic Pain

1. Authors:
   Biyanka Komandur, MPsych(Clin), Griffith University
   Paul R Martin, DPhil, Griffith University, Menzies Health Institute Queensland
   Siavash Bandarian-Balooch, Griffith University
2. Correspondence:
   Professor Paul R Martin,
   Department of Applied Psychology
   Griffith University, Mount Gravatt Campus
   176 Messines Ridge Road
   Queensland 4122, Australia
   Tel: +61 (0)7 3735 3322, Fax: +61 (0)7 3735 3388,
   E-mail: paul.martin@griffith.edu.au
3. Sources of support:
   None
   The authors declare no conflict of interest.

Abstract

Objectives: (1) To replicate a study by Schutze, Rees, Preece, and Schutze (2010) on a headache sample, rather than a heterogeneous chronic pain sample, investigating whether level of mindfulness predicts key components in the fear-avoidance model of chronic pain (pain intensity, negative affect, pain catastrophizing, pain-related fear, pain hypervigilance, and functional disability); (2) to investigate the relationships between level of mindfulness and headache/migraine pain intensity, frequency, and duration. **Method:** Participants were 217 self-reported chronic headache/migraine sufferers (51 male, 166 female), aged between 18 and 65 years. Participants completed an online survey measuring demographics, mindfulness, the key components of the fear-avoidance model, and headache pain intensity, duration, and frequency. **Results:** Mindfulness had significant negative correlations ($p < .05$) with all variables except headache pain intensity and headache frequency. Mindfulness significantly predicted negative affect, pain catastrophizing, fear of pain, pain hypervigilance, and headache duration ($p < .05$). Mindfulness remained a significant predictor of negative affect and pain hypervigilance after controlling for other key components and background characteristics ($p < .05$). Mindfulness did not moderate the relationship between pain intensity and pain catastrophizing ($p = .204$). **Discussion:** Findings suggest that mindfulness may be integrated into the fear-avoidance model of chronic pain for chronic headache/migraine sufferers. Directions for future research are discussed.

Key Words: chronic pain, headache/migraine, mindfulness, fear-avoidance model

Introduction

On the World Health Organization's ranking for causes of disability, headache disorder has been estimated to fall amongst the most common.[1] Traditional 'headache hygiene' suggests that identification and avoidance of headache triggers is most effective in the management of headache disorders. However, such an approach appears to lack an evidence-base, and may instead be maladaptive.[2-4]

Fear-Avoidance Model of Chronic Pain

The fear-avoidance model of chronic pain[5] (see figure 1) postulates that the experience of pain may be associated with negative appraisal of the pain (e.g., catastrophic thoughts), leading to the development of pain-related fear, and subsequently to maladaptive coping behaviors such as escape, avoidance, and/or hypervigilance. In addition, it suggests that these maladaptive coping behaviors may lead to depression, impaired musculoskeletal and cardiovascular functioning from long-term inactivity, or other disability. Such psychological or physical disability may be associated with a decline in pain tolerance, thereby increasing the likelihood of pain experience. In contrast, the model suggests that if no pain-related fear is developed following the experience of pain, this may result in confrontation/approach behavior (as opposed to avoidance/escape behavior), which may in-turn lead to recovery. Numerous studies involving chronic pain patients, have found support for the fear-avoidance model of pain.[6-9] These studies have generally focused on lower back pain patients.

Martin (2010a) developed the Trigger Avoidance Model of Headaches. Similar to the fear-avoidance model of pain, this model suggests that avoidance and escape behavior, with respect to headache/migraine triggers, may result in increased sensitivity to, and decreased tolerance for the triggers. Avoidance of headache triggers is also suggested to be problematic in a practical sense as it is not always possible to identify and/or avoid all triggers, and attempting to do so may be stressful and can lead to a restricted lifestyle.[3,10] Psychological treatments involving exposure techniques (i.e., approach behavior) are being increasingly utilized in the effective treatment of chronic pain disorders

such as chronic headaches and migraines.[11-13] Another practice that involves approach behavior, as opposed to avoidance behavior, is the practice of mindfulness.[14]

Mindfulness and Chronic Pain.

Mindfulness is a concept derived from the historical practice of Buddhist meditation[15] and refers to a heightened act of consciously and intentionally bringing one's attention and awareness to the present moment. Mindfulness involves nonjudgmental acceptance of internal and external experiences of the present moment,[14,16] and is considered the opposite of mindlessness, which refers to a state of mind that is actively avoiding or denying the experience of certain thoughts, emotions, or perceptions.[14] Research has found that beneficial psychological and physical outcomes may be cultivated through mindfulness training.[16,17]

There is a growing interest in the use of Mindfulness Based Interventions (MBIs) in the treatment of chronic headaches and migraines,[18-24] however, currently there is limited and mixed evidence available on the effectiveness of these interventions. As demonstrated in Table 1, while some studies have found support for MBIs in the treatment of headache/migraine, others have not. These varied findings may be due to the presence of methodological limitations in some studies, including small sample sizes and confounding factors.

Schutze, Rees, Preece, and Schutze (2010) aimed to investigate the role of mindfulness in the fear-avoidance model of chronic pain, using a sample of individuals suffering from a variety of chronic pain conditions[25]. Their sample consisted of 10 head/face pain patients, 50 lower back pain patients, 16 neck pain patients, 9 leg pain patients, 6 upper back pain patients, 5 abdomen pain patients, 2 shoulder/arm pain patients, 1 chest pain patient, 1 pelvis/genitals pain patient, and 4 equal multiple sites pain patients. Participants were asked to complete a survey consisting of self-report measures, with one measure for each key component in the fear-avoidance model, and two measures for the mindfulness construct: the Five-Factor Mindfulness Questionnaire (FFMQ)[26] and the

Mindful Attention Awareness Scale (MAAS).[27] Schutze and colleagues (2010) explain that the five subscales of the FFMQ, pertaining to five facets of the mindfulness construct (non-reactivity to inner experience, observing inner experience, acting with awareness, describing experience, and non-judging of experience) allow deeper examination of the role of mindfulness in the fear-avoidance model. Therefore in their study, the FFMQ was utilized in the analyses where a single total score was not required, and the MAAS was utilized where a single total score was required (i.e., the correlation and moderation analyses).

Schutze and colleagues (2010) found that mindfulness had significant negative medium strength correlations[28] with each of the key components in the fear-avoidance model (pain intensity, negative affect, pain catastrophizing, pain-related fear, pain hypervigilance, and functional disability). Correlations ranged from -.22 to -.50, wherein higher level of mindfulness, was associated with lower levels of each key component. In addition, it was found that the key component most strongly predicted by mindfulness was pain catastrophizing, and after controlling for the other key components and background characteristics, mindfulness remained a significant predictor of pain catastrophizing. Additionally, Schutze and colleagues (2010) found that mindfulness moderated the relationship between pain intensity and pain catastrophizing, such that at high levels of mindfulness, the strength of the positive association between pain intensity and pain catastrophizing was lower. Therefore, Schutze and colleagues (2010) suggested that mindfulness may be integrated into the fear-avoidance model as a key component in itself, between pain experience and pain catastrophizing.

