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ATTENTIONAL BIAS TOWARD PAIN-RELATED PICTORIAL STIMULI
AMONG INDIVIDUALS WITH MIGRAINE
FOLLOWING NEGATIVE MOOD INDUCTION

A Dissertation

Presented in partial fulfillment of requirements

For the degree of Doctor of Philosophy

in the Department of Psychology

The University of Mississippi

by

MICHAEL J. MCDERMOTT

August 2015

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ABSTRACT

Migraine is associated with significant reductions in daily functioning and quality of life and is the 19th largest cause of disability globally. The fear-avoidance model of chronic pain details potential pathways for the development of pain disability and affective distress and provides a platform for understanding the dynamic relationship between psychological factors and migraine. Consistent with the fear-avoidance model, a growing body of research provides support for the role of selective attentional biases toward threat-related stimuli among chronic pain patients. However, the few studies to examine the role of selective attentional biases in migraine demonstrate mixed findings, and the exact nature of this relationship remains unclear. The current study examined effects of components of the fear-avoidance model (i.e., fear of pain, negative affectivity, and anxiety sensitivity) on attentional biases to pain-related pictorial stimuli among individuals with migraine. A mood-induction procedure was used to experimentally manipulate negative affectivity.

Contrary to hypotheses, neither fear of pain ($B = -0.55, p = .38$), nor negative affect ($B = -0.17, p = .65$), nor anxiety sensitivity ($B = -0.20, p = .70$) significantly predicted attentional processing of headache-related threat stimuli. Although the negative affect mood manipulation was successful, those who completed the negative mood induction and experienced heightened negative affect did not differ from controls (i.e., neutral mood condition) in attentional biases to threat stimuli ($F(1, 64) = 0.06, p = .81$). Anxiety emerged as the only significant predictor of attentional bias to threat stimuli ($B = 1.28, p = .04$). Findings contribute to a growing body of research examining attentional bias in headache and suggest that individuals who experience

migraine with moderate frequency do not selectively attend to headache-related facial expressions, even when in a negative mood state.

LIST OF ABBREVIATIONS AND SYMBOLS

TTH	Tension-type headache
ICHD-II	International Classification of Headache Disorders, 2 nd Edition
SDIH-R	Structured Diagnostic Interview for Headache-Revised
PASS-20	Pain Anxiety Symptoms Scale – 20
PANAS-NA	Positive and Negative Affect Scale – Negative Affect
ASI-3	Anxiety Sensitivity Index – 3
DASS-21	Depression and Anxiety Stress Scale – 21 Item
RT	Reaction time
PASAT-C	Paced Auditory Serial Addition Task – Computerized Version

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CHAPTER 1

INTRODUCTION

Prevalence and Impact of Migraine

Migraine affects 12% of the population yearly, with higher prevalence among women compared to men (18% vs. 6%, respectively; Lipton et al., 2007), and is associated with considerable reductions in daily functioning (Bigal, Serrano, Reed, Lipton, 2008) and quality of life (Powers SW, Patton SR, Hommel KA, Hershey, 2004). Migraineurs experience reduced physical health, mental health, and social functioning compared to those without migraine (Lipton, Hamelsky, Kolodner, Steiner, & Stewart, 2000; Terwindt, Ferrari, Tijhuis, Groenen, Picavet, Launer, 2000). Due to its substantial impact on quality of life, migraine is the 19th largest cause of disability globally, ranking as the 12th largest cause of disability among women specifically (Leonardi, Steiner, Scher, Lipton, 2005).

Migraine is associated with significant functional impairment and limitations in school and work performance. Individuals with migraine experience substantial disability on more than half of the days they have a migraine attack (Park, Shin, Kim, & Lee, 2008), and findings from a large-scale longitudinal study confirm increased days of missed work among individuals with migraine (Von Korff, Stewart, Simon, Lipton, 1998). Follow-up findings from this longitudinal study suggest the burden of migraine increases with attack frequency, such that individuals with chronic daily headache conditions experience higher rates of missed work/school time and

greater reductions in productivity compared to individuals with migraine (Munakata et al., 2009). These direct and indirect effects of migraine represent substantial financial and economic costs (Dahlöf, 1999).

Psychological Factors in Migraine and Chronic Pain Conditions

Comorbid psychological disorders. Migraine is commonly associated with comorbid psychological disorders, with migraineurs at 2 to 5 times greater risk for anxiety and depressive disorders compared to those without migraine (Breslau, 1998; Hamelsky & Lipton, 2006; Radat & Swendsen, 2005; Saunders, Merikangas, Low, Von Korff, & Kessler, 2008). The association between migraine and psychological disorders appears to be strongest for major depressive disorder (Breslau, Lipton, Stewart, Schultz, & Welch, 2003) and panic disorder (Breslau, Schultz, Stewart, Lipton, & Welch, 2001; Smitherman, Kolivas, & Bailey, 2013); however, increased rates of generalized anxiety disorder (Kalaydjian & Merikangas, 2008) and phobias (Radat & Swendsen, 2005) are also found among individuals with migraine (Swartz, Pratt, Armenian, Lee, & Eaton, 2000). The presence of comorbid migraine and psychological disorders is associated with increased risk for migraine-related disability, lower health-related quality of life, increased use of health care (Kalaydjian & Merikangas, 2008), and poorer health-related outcomes (e.g., increased 2-week disability, restriction of activities, and poorer quality of life) compared to having either migraine or a psychiatric condition only (Jette et al., 2008).