The Current Study, Aims, and Hypotheses

There is reason to believe that if Schutze and colleagues (2010) restricted their sample to primary headache/migraine sufferers, their findings may have been different. The pain conditions other than head/face pain included in Schutze and colleagues (2010), differ from primary

headache/migraine in a number of ways. First, primary headache/migraine differs from the other chronic pain conditions in its pattern of pain. The majority of headache sufferers are absent from pain most of the time and experience painful headache 'attacks' when exposed to triggers. Therefore, in the absence of triggers and associated headache 'attacks', the ability of headache sufferers to cope, and their psychosocial functioning, would be greater than in the presence of triggers and headache 'attacks'. Individuals suffering from the other chronic pain conditions are rarely in the absence of pain, as their pain is not dependent on the presence of triggers, however, their pain is likely to be less debilitating than pain associated with headache 'attacks'. The level of disability associated with chronic headache disorders has been likened to that of quadriplegia, dementia, and psychosis.[29] Second, unlike the other chronic pain conditions, primary headache/migraine is not associated with any identified damage or structural pathology[30] due to injury. Finally, primary headache/migraine often resolves with or without treatment. In comparison, due to underlying damage or structural pathology, the other chronic pain conditions are likely to be permanent.

The current study investigated the role of mindfulness in the fear-avoidance model of chronic pain by replicating the study conducted by Schutze and colleagues (2010); however, using a sample restricted to chronic primary headache/migraine sufferers. The current study also aimed to contribute to the growing literature on the relationship between mindfulness and important headache parameters such as headache intensity, frequency, and duration. The specific hypotheses of the current study are as follows:

1. It is hypothesized that higher level of mindfulness will be associated with and predict lower levels of negative affect, pain catastrophizing, pain-related fear, pain hypervigilance, functional disability, headache pain intensity, headache frequency, and headache duration.
2. It is hypothesized that mindfulness will most strongly predict pain catastrophizing, and will remain a significant predictor of pain catastrophizing after controlling for the other key components in the fear-avoidance model and the background characteristics identified in Schutze and colleagues (2010):

age, gender, and headache duration.

3. It is hypothesized that mindfulness will moderate the relationship between headache pain intensity and pain catastrophizing.

Materials and Method

Materials

As the current study replicated the study conducted by Schutze and colleagues (2010), the measures used in the current study, with the exception of the demographics questionnaire, were the same as those used in their study, and any variation is discussed.

Demographics questionnaire. The demographics questionnaire collected information on participant age, gender, ethnicity, education level, medication use, headache diagnosis, and on whether participants had any medical or psychological diagnoses other than the headache disorder. In relation to headache diagnosis, participants were first asked "Have you been diagnosed with headache disorder?" where responses were made on a Yes/No format. This was followed by the question "Which one or more of the following headache disorders have you been diagnosed with?" where responses were made on a multiple check box format. Specifically, participants were asked to select one or more of the following responses: Migraine, Tension-type headache, Cluster headache, other. In relation to comorbid medical or psychological diagnoses, participants were asked "Do you have any current medical or psychological diagnoses? If Yes, please specify". Responses were made on a Yes/No format, and a space was provided for participants to specify further details if they selected Yes.

The Mindful Attention Awareness Scale (MAAS). The MAAS[27] consists of 15 items measuring the respondent's tendency to attend to and be aware of the present moment with respect to internal (e.g., thoughts) and external (e.g., interpersonal communication) events. Higher scores indicate a higher level of mindfulness. The MAAS has been found to have good

reliability and validity with coefficient alphas ranging from .82 to .87.[27,14] In the current study, the internal consistency as measured by Cronbach's alpha was $\alpha = .91$.

The Five-Factor Mindfulness Questionnaire (FFMQ). The FFMQ[26] with a total of 39 items, consists of five subscales measuring non reactivity to inner experience, observing inner experience, acting with awareness, describing experience, and non-judging of experience. Higher scores on each subscale indicate a higher level of mindfulness. The FFMQ has been found to have good reliability and validity with coefficient alphas ranging from .75 to .91.[26,31] In the current study, the internal consistencies as measured by Cronbach's alpha for each of the five subscales of the FFMQ were $\alpha = .78$, $\alpha = .81$, $\alpha = .90$, $\alpha = .88$, $\alpha = .90$, respectively.

The Migraine Disability Assessment Scale (MIDAS). The MIDAS[32] consists of five items designed to measure the impact of headaches on daily life. Higher scores indicate higher levels of headache related disability. The MIDAS has been found to have good reliability and validity with a coefficient alpha of .83.[33,34] In the current study, the MIDAS was used as an operational measure of 'functional disability', and replaces the Brief Pain Inventory[35] (BPI) used in Schutze and colleagues (2010). The BPI was not appropriate for use in the current sample. The internal consistency of the MIDAS in the current study, as measured by Cronbach's alpha, was found to be $\alpha = .77$.

The Brief Headache Screen (BHS). The BHS[36] consists of six questions and may be used as a screening tool for migraine disorder. The completed screen is interpreted according to certain rules as explained by Maizels and Burchette (2003). The BHS has been found to have good psychometric properties.[36] The BHS was not used in the study by Schutze and colleagues (2009). In the current study, the items of the BHS were used to screen for migraine disorder and to collect descriptive information on the sample.

The Positive and Negative Affect Schedule (PANAS). The PANAS[37] with a total of 20

items, consists of two subscales measuring positive and negative affect respectively. In the current study, only the negative affect subscale was used, and was an operational measure of 'negative affect'. Scores may range from 10 to 50, and higher scores indicate a higher level of negative affect. The negative affect subscale of the PANAS has been found to have good reliability and validity with coefficient alphas ranging from .84 to .87.[37] In the current study the internal consistency as measured by Cronbach's alpha, was found to be α =.87.

The Pain Catastrophizing Scale (PCS). The PCS[38] with a total of 13 items, contains three subscales each addressing a different aspect of catastrophizing behavior: rumination, magnification, and helplessness. Higher scores indicate greater catastrophizing. The PCS has been found to have good reliability and validity with a coefficient alpha of .87.[38,39] In the current study the PCS was used as an operational measure for 'pain catastrophizing'. The internal consistency as measured by Cronbach's alpha, was found to be α =.93.

The Fear of Pain Questionnaire (FPQ-III). The FPQ-III[40] with a total of 30 items, consists of three subscales measuring fear of severe pain, minor pain, and medical pain, respectively. Higher scores indicate greater pain-related fear. The FPQ has been found to have good reliability and validity with an alpha coefficient of .92.[40] In the current study, the FPQ will be used to measure 'pain-related fear', in replacement of the Tampa Scale for Kinesiophobia[41] (TSK) which was used by Schutze and colleagues (2010). The TSK was not appropriate for use in the current sample. In the current study, the internal consistency of the FPQ-III was found to be α = .95.

Pain Vigilance and Awareness Questionnaire (PVAQ). The PVAQ[42] consists of 16 items measuring attention to pain through awareness, consciousness, observation, and vigilance. Items are self-descriptive statements with respect to the experience of pain (e.g., *I am very sensitive to pain*), and respondents are required to indicate the frequency with which the item describes them.

Responses are made on a 6-point Likert scale ranging from 0 *never* to 4 *always*. Two items are reverse scored. A total score is derived from summing the items, and may range from 0 to 80, with higher scores indicating greater attention to pain. The PVAQ has been found to have a good internal consistency of $\alpha = .86$.[42] It has also been demonstrated to have good construct validity, and criterion validity.[42,43] In the current study, the PVAQ will be used as an operational measure of the pain hypervigilance component of the fear-avoidance model. The internal consistency was found to be $\alpha = .90$.