The relationship between migraine and affective disorders is likely bidirectional, with the presence of either disorder increasing the risk for the development of the other (Breslau, 1998; Breslau et al., 2001; Breslau et al., 2003; Breslau, Davis, Schultz, & Paterson, 1994). For example, in a 12 year longitudinal study of 15,254 participants from the general population, Modgill and colleagues (2011) demonstrated that migraine is significantly associated with major

depression and that this relationship is bidirectional and independent of sex, age, other chronic health conditions, and a family history or major depression. This study found the strongest statistical effects for those with migraine, who were 80% more likely to develop a major depressive episode compared to those without migraine; individuals with a major depressive episode were 40% more likely to develop migraine compared to those without a major depressive episode (Modgill, Jette, Wang, Becker, & Patten, 2011). Environmental risk factors such as childhood trauma and stress (Bruti, Magnotti, & Iannetti, 2012) and genetic influences, such as shared neurological or biological underpinnings (Bruti et al., 2012; Ligthart, Nyholt, Penninx, & Boomsma, 2010), likely underlie high rates of comorbidity between these conditions (Breslau, Merikangas, & Bowden, 1994). Although the underlying mechanisms are not fully understood, high rates of comorbidity suggest a strong interaction between psychological factors and migraine.

Psychological factors in the development and maintenance of migraine and chronic pain. Traditional biomedical models of pain perception pose a direct linear relationship between physical pathology (e.g., tissue damage) and pain experience. However, these models fail to adequately account for observed discrepancies between physical symptoms and under- or over-reporting of pain and disability (Turk, 1996), suggesting a more complex relationship. These discrepancies, as well as high rates of comorbidity between chronic pain conditions and psychological disorders, have led researchers to highlight the previously neglected role of psychological factors in pain perception and exacerbation (Turk, 1996).

Psychological factors such as negative emotional states are frequently referenced in the development and maintenance of migraine (Nicholson, Houle, Rhudy, & Norton, 2007) and other chronic pain conditions (Gustin, Wilcox, Peck, Murray, & Henderson, 2011). The

experience of negative emotional states such as anxiety, depression, and anger may enhance migraine intensity, migraine-related pain, and migraine-related disability via physiological and psychological pathways (Nicholson et al., 2007). Other psychological factors such as external locus of control, low perceived self-efficacy, and pain-related catastrophizing are associated with increased pain intensity, pain-related disability, and poorer overall functioning (Nicholson et al., 2007; Osborne, Jensen, Ehde, Hanley, & Kraft, 2007). Alternatively, high perceived control over pain and optimism regarding future physical outcomes may serve as protective factors (Powell et al., 2012), and such resilience is associated with mental health-related quality of life beyond pain severity alone (Viggers & Caltabiano, 2012). Successful understanding and treatment of migraine and chronic pain conditions thus requires understanding of psychological factors that contribute to their development and maintenance. Although the etiology and mechanisms underlying these relationships are not fully understood (Silberstein, 2001), further research is needed to elucidate the nature of psychological factors in migraine.

Fear and Avoidance in the Development and Maintenance of Chronic Pain

The fear-avoidance model details a potential pathway for the development of pain disability, affective distress, and physical disuse resulting from fear-driven avoidance behaviors (Vlaeyen & Linton, 2000; 2012) and provides a platform for understanding the dynamic relationship between psychological factors and chronic pain (see Figure 1). This model outlines the role of psychological factors such as pain-related fear and catastrophizing, negative affectivity, and anxiety sensitivity in the development and maintenance of chronic pain through their contributions to avoidance behaviors and increased hypervigilance toward pain-related threat cues. The fear-avoidance model posits that pain-related avoidance behaviors and withdrawal, as well as increased vigilance toward internal bodily sensations and external threats

of pain, play an adaptive and functional role in protecting the body. For example, bending or lifting heavy objects may be avoided in order to limit lower back pain from a previous injury. Although adaptive in promoting recovery in acute phases of pain, prolonged hypervigilance and avoidance behaviors may serve to maintain or even exacerbate pain symptoms in the long term (Lethem, Slade, Troup, & Bentley, 1983; Norton et al., 2003; Vlaeyen & Linton, 2000). Persistent pain hypervigilance and avoidance behaviors may inadvertently increase pain disability and affective distress (Crombez, Eccleston, Van Damme, Vlaeyen, & Karoly, 2012; Vlaeyen & Linton 2000; 2012). Hypervigilance and avoidance behaviors in anticipation of pain, rather than in direct response to pain, may contribute to physical deconditioning, negative affect or affective comorbidities, and preoccupation with physical and somatic symptoms associated with pain (Asmundson, Norton, & Norton, 1999). These effects in turn may increase sensitization to pain and pain-related stimuli, decrease self-efficacy, increase expectation of pain, and increase pain perception (Asmundson et al., 1999), ultimately perpetuating pain-related disability and functional impairment.

Psychological factors contributing to fear and avoidance. Central to the fear-avoidance model is the role of pain appraisal, in which pain is appraised as threatening or nonthreatening (Lethem et al, 1983; Vlaeyen & Linton, 2000; 2012). When appraised as threatening, fear of pain fosters subsequent hypervigilance and avoidance of pain or pain-related stimuli. A number of factors likely contribute to the appraisal of pain as threatening and subsequent pain-related avoidance. Physical factors such as high pain intensity, high frequency, and long duration of pain likely increase escape and avoidance responses among individuals with chronic pain conditions (Leeuw, Goossens, Linton, Crombez, Boersma, & Vlaeyen, 2007), including those with recurrent headache disorders (Norton & Asmundson, 2004). In addition to

physical factors, numerous psychological factors have been indicated in chronic pain development and maintenance through fear and avoidance processes.

Fear of pain. Pain-related fear plays an integral role in escape and avoidance behaviors within the fear-avoidance model (Leeuw, Goossens, Linton, Crombez, Boersma, & Vlaeyen, 2007; Vlaeyen, 2012), suggesting *meaning* of pain plays a role in withdrawal and protective behaviors (Arntz & Claassens, 2004). Pre-injury fear of pain and pain catastrophizing are associated with increased pain intensity and pain-related disability following exercise-induced injury (Parr, Borsa, Fillingim, Tillman, Manini, Gregory, & George, 2012), demonstrating a directional relationship and highlighting the role of fear of pain in the development of pain conditions. In experimental settings utilizing cold pressor tasks to measure pain, fear of pain also is predictive of pain intensity at threshold (i.e., when pain is first reported) and pain intensity at task tolerance (i.e., when one's hand is voluntarily removed from painful stimuli), though not predictive of pain tolerance per se (i.e., endurance of pain as measured by task duration; George, Dannecker, & Robinson, 2006). Further demonstrating the effect of fear of pain within chronic pain conditions, in vivo graded exposure to situations or behaviors perceived to be threatening is effective in reducing pain-related fears and subsequent pain-related disability among individuals with complex regional pain syndrome (de Jong, Vlaeyen, Onghena, Cuypers, et al., 2005; 2012) and chronic low back pain (Vlaeyen, de Jong, Geilen, Heuts, & van Breukelen, 2001; Vlaeyen, de Jong, Geilen, Heuts, & van Breukelen, 2002). These exposure-based treatments serve to underscore the detrimental effects of avoidance in establishing and maintaining disability through mechanisms of pain-related fear.

Fear of pain may be equally relevant among individuals with migraine. Structural equation modeling demonstrates that fear of pain is significantly associated with headache-

related avoidance behaviors among patients seeking treatment for migraine and other headache conditions (Norton & Asmundson, 2004). When examined experimentally, female migraine patients have reported significantly higher pain-related cognitive anxiety compared to female control participants (Bishop, Holm, Borowiak, & Wilson, 2001). However, due to null findings between headache and control conditions on other pain-related fear constructs, the authors of this study cautioned that results provide only limited support for the role of fear of pain in migraine (Bishop et al., 2001). Alternatively, by using a different measure of fear of pain, Hursey and Jacks (1992) provided more direct support for this relationship and demonstrated that individuals with headache experience significantly higher fear of severe and medical pain compared to healthy controls. Although not associated with headache frequency, severity, or disability, fear of pain was also associated with increased headache-related disability among this sample (Hursey & Jacks, 1992). Overall, findings demonstrate that fear of pain has a significant impact on pain-related intensity and disability within chronic pain conditions through escape and avoidance behaviors and may contribute, at least in part, to the pain experience among migraineurs. However, more studies are needed to further elucidate the role of fear of pain in migraine, as the periodic attacks characteristic of migraine differ from the experience of chronic musculoskeletal pain conditions.

Negative affect. Negative affectivity may contribute the development and maintenance of chronic pain conditions by affecting the relationship between pain-related fear and subsequent hypervigilance and avoidance behavior (Vlaeyen & Linton 2000; 2012). The experience of high negative affect may play a moderating role by increasing hypervigilance to threat cues and acting as a vulnerability to develop pain-related fear (Vlaeyen & Linton, 2000). Studies examining positive and negative affectivity measure trait-based affect or current mood state (i.e., state-based

affect; Pressman & Cohen, 2005) and should be considered separately within the fear-avoidance process, as state- (vs. trait-) based negative affect may differentially affect pain-related fear. Current research on the role of long-term, trait-based negative affect remains somewhat inconsistent. For example, trait-based negative emotionality was significantly associated with pain-related disability at one-year follow-up among individuals with chronic low back pain (Sieben et al., 2005), even after controlling for baseline pain (Boersma & Linton, 2006). Experimental studies demonstrate a significant effect of trait-based affective patterns (i.e., patterns of high and low negative and positive affectivity) on laboratory-based pain sensitivity and pain-related coping strategies (Sibille et al., 2012). However, path analyses and maximum likelihood best fit modeling demonstrate a relatively limited effect of 12-month negative affect on pain severity and pain disability at baseline and at 18-month follow-up and instead suggest that pain-related fear, rather than negative affect, may play a more significant role among individuals with back pain (Gheldof et al., 2010). These mixed findings demonstrate the potential for alternative factors (e.g., protective or resiliency factors) contributing to the relationship between trait-based negative affect and pain.

Findings have been more consistent across studies regarding the role of short-term state-based negative affectivity in the development and maintenance of chronic pain. Negative affective states such as the experience of anxiety regarding pain are associated with heightened somatic focus and a hypervigilant response to pain (O'Brien, Atchison, Gremillon, Waxenberg, & Robinson, 2008). Also, state-based negative affect (i.e., past 24 hour pain-related depression, anxiety, frustration, anger, and fear) significantly predicts pain intensity among patients with fibromyalgia (Straud, Price, Robinson, & Vierck, 2004). Studies utilizing longitudinal designs have also demonstrated an association between weekly negative affect and weekly pain and

stress among individuals with rheumatoid arthritis (Strand, Zautra, Thoresen, Ødegård, Uhlig, & Finset, 2006). Findings from this study additionally highlight the protective role of positive affect in reducing negative affect during the experience of heightened pain. Similar findings have been observed among women with osteoarthritis and fibromyalgia, in which weekly negative affect was associated with increased pain and high weekly positive affect was associated with reduced pain in subsequent weeks (Zautra, Johnson, & Davis, 2005). In addition to pain symptoms, negative affect is associated with pain-related disability among non-clinical samples, and this relationship is mediated by fear of pain and emotion-oriented coping (Lightsey et al., 2009). These results highlight the close relationship between current emotional states and chronic pain conditions and are consistent with studies demonstrating that maladaptive styles of coping with chronic pain are associated with increased negative affect and decreased positive affect (Zautra et al., 1995).