Pain intensity, duration, and frequency. In the current study, the intensity of pain experienced from headaches, the duration of headaches, and the frequency of headaches are measured by three questions that were derived from previous large scale studies that utilised the same three questions to measure these constructs.[44, 45] Rather than open ended questions, these questions were used in the current study to make the responses comparable to these previous studies. Headache pain intensity is measured by the question: *On average, how painful are your headaches?* Responses are made on a 5- point Likert scale ranging from 1 *slightly painful* to 5 *extremely painful*. In the current study, the headache pain intensity question was used as an operational measure of the pain experience component of the fear-avoidance model. Duration is measured by the question: *On average, how long do your headaches last?* Responses are made on an 8-point Likert scale ranging from 1 *more than 24 hours* to 8 *less than 1 hour*. This scale was not reversed prior to analysis. In the current study, headache duration was utilized in the primary analyses as well as included in the demographics information for the current sample. Frequency is measured by the question: *How frequently do you experience headaches?* Responses are made on a 9-point Likert scale ranging from 1 *4 or more per day* to 9 *never.* This scale was not reversed prior to analysis. These questions were not utilized in the study by Schutze and colleagues (2010).

Method

Participants. Participants were recruited via the Headache Australia website by placing an advertisement and link to the survey under their "volunteers required for research" section. Participants were also recruited via the Griffith University undergraduate psychology student research participation scheme, as well as the Griffith University Surveys Unit, through the use of an information sheet on the current study and a link to the survey. Participants were included in the final analyses if they were aged between 18 and 75 years inclusive, had been suffering from headaches for at least one month, and were not diagnosed with medication overuse headache or a secondary headache. A total of 19 participants did not meet these criteria and were therefore excluded from the study. A total of 217 participants were included in the final analyses, 160 participants were undergraduate psychology students, and 57 were from the community. Participants in the current sample were aged between 18 and 65 years inclusive (M = 26.02, SD = 10.61), and 88.5 percent of the current sample reported that they had been suffering from headaches for more than three months. On the basis of self-reported physician diagnosis, 40.1 percent of the sample suffered from migraine, compared to 46.6 percent on the basis of the BHS (chronic migraine, 58 participants; episodic migraine, 43 participants). Further descriptive characteristics of the sample are presented in Table 2.

Procedure. The current study was approved by the Griffith University Ethics Committee. The aforementioned questionnaires were compiled into an online survey, which participants accessed via an online link at their own convenience. Prior to their commencement of the survey, participants were required to read an information sheet through which informed consent was obtained. Any incomplete surveys were interpreted as withdrawal of consent and were not utilized in the final analyses. Random responding of participants was unfortunately not checked. The survey took approximately 25 minutes to complete. Upon completion of the survey, undergraduate psychology students were able to receive course credit for their participation, and

all other participants were given the option to enter a prize draw to win one of two $50 Coles-Myer gift cards. After recruitment was completed, two participants who opted to enter the prize draw were selected at random to receive the gift cards.

Results

Checking Assumptions in the Data

Data was analyzed using the Statistical Package for the Social Sciences,[46] Version 22 (SPSS). Missing values analyses found that in the overall dataset, there was only 0.56% missing data. Little's MCAR test indicated that the missing data was missing completely at random, χ^2 (7734) = 7892.47, p = .102, *n.s.* Due to the small number and random nature of missing data, mean substitution was used to replace any missing values on all the variables.[47] The data was checked for any violation of assumptions, and as a result three univariate outliers were removed. All variables had good internal consistencies, as measured by Cronbach's alpha. As the current study is replicating the study conducted by Schutze and colleagues (2010), the following statistical analyses are the same as the analyses conducted in their study.

Correlational Analyses

Results found that mindfulness (MAAS) had significant negative correlations with all variables except headache pain intensity and headache frequency (see Table 3). As headache duration was not reverse scored, the negative correlation between mindfulness and headache duration, actually suggests a positive association between mindfulness and headache duration. Correlations ranged in strength from weak negative correlations to moderate negative correlations: -.14 to -.43. Upon cross checking these results with the FFMQ subscales, it was found that none of the FFMQ subscales correlated significantly with headache frequency, however, the describing subscale had a significant positive weak-strength correlation with headache pain intensity. As there was no significant correlation found between mindfulness and

headache frequency, no further exploration was conducted with respect to whether mindfulness predicted headache frequency in the standard multiple regression analyses.

Standard Multiple Regression Analyses

Seven Standard Multiple Regression (SMR) analyses were conducted (see Table 4). In each of the seven SMRs, the five subscales of the FFMQ were entered simultaneously as the predictor variables. The criterion variables were negative affect, pain catastrophizing, fear of pain, pain hypervigilance, functional disability, headache pain intensity, and headache duration, respectively. The results of the SMRs revealed that the FFMQ subscales most strongly predicted negative affect and accounted for 32% of the variance in negative affect scores. It was found that the awareness subscale uniquely explained a significant 7% of the variance in negative affect (β = -.32, $t(211)$ = -4.59, $p < .001$, 95% CI for B [-.57, -.23]), and the non-judging subscale also uniquely explained a significant 7% of the variance in negative affect (β = -.32, $t(211)$ = -4.57, $p < .001$, 95% CI for B [-.52, -.21]). The SMRs also revealed that the FFMQ subscales significantly predicted pain catastrophizing, fear of pain, pain hypervigilance, and headache duration. Although it was found that the FFMQ subscales did not significantly predict headache pain intensity in the overall model, the describing subscale uniquely explained a significant 2% of the variance in headache pain intensity (β = .16, $t(211)$ = 2.11, p = .036, 95% CI for B [.001, .04]).

Hierarchical Multiple Regression Analyses

The components of the fear-avoidance model significantly predicted by mindfulness in the standard multiple regressions were: negative affect, pain catastrophizing, fear of pain, pain hypervigilance, and headache pain intensity. Hierarchical Multiple Regression (HMR) analyses were then conducted to investigate whether mindfulness remained a significant predictor of these components, after controlling for background characteristics (age, gender, and headache duration), and the other components in the fear-avoidance model. The background characteristics were entered

into the regressions first, followed by the components in the fear-avoidance model in the same order as they are found in the model. The FFMQ subscales were entered in the last step in order to determine the unique contribution of mindfulness.

Results of the HMR analyses revealed that the FFMQ subscales accounted for an additional 22% of the variance in negative affect (see Table 5), over and above that accounted for by the other predictors. It was found that the awareness subscale uniquely explained a significant 4% of the additional variance accounted for in negative affect (β = -.28, t(203) = -3.85, p < .001, 95% CI for B [-.52, -.17]), and the non-judging subscale uniquely explained a significant 6% of the additional variance accounted for in negative affect (β = -.32, t(203) = -4.64, p < .001, 95% CI for B [-.51, -.21]). The HMR analyses also revealed that the FFMQ subscales accounted for an additional 11% of the variance in pain hypervigilance, over and above that accounted for by the other predictors. It was found that the observing subscale uniquely explained a significant 6% of the additional variance accounted for in pain hypervigilance (β = .31, t(203) = 4.66, p < .001, 95% CI for B [.33, .82]).

Moderation Analyses

A moderation analysis was conducted to investigate whether mindfulness moderated the relationship between pain intensity and pain catastrophizing. The moderation analysis was completed using the PROCESS tool for SPSS developed by Andrew Hayes.[48] Headache pain intensity and mindfulness (MAAS) were both mean centered before they were entered into the analysis. Pain catastrophizing was entered as the dependent variable, headache pain intensity was entered as the independent variable, and mindfulness (MAAS) was entered as the moderating variable. Results revealed that the interaction between headache pain intensity and mindfulness did not account for any significant amount of additional variance in pain catastrophizing, (β = 1.13, t(213) = 1.27, p = .204, 95% CI for B [-.62, 2.88]). This indicated that mindfulness did not moderate the relationship between pain intensity and pain catastrophizing.

Discussion

The current study investigated the role of mindfulness in the fear-avoidance model of chronic pain by replicating a study conducted by Schutze and colleagues (2010). The sample in the current study differed from the sample in Schutze and colleagues (2010) in that it consisted solely of chronic primary headache/migraine sufferers instead of individuals suffering for various locations of pain. Additionally, to contribute to the growing literature on the impact that mindfulness may have on chronic headache/migraine, the current study investigated the relationships between level of mindfulness and headache/migraine intensity, frequency, and duration.

Similar to the findings of Schutze and colleagues (2010), results in the current study found that higher level of mindfulness was significantly associated with lower levels of the negative affect, pain catastrophizing, pain-related fear, pain hypervigilance, and functional disability components of the fear-avoidance model. Additionally, the current study found that mindfulness was not associated with the pain intensity component of the fear-avoidance model, and was not associated with headache frequency. Furthermore, surprisingly, mindfulness was positively associated with headache duration.

Mixed findings regarding the effect of mindfulness on headache pain intensity, frequency, and duration have also appeared in clinical studies where mindfulness has been used as a treatment for chronic headaches.[18-24] For example, Wells et al. (2014) found that mindfulness training did not result in a significant reduction of headache frequency, but it did result in reduced headache duration, in episodic migraine sufferers. Conversely, Cathcart and colleagues (2014) found that mindfulness-based therapy was not associated with a reduction in headache pain intensity or duration, however was effective in reducing headache frequency. Taken together, these mixed findings, suggest a need for future research to further explore the relationship between mindfulness and headache parameters such as intensity, frequency, and duration.

It may be suggested that the role of mindfulness in the fear-avoidance model of chronic pain may be different for individuals suffering from chronic primary headache/migraine, in comparison to the other chronic pain conditions found in the Schutze and colleagues (2010) study. One reason for this may be that, unlike other chronic pain conditions, primary headaches/migraines occur in the absence of any identified underlying structural damage.[30] Therefore, an approach such as mindfulness that utilizes acceptance in its practice may be undesirable and/or less effective for individuals suffering from a condition such as headache/migraine that often resolves with or without treatment, in comparison to chronic pain conditions that are permanent.

The current study did not find a relationship between mindfulness and functional disability. This finding is not line with the findings by Schutze and colleagues (2010) who found that mindfulness did significantly predict functional disability in chronic pain sufferers. The findings in the current study are also not in line with studies where mindfulness predicted psychosocial functioning in a sample of lower back pain, lower extremity, shoulder or upper limb, full body, and "other" chronic pain sufferers.[49] This further suggests that mindfulness may play a different role in the fear-avoidance model for individuals suffering from chronic primary headache/migraine in comparison to the other chronic pain conditions. Unlike the other chronic pain conditions used in Schutze and colleagues (2010), primary headache/migraine sufferers experience headache 'attacks' when exposed to triggers, and therefore these individuals are often in the absence of pain and any pain-related functional disability. Therefore, mindfulness may not be effective in predicting pain-related functional disability in this population. The finding that mindfulness did not predict functional disability, may also be explained by the observation that mindfulness did not predict headache frequency in the current study, and on the MIDAS,

disability is dependent on frequency. Future research should explore the relationship between mindfulness and functional disability as measured by a different disability assessment(s).

In the current study, it was found that mindfulness most strongly predicted the negative affect component of the fear-avoidance model, and the components of mindfulness that contributed significantly to the prediction of negative affect scores, were *awareness* and *non-judging*. This is unlike the findings of Schutze and colleagues (2010) who found that mindfulness most strongly predicted pain catastrophizing in their sample of heterogeneous chronic pain sufferers. It may be suggested that the relationships between mindfulness and pain catastrophizing, and mindfulness and negative affect, differ in headache/migraine sufferers due to the transient nature of headache/migraine 'attacks'.

The transient nature of headache/migraine 'attacks' may alter the nature of the catastrophic thoughts and negative affect experienced by individuals with headache/migraine. A person with chronic headaches may have thoughts of hopelessness such as "there is nothing I can do to prevent or combat headaches" rather than catastrophic thoughts related to the headache episode, such as "this migraine will last forever". Thoughts of hopelessness are particularly common in individuals who suffer from chronic headaches and comorbid depression.[50] In the current study, the results revealed that mindfulness remained a significant predictor of negative affect, and pain hypervigilance, after controlling for the other key components and background characteristics. However mindfulness did not remain a significant predictor of pain catastrophizing or fear of pain. This is unlike the findings of Schutze and colleagues (2010) who found that mindfulness significantly predicted pain catastrophizing after controlling for the other key components and background characteristics.

Unlike the findings of Schutze and colleagues (2010), in the current study mindfulness

was not found to moderate the relationship between pain intensity and pain catastrophizing. As it was noted earlier, mindfulness most strongly predicted the negative affect component of the fear-avoidance model, and not the pain catastrophizing component as in the Schutze and colleagues (2010) study. Therefore, it may have been interesting to investigate the relationship between mindfulness and the negative affect component of the fear-avoidance model in more depth. Research has found that rumination on negative affect may result in its maintenance and exacerbation.[51] Mindfulness involves the redirection of one's attention away from rumination and towards the present moment, [52] which therefore may be associated with a lower level of negative affect.

Surprisingly, the current study also found that observing, as a dimension of mindfulness, was positively correlated with pain hypervigilance. Theoretically, observing, in Mindfulness is a meta-cognitive monitoring process that facilitates awareness and diffusion from cognitive, emotional, and physical experiences.[53] In turn, the process of diffusion is suggested to reduce psychological distress associated with physiological pain.[54-56] The fear-avoidance model of chronic pain[5] suggests that pain hypervigilance is related to unhealthy avoidance of pain triggers. In the current study, it is unclear whether cognitive diffusion accompanied pain hypervigilance, and whether the relationship between observing and pain hypervigilance results in unhealthy avoidance of potentially pain provoking stimuli. To test for this, future research could manipulate mindful observing in isolation and examine its effects on pain hypervigilance and avoidance of potentially pain provoking stimuli in a sample of headache sufferers.

Similarly, the current study found that fear of pain was negatively associated with headache duration, and mindfulness was associated with increased headache duration. The fear-avoidance model of chronic pain[5] suggests that pain-related fear leads to avoidance behavior;

therefore it is possible that the reduced headache duration is due to removing oneself from the headache trigger(s). Along these lines, increased mindfulness may, through nonjudgmental acceptance of internal experiences of the present moment[14,16], be associated with reduced avoidance behavior. Therefore the continued presence of the headache trigger(s) may lead to increased headache duration. However, avoidance behavior was not measured in the current study, and it is important to keep in mind that the correlational design of this study prevents causal inferences from being made.

The surprising associations between fear of pain and headache duration, and mindfulness and headache duration, may also be explained by arguments that were made by Van Dam and colleagues (2017) in their critical evaluation of mindfulness and meditation research. They argue that as there is no universally accepted definition of mindfulness and the underlying factors that constitute this concept, comparisons between different studies exploring mindfulness may be inappropriate due to mindfulness being measured, taught, and practiced in different ways across these studies.[57,58] Furthermore, Van Dam and colleagues (2017) suggest that the benefits of mindfulness practice for individuals suffering from psychological and physical conditions may be exaggerated by researchers and the media. Future research should explore the associations between mindfulness, the components of the fear-avoidance model, and avoidance behavior in headache sufferers, taking into consideration critiques of current mindfulness research.