Among migraineurs, negative affective states such as anxiety, depression, anger, or distress may trigger migraine through neurological activation (Nicholson et al., 2007), and affective disorders occur at increased rates among migraineurs compared to those without migraine (Breslau, 1998; Hamelsky, & Lipton, 2006; Radat & Swendsen, 2005; Saunders et al., 2008). Despite considerable theoretical evidence, few studies have directly examined the role of negative affect in migraine or other headache conditions. In one of the only studies to date, Johnson (2003) demonstrated a significant moderate correlation between negative affect and migraine likelihood independent of over-reporting due to a heightened sensitivity to detect and report physical symptoms. However, this study required participants to indicate their level of inclination (low to high) to experience migraine and did not assess migraine symptoms directly, potentially limiting generalizability to bona fide migraine sufferers. In a study examining

negative affect and stress-related physiological activation (i.e., electromyographic activity) in tension-type headache (TTH), increased negative affect and physiological activation on stressful days was not associated with an increase in pain, but individuals with TTH reported higher frustration compared to control participants (Rugh, Hatch, Moore, Cyr-Provost, Boutros, & Peilegrino, 1990). Despite evidence for the effects of negative affect on fear of pain, pain symptoms, and pain-related disability, prior research has not examined the role of negative affect on hypervigilance and avoidance among individuals with migraine.

Anxiety sensitivity. Anxiety sensitivity, the fear of anxiety-related sensations due to beliefs about their harmful social, somatic, and/or psychological consequences (Reiss, 1991), has received considerable attention in chronic pain and has been implicated in the fear-avoidance process (Asmundson et al., 1999). Anxiety responses such as increased autonomic arousal may increase pain-related fear through prompting misinterpretations of these salient somatic sensations (Norton & Asmundson, 2003), ultimately increasing hypervigilance and avoidance. Using structural equation modeling among patients with chronic low back pain, Asmundson and Taylor (1996) observed a significant relationship between anxiety sensitivity and pain-related fear that was associated with pain-related escape/avoidance behaviors. Although informative, this study did not examine a direct pathway between anxiety sensitivity and pain-related escape and avoidance behaviors. Building upon these findings and utilizing similar methodology, Esteve and colleagues (2012) demonstrated that anxiety sensitivity, as well as experiential avoidance, independently contributed to pain-related avoidance among patients with chronic back pain (Esteve, Ramirez-Maestre, & Lopez-Martinez, 2012). However, in contrast to previous findings, this study failed to find a direct association between anxiety sensitivity and fear of pain. The

authors suggest that differences in measurement of fear of pain may have contributed to discrepancies in results between these studies (Esteve et al., 2012).

Anxiety sensitivity is significantly associated with headache intensity and number of physical symptoms among non-clinical samples (Drahovzal, Stewart, & Sullivan, 2006). For instance, Asmundson, Norton, and Veloso (1999) found that recurrent headache patients with high anxiety sensitivity endorsed higher fear of pain and pain-related escape/avoidance behaviors than those with medium or low anxiety sensitivity. In the only other study to examine the role of anxiety sensitivity in fear-avoidance among individuals with headache, structural equation modeling demonstrated a significant direct effect of anxiety sensitivity on fear of pain that was equal to that of pain severity. Fear of pain, in turn, loaded significantly on pain-related escape and avoidance, although direct effects of anxiety sensitivity on escape and avoidance were not examined (Norton & Asmundson, 2004). Although the exact nature of the relationship between anxiety sensitivity, fear of pain, and avoidance remains somewhat unclear, findings have highlighted the maintaining role of anxiety sensitivity in chronic pain conditions including migraine. Further research is needed, however, to establish a more comprehensive understanding of the role of anxiety sensitivity in migraine symptomatology. Determining the role of anxiety sensitivity in migraine by means of studying increased vigilance to threat-related stimuli, as well as escape and avoidance behaviors, may shed yet additional light on this relationship.

Hypervigilance and selective attentional processes. Attentional processes that influence hypervigilance to internal and external threat cues play central development and maintenance roles in the fear-avoidance model through perpetuating secondary pain-related symptoms and increasing pain-related disability (Vlaeyen et al., 2000; 2012). When pain is interpreted as threatening, an individual may scan their body for pain-related threat cues or become

hypervigilant to other information potentially indicative of impending pain (e.g., external threat cues; Crombez et al., 2012), resulting in further avoidance behaviors. Similar to avoidance behaviors, increased hypervigilance or selective attention to pain-related stimuli and somatic sensations is seemingly adaptive in the immediate moment but has the potential to increase pain-related disability by fostering preoccupation with symptoms associated with pain (Vlaeyen & Linton, 2012). As mentioned earlier, psychological constructs such as fear of pain, negative affect, and anxiety sensitivity presumably contribute to increased pain-related attentional focus.