In the current study, mindfulness continued to predict negative affect after controlling for other variables in the fear-avoidance model of chronic pain and background characteristics. When considering the fear-avoidance model, negative affect is directly linked to pain catastrophizing, and both components immediately follow the experience of pain. Although in the study conducted by Schutze and colleagues (2010) pain catastrophizing was the key

component most strongly predicted by mindfulness, it is suggested that in chronic primary headache/migraine sufferers, negative affect is the key component of interest. Therefore, it is proposed that for individuals suffering from chronic primary headache/migraine, mindfulness may be integrated into the fear-avoidance model beside negative affect (See figure 1). This may then have a cascading effect on the other components in the fear-avoidance model. However, again the correlational nature of the current study prevents causal inferences. Boselie and Vlaeyen (2017)[59] suggest that including mindfulness in the fear-avoidance model is congruent with a positive psychology approach, wherein the focus of the model shifts to incorporate protective factors other than no pain-related fear, rather than the main focus being on vulnerability factors as in the original model[5]. They further suggest that this shift will allow a greater and more balanced understanding of factors that lead to recovery in chronic pain sufferers.

Overall, it is suggested that mindfulness plays a role in the experience of chronic headache/migraine, albeit a different role than that observed in the other chronic pain conditions included in the Schutze and colleagues (2010) study. It is suggested that this may be due to differences between chronic headache/migraine and the other chronic pain conditions with respect to pattern of pain, origin of pain, and prognosis of the condition. Negative affect may be the key component in the fear-avoidance model that would be most beneficial to examine in chronic headache/migraine sufferers. Increased level of mindfulness may allow individuals to recognize when their attention has been automatically engaged by rumination on negative affect, and consciously redirect this attention to the present moment. Specifically, the relationships between mindfulness and headache duration, and mindfulness and negative affect may be worth exploring further in chronic headache/migraine sufferers.

The current study had some limitations including the correlational design which prevents causal inferences, and the use of self-report measures which were subject to social desirability and the honesty and integrity of the participants completing the online survey. Additionally, the order of the questionnaires within the survey was not randomized, and random responding of participants was not checked, therefore subjecting the study to methodological bias. As another limitation, it is acknowledged that 71% of the final sample were using pain relievers or any medication to relieve headache symptoms at least three days per week. Therefore, it is possible that the current sample consisted of individuals with undiagnosed Medication Overuse Headache, and future studies should account for this by appropriately adjusting the exclusion criteria for research participation. It is also noted that approximately 39 percent of participants in the current study were aged between 18 and 19 years, and that within these participants approximately 15 percent (i.e., 13 participants in the total sample) identified that they had been suffering from headaches for one to three months. Therefore, there is a possibility that some of these participants may be suffering from presentations that have not yet reached chronification.

The current study would have been strengthened if evidence of a physician diagnosis was collected from each participant, rather than self-report of a physician verified diagnosis. Future research should ensure that all participants have a diagnosis of chronic headache/migraine from a medical professional. Specific information about headache diagnosis, including whether participants are suffering from primary versus secondary headaches, chronic versus episodic headaches, or whether they are experiencing other symptoms such as nausea, dizziness, or fatigue, should also be collected in future research. The role of mindfulness in the fear-avoidance model of chronic pain may differ with different headache presentations, due to the high variability between different presentations. Therefore, this is an important area of exploration for

future research.

Finally, the current findings suggest that in chronic headache and migraine sufferers, mindfulness may be integrated into the fear-avoidance model beside negative affect. The current study contributes to existing literature on mindfulness and the experience of pain in chronic headache/migraine sufferers, by exploring relationships between mindfulness and key constructs in the fear-avoidance model of chronic pain.

References

1. Stovner LJ, Hagen K, Jensen R, et al. The global burden of headache: a documentation of headache prevalence and disability worldwide. *Cephalalgia.* 2007;27:193–210.

2. Martin PR. How do trigger factors acquire the capacity to precipitate headaches? *Behav Res and Ther.* 2001;39:545-554.

3. Martin PR. Managing heading triggers: Think 'coping' not 'avoidance'. *Cephalalgia.* 2010;30:634-637.

4. Martin PR, MacLeod C. Behavioral management of headache triggers: Avoidance of triggers is an inadequate strategy. *Clin Psychol Rev.* 2009;29:483-495.

5. Vlaeyen JWS, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain.* 2000;85:317-332.

6. Crombez G, Vlaeyen JWS, Heuts PHTG, et al. Pain-related fear is more disabling than pain itself: evidence on the role of pain related fear in chronic back pain disability. *Pain.* 1999;80:329–339.

7. Swinkels-Meewisse IEJ, Roelofs J, Verbeek ALM, et al. Fear of movement/(re)injury, disability and participation in acute low back pain. *Pain.* 2003;105:371–399.

8. Vlaeyen JWS, Kole-Snijders AMJ, Boeren RGB, et al. Fear of movement/(re)injury in chronic low back pain and its relation to behavioural performance. *Pain.*. 1995;62:363-372.

9. Vlaeyen JWS, Kole-Snijders AMJ, Rotteveel A, et al. The role of fear of movement/(re)injury in pain disability. *J Occup Rehabil.* 1995;5:235-252.

10. Kelman L. The triggers or precipitants of the acute migraine attack. *Cephalalgia.* 2007;27:394–402.

11. Martin PR, Callan M, Reece J, et al. Behavioral management of the triggers of recurrent

headache: A randomized controlled trial. *Behav Res and Ther.* 2014;61:1-11.

12. Rains JC, Penzien DB, McCrory DC, et al. Behavioral headache treatment: History, review of the empirical literature, and methodological critique. *Headache.* 2005;45:92-109.

13. Veehof MM, Oskam MJ, Schreurs KMG, et al. Acceptance based interventions for the treatment of chronic pain: A systematic review and meta-analysis. *IASP*. 2011;152:533-542.

14. Brown KW, Ryan RM. The benefits of being present: mindfulness and its role in psychological well-being. *J Pers Soc Psychol.* 2003;83:822-848.

15. Kabat-Zinn J. Mindfulness-based interventions in context: Past, present, and future. *Clin Psychol Sci Pract.* 2003;10:144-156.

16. Kabat-Zinn J. *Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness.* New York: Delacourt, 1990.

17. Shapiro SL, Schwartz GE, Bonner G. Effects of mindfulness-based stress reduction on medical and premedical students. *J Behav Med.* 1998;21:581-599.

18. Nash-McFeron DE. Mindfulness in the treatment of chronic headache pain. *Diss Abstr Int.* 2006;67:28–41.

19. Rosdahl DRL. *The Effect of Mindfulness Meditation on Tension Headaches and Secretory Immunoglobulin A in Saliva*. Arizona: The University of Arizona, 2003.

20. Wells RE, Burch R, Paulsen RH, et al. Meditation for migraines: A pilot randomized controlled trial. *Headache.* 2014;54:1484–1495.

21. Day MA, Thorn BE, Ward LC, et al. Mindfulness-based cognitive therapy for treatment of headache pain: A pilot study. *Clin J Pain.* 2014;30:152–161.

22. Omidi A, Zargar F. Effect of mindfulness-based stress reduction on pain severity and mindful awareness in patients with tension headache: A randomised controlled clinical trial.

Nurs Midwifery Stud. 2014;3:1-5.

23. Cathcart S, Galatis N, Immink M, et al. Brief mindfulness based therapy for chronic tension-type headache: A randomized controlled pilot study. *Behav and Cogn Psychother.* 2014;42:1-15.

24. Bakhshani NM, Amirani A, Amirifard H, et al. The effectiveness of mindfulness-based stress reduction on perceived pain intensity and quality of life in patients with chronic headache. *Glob J Health Sci.* 2015;8:142–151.

25. Schutze R, Rees C, Preece M, et al. Low mindfulness predicts pain catastrophizing in a fear-avoidance model of chronic pain. *Pain.* 2010;148:120-127.

26. Baer RA, Smith GT, Hopkins J, et al. Using self-report assessment methods to explore facets of mindfulness. *Assessment.* 2006;13:27-45.

27. Brown KW, Ryan RM. Perils and promises in defining and measuring mindfulness: Observations from experience. *Clin Psychol Sci Pract.* 2004;11:242-248.

28. Cohen J. *Statistical power analysis for the behavioural sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.

29. Dahlof CGH, Soloman GD. Impact of headache on the individual and family. In: Olesen J, Goadsby PJ, Ramadan NM, Tfelt-Hansen P, Welch KMA, Eds. *The Headaches*. Philadelphia: Williams and Williams, 2006:27-34.

30. Benoliel R, Eliav E. (2013). Primary headache disorders. *Dent Clin North Am.* 2013;57:513-539.

31. Baer RA, Smith GT, Lykins E, et al. Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. *Assessment.* 2008;15:329-342.

32. Stewart WF, Lipton RB, Dawson AJ, et al. Development and testing of the Migraine Disability Assessment (MIDAS) Questionnaire to assess headache-related disability. *Neurology.*

2001;56:20-28.

33. Stewart WF, Lipton RB, Kolodner K, et al. Reliability of the migraine disability assessment (MIDAS) score in a population-based sample of headache sufferers. *Cephalalgia.* 1999;19:107-114.

34. Stewart WF, Lipton RB, Kolodner K, et al. Validity of the migraine disability assessment (MIDAS) score in comparison to a diary-based measure in a population-based sample of migraine sufferers. *Pain.* 2000;88:41-52.

35. Cleeland CS, Ryan KM. Pain assessment: global use of the brief pain inventory. *Ann Acad of Med.* 1994;23:129-138.

36. Maizels M, Burchette R. Rapid and sensitive paradigm for screening patients with headache in primary care settings. *Headache.* 2003;43:441-450.

37. Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: The PANAS scales. *J Pers Soc Psychol.* 1988;54:1063-1070.

38. Sullivan MJ, Bishop SR, Pivik J. The pain catastrophising scale: Development and validation. *Psychol Assess.* 1995;7:524-532.

39. Osman A, Barrios FX, Gutierrez PM, et al. The pain catastrophizing scale: Further psychometric evaluation with adult samples. *J Behav Med.* 2000;23:351-365.

40. McNeil DW, Rainwater AJ. Development of the fear of pain questionnaire – III. *J Behav Med.* 1998;21:389-410.

41. Miller RP, Kori S, Todd D. The Tampa Scale: a measure of kinesiophobia. *Clin J Pain.* 1991;7:51–52

42. McCracken LM. "Attention to pain in persons with chronic pain: A behavioral approach. *Behav Ther.* 1997;28:271-284.

43. Roelofs J, Peters ML, McCracken L, et al.. The pain vigilance and awareness questionnaire (PVAQ): Further psychometric evaluation in fibromyalgia and other chronic pain syndromes. *Pain.* 2003;101:299-306.

44. Andrasik F, Holroyd KA, Abell T. Prevalence of headache within a college student population. *Headache.* 1979;19:384-387.

45. Martin PR, Nathan PR. Differential prevalence rates for headaches: A function of stress and social support? Headache. 1987;27:329-333.

46. SPSS Statistics for Windows [Software]. Version 20. Armonk, NY: IBM Corporation, 2011.

47. Tabachnick BG, Fidell LS. Using multivariate statistics. Pearson: USA, 2007.

48. Hayes AF. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. New York: Guilford Press, 2013.

49. McCracken LM, Gauntlett-Gilbert J, Vowles KE. The role of mindfulness in a contextual cognitive-behavioral analysis of chronic pain-related suffering and disability. Pain. 2007;131:63-69.

50. Martin PR, Aiello R, Gilson K, et al. Cognitive behavior therapy for co-morbid migraine and/or tension-type headache and major depressive disorder: An exploratory randomized controlled trial. Behav Res Ther. 2015;73:8-18.

51. Morrow J, Nolen-Hoeksema S. Effects of responses to depression on the remediation of depressive affect. J Pers Soc Psychol. 1990;58:519-527.

52. Teasdale JD, Segal ZV, Williams MG. Mindfulness training and problem formulation. Clin Psychol Sci Pract. 2003;10:157-160.

53. Harris R, Hayes SC. ACT made simple. Oakland, CA: New Harbinger Publications, 2009.

54. Basmajian JV. Biofeedback: Principles and practice for clinicians. Baltimore: William & Wilkins, 1989.

55. Gregg JA, Callaghan GM, Hayes SC, et al. Improving diabetes self-management through acceptance, mindfulness, and values: A randomized controlled trial. J Consult Clin Psychol. 2007;75:336-343.

56. Morone NE, Greco CM, Weiner DK. Mindfulness meditation for the treatment of chronic low back pain in older adults: A randomized controlled pilot study. Pain. 2008;134:310–319.

57. Van Dam NT, van Vugt MK, Vago DR, et al. A critical evaluation and prescriptive agenda for research on mindfulness and meditation. Perspect Psychol Sci. 2017;1-26.

58. Bodhi B. What does mindfulness really mean? A canonical perspective. Contemp Buddhism. 2011;12:19-39.

59. Boselie JJLM, Vlaeyen JWS. Broadening the fear-avoidance model of chronic pain? Scand J Pain. 2017;17:176-177.

Figure 1. Fear-avoidance model of chronic pain incorporating the suggested role of trigger(s) and mindfulness in chronic headache/migraine sufferers. Adapted from the version presented by Vlaeyen and Linton (2000), and Schutze and colleagues (2009). *Note.* In this adjusted version, Trigger(s) has replaced Injury and Mindfulness has been added.

Table 1
Summary of Studies Investigating MBIs in the Treatment of Headache/Migraine

Authors	Intervention	Participants	Headache Variables	Intervention Outcome
Bakhshani et al., 2015	Mindfulness Based Stress Reduction	40 chronic primary headache sufferers. Randomly allocated to treatment group (n = 20) or control group (n = 20).	- Perceived pain intensity - Perceived quality of life	There was a significant reduction in the perception of pain intensity and a significant increase in some quality of life dimensions.
Cathcart et al., 2014	Mindfulness Based Therapy	42 chronic tension-type headache sufferers. Randomly allocated to treatment group (n = 23) or control group (n = 19).	- Headache intensity, duration, frequency	There was no significant reduction in headache intensity or duration, however, there was a significant reduction in headache frequency.
Day et al., 2014	Mindfulness Based Cognitive Therapy	36 primary headache disorder sufferers.	- Pain acceptance - Pain interference - Pain catastrophizing	There was a significant improvement in pain acceptance, pain interference, and pain catastrophizing.
Nash-McFeron, 2006	Mindfulness Based Stress Reduction	40 chronic headache pain sufferers. Randomly allocated to treatment group (n = 20) or control group (n = 20).	- Headache pain (intensity, duration, frequency) - Health-related quality of life	There was no significant reduction in participants' headache pain and no significant improvement in participants' health-related quality of life.
Omidi & Zarger, 2014	Mindfulness Based Stress Reduction	60 tension-type headache sufferers. Randomly assigned to treatment group (n = 30) or control group (n = 30).	- Pain severity	There was a significant reduction in pain severity.
Rosdahl, 2003	Mindfulness Based Stress Reduction	64 tension headache sufferers. Randomly allocated to treatment group (n = 34) or control group (n = 30).	- Headache intensity - Headache Duration	There was no significant reduction in headache intensity or duration.