Methods for Assessing Selective Attention in Chronic Pain Conditions

Modified Stroop task. Consistent with the fear-avoidance model, a growing body of research has examined the roles of hypervigilance and selective attention to pain-related stimuli in the development and maintenance of chronic pain. Initial studies examining attentional processes among chronic pain populations utilized the modified Stroop task (Mathews & MacLeod, 1985; Mogg, Mathews, & Weinman, 1989). The modified Stroop task requires participants to report on the color of printed words that differ in emotional valence (i.e., participants indicate the ink color of the word while ignoring its actual meaning). Longer latencies in responding to particular word types presumably indicate increased allocation of attention to processing of meaning of the words. For instance, longer latencies in responding to more negatively-valenced words indicate selective processing of these threat-related words compared to neutral or non-threatening words. Meta-analytic examinations have confirmed a threat-related bias among anxious individuals that is not observed among non-anxious controls (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007), providing support for the validity of the Stroop task in measuring selective attentional processes. In a review of the Stroop task among clinical populations, Williams, Mathews, and MacLeod (1996)

concluded that individuals are generally slower in responding to words relevant to their particular clinical disorder than to neutral words, and that delayed responding is indicative of disrupted performance due to increased attention to threat stimuli. This effect is considerably stronger among individuals with anxiety compared to depression (Daggleish & Watts, 1990) and those with depression tend to demonstrate attentional biases only during task conditions of extended stimuli presentation (Mogg & Bradley, 2005).

When adapted for use among chronic pain conditions, the modified Stroop task typically requires participants to report the color of words that differ in pain-related valence (e.g., neutral words vs. pain-related words) or are affectively charged. Results from studies examining the modified Stroop paradigm among chronic pain populations have been somewhat inconsistent (Pincus & Morley, 2001). For example, individuals with fibromyalgia have shown increased attention to stimuli referring to fibromyalgia symptoms and both negative and positive arousal words as compared to neutral words (González et al., 2010). This pattern of responding was mediated by the perceived unpleasantness of the negatively arousing stimuli. Attentional biases also manifest in anticipation of pain (e.g., prior to outpatient surgery), in which patients exhibit attentional biases to physical threat stimuli (i.e., stimuli congruent with patient's concerns about surgery) but not to other emotional stimuli (Munafò & Stevenson, 2003). Interestingly, this study also demonstrated that preoperative attentional biases significantly predicted post-operative pain independently of state and trait anxiety (Munafò & Stevenson, 2003). Finally, meta-analytic data confirm that chronic pain patients show selective attention to sensory and affective pain stimuli (Roelofs, Peters, Zeegers, & Vlaeyen, 2002), providing support for the role of selective attentional processing in pain.

In contrast to the majority of studies showing a Stroop effect among chronic pain patients, others have failed to identify differences in attention to movement- or injury-related words among individuals with chronic low back pain (Roelofs, Peters, & Vlaeyen, 2003) or general musculoskeletal pain (Asmundson, Wright, & Hadjistavropoulos, 2005). Studies failing to demonstrate a Stroop effect between chronic pain and attentional processing biases have instead found evidence for the role of mood state, fear of pain (see Pincus & Morley, 2001 for a review), anxiety, and depression (Pincus, Fraser, & Pearce, 1998) on attentional biases rather than pain or pain status, suggesting that the experience of pain alone is insufficient to establish attentional processing biases. In this regard, observed attentional biases toward pain-related information within the Stroop task may be most strongly influenced by particular mood states or other psychological conditions.

In addition to the potential for psychological confounds in attentional processes, the modified Stroop task itself may not adequately measure selective attention. Evidence exists to suggest effects within the modified Stroop task are not driven by attentional processes per se but instead by overall delayed responding to threat-relevant words (Algom, Chajut, & Lev, 2004). Additionally, the Stroop paradigm may not measure *selective* attention insofar as there are no alternative or distractor stimuli presented simultaneously with target stimuli (Fox, 1993; Treisman, 1969). These limitations have resulted in the development of alternative methods for measuring selective attentional processes to emotionally salient stimuli.

Visual dot probe task. In order to address procedural and interpretational concerns within the modified Stroop task, the visual dot probe task was developed to more effectively measure selective attentional processing and allocation of visual attention distribution to spatial locations (MacLeod, Matthews, & Tata, 1986). The visual dot probe task displays paired stimuli

simultaneously in two locations on a computer monitor (e.g., left-center and right-center), which are subsequently removed following a predetermined presentation time (e.g., 500 milliseconds [ms] or 1250ms). Visual attention toward stimuli is then measured by requiring the participant to subsequently indicate the location of a visual dot that replaces one of the two competing stimuli. Response times are collected for trials when the visual dot probe replaces neutral or non-threatening stimuli and compared to those when the visual dot probe replaces threat stimuli. Shorter response latencies suggest visual allocation to stimuli that the dot probe replaced. Longer latencies suggest attentional allocation and vigilance to the competing stimuli (or difficulty disengaging from competing stimuli; Koster, Crombez, Verschuere, & De Houwer, 2004) due to the necessary shift of attention to the visual dot probe (MacLeod et al., 1986). By presenting competing stimuli, the dot probe task more effectively measures *selective* attention to threat-related stimuli and more appropriately corresponds to real-world conditions than the modified Stroop task. Correlational analyses between Stroop task and dot probe task scores among healthy controls and chronic pain patients have demonstrated no significant association between tasks, suggesting that the two tasks differentially measure attention (Asmundson et al., 2005). The dot probe task also provides a measurement of selective attentional processes specific to threat stimuli, as vigilance toward threat-related cues increases with threat salience (e.g., increased hypervigilance toward high-threat cues compared to mild-threat cues; Mogg, McNamara, Powys, Rawlinson, Seiffer, & Bradley, 2000). As such, the dot probe is particularly appropriate to measure selective attention to threat-related stimuli among individuals with chronic pain.