Wells et al., 2014	Mindfulness Based Stress Reduction	19 migraines sufferers. Randomly allocated to treatment group (*n* = 10) or control group (n = 9).	- Migraine frequency, severity, duration - Migraine-related disability/impact	There was no significant reduction in migraine frequency or severity, however, there was a significant reduction in migraine duration and migraine-related disability/impact.

Note. MBIs = Mindfulness Based Interventions

Table 2

Participant Demographics and Clinical Characteristics

Demographic category	%	*N*
Gender		
Male	23.5	51
Female	76.5	166
Age (years)		
18-19	38.7	84
20-28	36.0	78
29-48	19.3	42
49-65	6.0	13
Nationality		
Australia/New Zealand	49.8	108
England	4.1	9
Europe	3.7	8
Asia	5.5	12
Africa	0.9	2
Not specified	36	78
Highest level of education completed		
Grade 10 or high school	57.1	124
TAFE or diploma	20.7	45

Tertiary	22.1	48
Headache diagnosis (self-report of physician diagnosis)		
Migraine	40.1	87
Tension-type	24.0	52
Cluster	2.8	6
Other	4.1	9
Combination	19.8	43
No diagnosis[a]	9.2	20
Length of time suffering from headaches (months)		
1-3 months	11.5	25
4-12 months	30.0	65
13-48 months	24.9	54
49+ months	33.6	73
Headache pain intensity		
Slightly or mildly painful	22.6	49
Moderately painful	52.1	113
Very or extremely painful	25.3	55
Headache frequency (No. of headaches)		
4 or more per day	3.7	8
1-3 per day	15.2	33
5-6 per week	6.5	14
1-4 per week	60.8	132

1-2 per month	13.8	30
Headache duration		
More than 24 hours	16.1	35
8-24 hours	26.3	57
4-8 hours	16.6	36
1-4 hours	36.9	80
Less than 1 hour	4.1	9
Use of pain relievers or any medication to relieve headache symptoms		
Daily or near daily	15.7	34
3-4 days per week	17.1	37
Twice a week to twice a month	45.2	98
Once a month or less	15.2	33
Almost never	6.9	15
Use of daily prescription medication to prevent headache symptoms		
Yes	12.4	27
No	57.6	125
No, however the headache symptoms trouble me enough to take daily preventative medication.	30	65
Comorbidity		
Psychological or medical	19.4	42
Combination	4.1	9

None	76.5	166

Note. $N = 217$

[a]Although these participants did not have a physician verified diagnosis at the time they completed these measures, all participants suffered from self-reported chronic headaches/migraines.

Table 3

Means, Standard Deviations, and Zero-Order Correlations for Mindfulness, Negative Affect, Fear of Pain, Pain Hypervigilance, Functional Disability,

Headache Pain Intensity, Frequency, and Duration

Variables	MAAS	PANAS	PCS	FPQ	PVAQ	MIDAS	Headache pain intensity	Headache frequency	Headache duration	FFMQ_1	FFMQ_2	FFMQ_3	FFMQ_4	FFMQ_5	*M*	*SD*
MAAS	-	-.43**	-.21**	-.28**	-.18**	-.19**	.04	.05	-.14*	.11	.13	.58**	.19**	.43**	3.41	.88
PANAS	-	-	.31**	.29**	.33**	.07	.04	-.04	.05	-.12	.04	-.50**	-.11	-.50**	24.21	7.62
PCS	-	-	-	.26**	.45**	.23**	.36**	-.09	-.12	-.08	.05	-.19**	-.08	-.15*	20.35	11.24
FPQ	-	-	-	-	.40**	.02	-.13*	.10	.21**	-.04	.13*	-.37**	-.08	-.29**	83.73	23.18
PVAQ	-	-	-	-	-	.07	.20**	-.05	-.01	.09	.39**	-.27**	.14*	-.27**	29.82	10.86
MIDAS	-	-	-	-	-	-	.20**	-.24**	-.13	-.04	-.02	-.11	.03	-.07	30.92	31.73
Headache pain intensity	-	-	-	-	-	-	-	-.04	-.55**	.02	.04	.07	.16*	.04	3.06	.91
Headache frequency	-	-	-	-	-	-	-	-	.01	.05	.09	.05	.09	-.03	5.07	1.57
Headache duration	-	-	-	-	-	-	-	-	-	.02	-.01	-.24**	-.20**	-.20**	4.56	2.13
FFMQ_1	-	-	-	-	-	-	-	-	-	-	.52**	.02	.14*	-.02	19.47	4.29
FFMQ_2	-	-	-	-	-	-	-	-	-	-	-	-.05	.28**	-.21*	24.5	5.84

														*	1	
FFMQ_3	-	-	-	-	-	-	-	-	-	-	-	-	.28**	.57**	24.24	6.17
FFMQ_4	-	-	-	-	-	-	-	-	-	-	-	-	-	.16*	24.97	6.42
FFMQ_5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24.88	6.77

Note. MAAS = mindfulness total scores, FFMQ = Five Factor Mindfulness Questionnaire, FFMQ_1 = non-reactivity subscale score, FFMQ_2 = observing subscale score, FFMQ_3 = awareness subscale score, FFMQ_4 = describing subscale score, FFMQ_5 = non-judging subscale score, PANAS = negative affect total scores, PCS = pain catastrophizing total scores, PVAQ = pain hypervigilance total scores, MIDAS = functional disability total scores.

** $p < .01$ * $p < .05$ (2-tailed).

Table 4

Results of the Seven Standard Multiple Regression Analyses with the FFMQ Subscales as Predictor Variables to Determine whether Mindfulness Explains Variance in Negative Affect, Pain Catastrophizing, Fear of Pain, Pain Hypervigilance, Functional Disability, Headache Pain Duration, and Headache Pain Intensity

Criterion variable	R_2	Adjusted R_2	$F(5, 211)$	p	Predictor	B	β	$SE\ B$	sr^2	p	VIF
Negative affect	.33	.32	21.07	.00	Intercept	45.78		3.06			
					Non-reactivity	-.23	-.13	.12	.01	.055	1.39
					Observing	.01	.01	.09	.00	.93	1.59
					Awareness	-.40	-.32	.09	.07	.00	1.57
					Describing	.06	.05	.07	.00	.44	1.20
					Non-judging	-.36	-.32	.08	.07	.00	1.59
Pain catastrophizing	.05	.03	2.31	.05	Intercept	31.53		5.38			
					Non-reactivity	-.34	-.13	.21	.01	.10	1.39
					Observing	.21	.11	.16	.01	.19	1.59

					Awareness	-.27	-.15	.15	.01	.07	1.57
					Describing	-.08	-.04	.13	.00	.56	1.20
					Non-judging	-.05	-.03	.14	.00	.71	1.59
Fear of pain	.16	.14	8.26	.00	Intercept	115.98		10.43			
					Non-reactivity	-.64	-.12	.40	.01	.11	1.39
					Observing	.66	.17	.32	.02	.04	1.59
					Awareness	-1.15	-.31	.30	.06	.00	1.57
					Describing	-.05	-.02	.25	.00	.83	1.20
					Non-judging	-.27	-.08	.27	.00	.32	1.59
Pain hypervigilance	.24	.22	13.33	.00	Intercept	26.20		4.65			
					Non-reactivity	-.33	-.13	.18	.01	.07	1.39
					Observing	.73	.39	.14	.10	.00	1.59
					Awareness	-.42	-.2	.13	.04	.00	1.57

							4			
					Describing	.21	.12	.11	.06	1.20
					Non-judging	-.12	-.07	.12	.33	1.59
Functional disability	.02	.00	.83	.53	Intercept	48.17		15.45		
					Non-reactivity	-.16	-.02	.59	.79	1.39
					Observing	-.23	-.04	.47	.63	1.59
					Awareness	-.63	-.12	.44	.15	1.57
					Describing	.39	.08	.37	.30	1.20
					Non-judging	-.11	-.02	.40	.78	1.59
Headache pain duration	.09	.06	3.91	.00	Intercept	7.41		1.00		
					Non-reactivity	.03	.06	.04	.47	1.39
					Observing	-.01	-.03	.03	.76	1.59
					Awareness	-.05	-.15	.03	.07	1.57
					Describing	-.05	-.14	.02	.06	1.20

					Non-judging	-.03	-.10	.03	.01	.23	1.59
Headache pain intensity	.03	.00	1.18	.32	Intercept	2.44		.44			
					Non-reactivity	-.00	-.06	.02	.00	.94	1.39
					Observing	.00	.00	.01	.00	.97	1.59
					Awareness	.00	.02	.01	.00	.78	1.57
					Describing	.02	.16	.01	.02	.04	1.20
					Non-judging	.00	-.00	.01	.00	.97	1.59

Note. FFMQ = Five Factor Mindfulness Questionnaire, *B* = unstandardized regression coefficient, β = standardized regression coefficient, *SE B* = standard error, sr^2 = squared semi-partial correlations, VIF = Variance Inflation Factor.

Table 5

Results of the Hierarchical Multiple Regression Analyses with the FFMQ Subscales as Predictor Variables to Determine the Unique Contribution of Mindfulness in Explaining the Variance in Negative Affect, Pain Catastrophizing, Fear of Pain, Pain Hypervigilance, and Headache Pain Intensity

Criterion variable	R_2 *change*	*F*change(5, 203)	*p*	Predictor	*B(final)*	*β*	*SE B*	Sr_2^2	*p*	VIF
Negative affect	.22	14.86	.00	Intercept	46.23		5.07			
				Age	-.06	-.09	.05	.01	.18	1.41
				Gender	-.53	-.03	1.06	.00	.62	1.18
				Duration	-.50	-.14	.27	.01	.07	1.89
				Intensity	-.62	-.07	.61	.00	.31	1.76
				Pain catastrophizing	.12*	.18	.05	.02	.01	1.57
				Fear of pain	.00	-.01	.02	.00	.93	1.55
				Pain hypervigilance	.10	.14	.05	.01	.05	1.78
				Functional disability	-.01	-.03	.01	.00	.57	1.10
				FFMQ (Observing)	-.09	-.0	.10	.00	.38	1.82

						7				
				FFMQ (Describing)	.05	.05	.07	.00	.46	1.30
				FFMQ (Awareness)	-.35**	-.28	.09	.04	.00	1.78
				FFMQ (Non-judging)	-.36**	-.32	.08	.06	.00	1.61
				FFMQ (Non-reacting)	-.15	-.08	.12	.00	.21	1.43
Pain hypervigilance	.11	7.97	.00	Intercept	-10.80		8.18			
				Age	.09	.08	.06	.01	.18	1.41
				Gender	.08	.00	1.44	.00	.96	1.18
				Duration	.35	.07	.37	.00	.35	1.92
				Intensity	1.44	.12	.82	.01	.08	1.74
				Pain catastrophizing	.28**	.29	.06	.06	.00	1.47
				Negative affect	.19	.13	.10	.01	.05	1.64
				Fear of pain	.12**	.25	.03	.04	.00	1.44
				Functional disability	-.02	-.04	.02	.00	.43	1.10
				FFMQ (Observing)	.58**	.31	.12	.06	.00	1.65
				FFMQ (Describing)	.19	.11	.10	.01	.06	1.28
				FFMQ (Awareness)	-.15	-.08	.13	.00	.24	1.90
				FFMQ (Non-	.00	.0	.11	.0	.9	1.7

				judging)		0		0	8	9
				FFMQ (Non-reacting)	-.13	-.05	.16	.00	.41	1.44
Fear of pain	.02	1.51	.19	Intercept	100.11		17.63			
				Age	-.57**	-.26	.14	.05	.00	1.32
				Gender	6.01	.11	3.31	.01	.07	1.16
				Duration	.12	.01	.85	.00	.89	1.92
				Intensity	-4.54*	-.18	1.89	.02	.02	1.72
				Pain catastrophizing	.32*	.16	.15	.02	.03	1.58
				Negative affect	-.02	-.01	.22	.00	.93	1.67
				Pain hypervigilance	.62**	.29	.16	.05	.00	1.69
				Functional disability	.00	.00	.04	.00	.96	1.10
				FFMQ (Observing)	.20	.05	.30	.00	.51	1.82
				FFMQ (Describing)	.10	.03	.23	.00	.66	1.30
				FFMQ (Awareness)	-.59*	-.16	.29	.01	.04	1.87
				FFMQ (Non-judging)	-.19	-.05	.26	.00	.47	1.78
				FFMQ (Non-reacting)	-.29	-.05	.37	.00	.42	1.44
Pain catastrophizing	.03	2.06	.07	Intercept	-13.37		8.95			

				Age	.03	.03	.07	.00	.63	1.42
				Gender	.69	.03	1.58	.00	.66	1.18
				Duration	.32	.06	.40	.00	.44	1.92
				Intensity	4.04**	.33	.86	.07	.00	1.59
				Negative affect	.27*	.18	.10	.02	.01	1.61
				Fear of pain	.07*	.15	.03	.01	.03	1.51
				Pain hypervigilance	.34**	.32	.07	.06	.00	1.65
				Functional disability	.05*	.14	.02	.02	.02	1.07
				FFMQ (Observing)	-.08	-.04	.14	.00	.60	1.82
				FFMQ (Describing)	-.26*	-.15	.11	.02	.02	1.26
				FFMQ (Awareness)	.09	.05	.14	.00	.54	1.91
				FFMQ (Non-judging)	.12	.07	.12	.00	.33	1.78
				FFMQ (Non-reacting)	-.11	-.04	.17	.00	.52	1.44
Headache pain intensity	.01	.73	.60	Intercept	4.08		.64			
				Age	-.00	-.02	.01	.00	.78	1.42
				Gender	-.08	-.04	.12	.00	.50	1.17
				Duration	-.21	-	.03	.1	.0	1.4

		.50		6	0	9
Pain catastrophizing	.02	.30	.01	.06	.00	1.46
Negative affect	-.01	-.07	.01	.00	.31	1.66
Fear of pain	-.01	-.16	.00	.02	.02	1.51
Pain hypervigilance	.01	.12	.01	.01	.08	1.79
Functional disability	.00	.06	.00	.00	.27	1.10
FFMQ (Observing)	-.01	-.06	.01	.00	.41	1.82
FFMQ (Describing)	.01	.09	.01	.01	.16	1.30
FFMQ (Awareness)	-.01	-.04	.01	.00	.57	1.91
FFMQ (Non-judging)	-.01	-.07	.01	.00	.35	1.78
FFMQ (Non-reacting)	.01	.05	.01	.00	.45	1.44

Note. FFMQ = Five Factor Mindfulness Questionnaire, *B* = unstandardized regression coefficient, β = standardized regression coefficient, *SE B* = standard error, sr^2 = squared semi-partial correlations, VIF = Variance Inflation Factor.