Pain-Related Attentional Biases among Chronic Pain Patients.

Biases to pain-relevant word stimuli. In one of the first studies to examine selective attention among chronic pain patients using the dot probe task, Asmundson and colleagues

(1997) found no differences in attentional biases to pain and injury word stimuli among individuals with a chronic pain condition versus healthy controls. These findings were maintained even after controlling for depression. However, when accounting for the interactive effects of anxiety sensitivity, those low in anxiety sensitivity demonstrated an attentional bias toward neutral stimuli (i.e., they shifted attention away from pain-related words), whereas those high in anxiety sensitivity demonstrated no attentional biases to either neutral or threat-related stimuli. The authors suggest these findings demonstrate that fear of anxiety-related sensations may play a role in attentional biases to pain cues (Asmundson, Kuperos, & Norton, 1997). The methodology of this study, however, may have introduced error as participants were required to read aloud the top word in each trial and used a single button response format (Asmundson et al., 1997; Schoth, Nunes, & Lioffi, 2012). In a similar study conducted more recently among healthy individuals, those high in fear of pain demonstrated increased selective attention to pain-related word stimuli compared to those with medium or low fear of pain, further highlighting the role of fear of pain in selective attentional processes. This bias was found for pain-related word stimuli only and not for negatively or positively valenced stimuli and was not accounted for by depression (Keogh, Ellery, Hunt, & Hannent, 2001).

In further support of the relationship between hypervigilance and pain, sophisticated measurement techniques using eye-tracking procedures demonstrate that high fear of pain among chronic pain patients is associated with attentional biases characterized by initial attentional allocation and subsequent avoidance of threat stimuli compared to healthy controls (Yang, Jackson, & Chen, 2013). Longitudinal examinations demonstrate that hypervigilance to pain-related words is predictive of self-reported postoperative pain intensity (Lautenbacher et al., 2009), providing support for the role of hypervigilance as a risk factor in chronic pain conditions.

Although these studies did not uniformly support a direct effect between selective attention to threat related stimuli and chronic pain, in general findings are consistent with tenets of the fear-avoidance model, in which psychological factors such as fear of pain and anxiety sensitivity contribute to hypervigilance to threat stimuli.

Building on this initial research, several studies have examined attentional biases to threat stimuli representing different threat-related domains. In an investigation of attentional biases to sensory, affective, disability, and threat-related pain words, individuals with rheumatoid arthritis demonstrated a significant bias toward sensory-related words and avoidance of threat-related words. Further analyses of time course revealed that attentional biases to sensory-related stimuli resulted from difficulties disengaging from these stimuli rather than being hypervigilant toward them (Sharpe, Dear, & Schrieber, 2009). Using a similar design, Haggman and colleagues (2010) examined attentional bias to pain words among individuals with acute and chronic low back pain and “healthy” controls. Results demonstrated a significant bias toward sensory pain words for individuals with both pain conditions compared to controls, but not for affective, disability, or threat-related words. This study also found a bias toward sensory pain words for those with low and medium fear of injury/re-injury but not for those with high fear of injury and re-injury. The authors assert that these findings are counterintuitive to the fear-avoidance model and that pain experience, rather than pain duration, is perhaps most significant in pain-related biases. However, underrepresentation of patients with acute pain and high fear of injury may have limited statistical power in this study (Haggman, Sharpe, Nicholas, & Refshauge, 2010). This unexpected failure to find an attentional bias among those high in fear of injury calls attention to the need for continued elucidation of psychological factors within the fear-avoidance model.

The relationship between fear of injury and attentional biases among pain conditions may be affected by threat expectancy. For example, individuals made to expect threat regarding upcoming pain (i.e., threat condition) demonstrated an attentional bias toward affective words compared to those whose threat regarding upcoming pain was minimized (i.e., non-threat condition), who instead demonstrated a bias toward sensory words (Boston & Sharpe, 2005). Consistent with findings obtained by Haggman and colleagues (2010), Boston and Sharpe (2005) suggested that vigilance to sensory stimuli occurs in the absence of expected threat and may serve an adaptive function. During threat expectancy, attentional processing is instead prioritized toward affective pain stimuli. Although further research is needed to more effectively clarify the influence of stimulus type in attentional processes, these findings support the role of fear of pain in attentional processing among chronic pain conditions.

Biases to pain-relevant pictorial stimuli. Dot probe tasks using pictorial stimuli are less ambiguous and more representative of real world stimuli, and thus likely provide greater ecological validity than word-based dot probe tasks (Dear, Sharpe, Nicholas, & Refshauge, 2011; Kindt & Brosschot, 1997). Pictorial stimuli are more strongly valenced than verbal stimuli (Roelofs, Peters, Fassaert, & Vlaeyen, 2005), engender greater arousal (Kindt & Brosschot, 1997), and are more appropriate for use among chronic pain populations (Dear et al., 2011). In order to address potential limitations inherent in word stimuli dot probe tasks, Roelofs and colleagues (2005) examined attentional biases among patients with chronic low back pain using two versions of the dot probe task (word vs. pictorial version). The verbal dot probe task utilized injury- and movement-related words, and the pictorial dot probe task used pictures of individuals engaging in painful activities. Results from the pictorial dot probe demonstrated that chronic low back pain patients had difficulty disengaging from threat (i.e., demonstrating a selective

attentional bias) compared to healthy controls. Healthy controls also demonstrated a similar difficulty disengaging, but this effect was smaller than for the chronic pain condition. No significant biases were observed for the verbal dot probe task for either group (Roelofs, Peters, Fassaert, & Vlaeyen, 2005), confirming differences in bias substantiation based on stimulus type.

In one of the only other dot probe studies to utilize pictorial stimuli among a chronic pain sample, Khatabi and colleagues (2009) examined attentional biases to painful and happy faces compared to neutral faces. Both chronic pain patients and controls demonstrated an attentional bias toward neutral faces compared to happy faces (i.e., they shifted attention away from happy faces and toward neutral faces). A similar effect was observed toward neutral faces compared to painful faces for controls but not for chronic pain patients. The authors suggest these findings demonstrate that chronic pain patients may differentially attend to painful faces, despite demonstrating no attentional bias per se toward painful faces (Khatabi, Dehghani, Sharpe, Asmundson, & Pouretamad, 2009). Secondary analyses from this study demonstrated that, among chronic pain patients, those high and low in fear of pain demonstrated similar attentional shifts away from happy faces, but only those with low fear of pain shifted attention away from painful faces. Those with high fear of pain demonstrated an attentional bias toward painful expressions, highlighting the role of fear of pain in attentional processing of pictorial threat cues (Khatabi et al., 2009). Taken together and in conjunction with meta-analytic data (Schoth, Delgado Nunes, & Lioffi, 2012), these studies provide support for the role of selective attentional biases toward pictorial threat-related stimuli among chronic pain patients and highlight the role of fear of pain in this relationship.

Selective Attention to Pain-Relevant Stimuli in Migraine

Despite a growing consensus that pain-related attentional biases are present among individuals with chronic pain conditions, mixed results have emerged among the few studies of selective attention to pain-related stimuli among individuals with migraine. In a dot probe study utilizing sensory pain, affective pain, and neutral word stimuli, Lioffi and colleagues (2009) observed an attentional bias toward pain stimuli among chronic daily headache patients compared to healthy controls. An examination of the time course of attentional bias found headache patients experienced a bias in maintained attention versus a bias of initial orienting of attention (Lioffi, Schoth, Bradley, & Mogg, 2009). In a comparable study using a similar dot probe design, chronic TTH patients exhibited a bias in maintained attention to pain stimuli but not for social threat or anger-related stimuli (Lioffi, White, & Schoth, 2011). In contrast, Asmundson and colleagues (2005) failed to find differences in attentional bias toward affect pain or sensory pain word stimuli between individuals with chronic headache and healthy controls. Interpretation of these mixed findings is further complicated by the written verbal stimuli utilized in these studies, which limits generalizability to environmental pain-related stimuli (Dear et al., 2011).

To date, only two studies have examined attentional biases toward pictorial stimuli among headache patients. Schoth and Lioffi (2010) found significantly heightened attentional bias to headache-related facial expressions (i.e., facial expressions of pain with individuals holding their temples or forehead) among individuals with chronic daily headache compared to controls. In the other study, McDermott, Peck, Walters, and Smitherman (2013) found no differences in attentional allocation to migraine-related facial expressions among individuals with episodic migraine versus controls. However, this study failed to examine potentially relevant factors such as fear of pain, negative affect, or anxiety sensitivity. Taken together, these

studies suggest that attentional biases to threat-related stimuli are most pronounced among more frequent headache subforms, perhaps as a function of variations in visuocortical hyperexcitability (Mickelborough, Hayward, Chapman, Chung, & Handy, 2011). Clearly, however, more research is needed to determine the extent to which the aforementioned psychological factors might affect selective attention to threat-related stimuli among individuals with migraine.

Aims of Present Study

In order to examine the components of the fear-avoidance model as they relate to migraine, the present study examined the role of fear of pain, negative affectivity, and anxiety sensitivity on attentional biases to pain-related pictorial stimuli among individuals with migraine. This study used a mood induction procedure designed to increase state-based negative affectivity to examine its moderating effect on fear of pain and selective attentional processes. The stimuli of interest were negatively-valenced facial pain expressions as compared to neutral and positively-valenced facial expressions. As a secondary aim, this study sought to explore the moderating role of anxiety sensitivity on fear of pain and selective attentional biases among individuals with migraine.

Preliminary Study Goal: Explore the roles of fear of pain, negative affectivity, and anxiety sensitivity on selective attention toward pictorial stimuli.

H₁—Individuals with high fear of pain, high negative affect, and high anxiety sensitivity will demonstrate heightened attentional biases.

Primary Study Goal: Examine the moderating role of negative affectivity following mood induction (negative affect mood induction vs. neutral mood condition) on the relationship between fear of pain and selective attention toward pictorial facial stimuli.

H₂—Negative affect following mood induction will moderate the relationship between fear of pain and attentional bias toward pictorial facial stimuli. The relationship between fear of pain and attentional bias to negatively valenced pain-related facial stimuli will be stronger for those with high negative affect compared to those with neutral negative affect.

Secondary Study Goal: Examine the moderating role of anxiety sensitivity on the relationship between fear of pain and selective attention toward pictorial facial stimuli.

H₃—Anxiety sensitivity will moderate the relationship between fear of pain and attentional bias toward pictorial facial stimuli. The relationship between fear of pain and attentional bias to negatively valenced pain-related facial stimuli will be stronger for those with high anxiety sensitivity compared to those with low anxiety sensitivity, even after controlling for general anxiety symptoms.

CHAPTER 2

METHOD

Participants

A priori power analyses indicated that 68 participants were optimal, assuming an effect size of $f^2 = 0.15$, a power of .80, and an alpha of .05. Participants were 67 university students who met ICHD-II diagnostic criteria for episodic migraine ($n = 65$) and chronic migraine ($n = 2$) and received course credit for participation. (One participant was excluded from analyses due to frequent errors in responding, as described later.) The retained 66 participants were predominantly female (77.27%) and ranged in age from 18 to 45 ($M = 19.94$, $SD = 3.78$). In regard to racial/ethnic background, 74.2% were White, 22.7% were Black, 1.5% were Hispanic/Latino/Latina, and 1.5% were Asian.

Diagnostic Assessment Measures

Structured Diagnostic Interview for Headache-Revised (SDIH-R). To establish current migraine diagnoses, participants were interviewed using the *Structured Diagnostic Interview for Headache – Revised* (SDIH-R; Andrew, Penzien, Rains, Knowlton, & McAnulty, 1992; International Headache Society, 2004). The SDIH-R is a revised version of the original Structured Diagnostic Interview for Headache with modifications to maintain concordance with ICHD-II diagnostic criteria (International Headache Society, 2004). Diagnostic questions assess features of head pain such as pain intensity and pain distribution, pain frequency and severity,

and potential secondary causes of headache (e.g., medication overuse or posttraumatic headache). The current study allowed a minimum migraine duration of 2 hours (compared to 4 hours required by ICHD-II Criterion B) to account for the fact that younger adults often experience shorter but otherwise prototypical migraine attacks (Rains, Penzien, Lipchik, & Ramadan, 2001; Rasmussen, Jensen, & Olesen, 1991). Migraineurs who met ICHD-II diagnostic criteria for episodic and chronic migraine with or without aura (ICHD-II 1.1 and 1.2.1) were enrolled, and those reporting symptoms of episodic or chronic TTH, cluster headache, or headache due to secondary causes such as medication overuse or posttraumatic headache were excluded.

Self-Report Measures

Pain Anxiety Symptoms Scale – 20 (PASS-20). The Pain Anxiety Symptoms Scale – 20 (PASS-20; McCracken & Dhingra, 2002) is a 20-item shortened version of the original 40-item Pain Anxiety Symptoms Scale (McCracken, Zayfert, & Gross, 1992). The PASS-20 is a self-report measure designed to measure anxiety symptoms specific to pain and includes subscales for four domains of pain-specific anxiety: cognitive, escape and avoidance, fear, and physiological (McCracken & Dhingra, 2002). Items are rated on a Likert-type scale measuring frequency of occurrence ranging from 0 (never) to 5 (always). The PASS-20 demonstrates good convergent, divergent, and criterion validity. Total scale scores ($r = 0.97$) and subscale scores ($r = 0.44-0.96$) are strongly correlated with the original PASS and demonstrate strong internal consistency validity (total scale score $\alpha = 0.91$; subscales $\alpha = 0.75-0.86$; McCracken & Dhingra, 2002). The four-factor PASS-20 additionally has strong factor stability, reliability and internal consistency, and concurrent and construct validity, among both clinical (Coons,

Hadjistavropoulos, & Asmundson, 2004; Roelofs, McCracken, Peters, Crombez, van Breukelen, & Vlaeyen, 2004) and non-clinical samples (Abrams, Carleton, & Asmundson, 2007).

Positive and Negative Affect Scale – Negative Affect (PANAS-NA). The negative affect module of the Positive and Negative Affect Scale (PANAS-NA; Watson, Clark, & Tellegen, 1988) is a 10-item self-report measure designed as a dimensional assessment of negative affective states. The PANAS-NA can be administered to measure present moment, past day, past few days, past few weeks, past year, or general negative affect (Watson et al., 1988) and is appropriate for measuring state or trait negative affectivity (Merz & Roesch, 2011). The PANAS-NA consists of single words related to negative affectivity (e.g., distressed, upset, or guilty) which are rated from 1 (very slightly or not at all) to 5 (extremely) on how much each word relates to the indicated time period. The current study instructed respondents to report on negative affect “at this very moment” to assess present moment negative affectivity. The PANAS-NA demonstrates strong construct validity (Crawford & Henry, 2004), excellent convergent and discriminant validity, and good internal consistency reliability for present moment ($\alpha = 0.85$), past day ($\alpha = 0.87$), past few days ($\alpha = 0.85$), past few weeks ($\alpha = 0.87$), past year ($\alpha = 0.84$), and general ($\alpha = 0.87$) negative affective states (Watson et al., 1988).

Anxiety Sensitivity Index – 3 (ASI-3). The Anxiety Sensitivity Index – 3 (ASI-3; Taylor et al., 2007) is an 18-item self-report questionnaire designed to measure lower-order dimensions of anxiety sensitivity. The ASI-3 yields an overall score of anxiety sensitivity as well as individual scores specific to physical concerns (e.g., beliefs that elevated heart rate will lead to cardiac arrest), cognitive concerns (e.g., beliefs that anxiety-related concentration difficulties indicate mental illness), and social concerns (e.g., beliefs that observable anxiety responses will result in social denunciation; Taylor et al., 2007). ASI-3 items are rated from 0 (very little) to 4

(very much) on the extent to which respondents agree with each statement (e.g., It is important for me not to appear nervous). Items are summed to create a total score (ranging from 0 to 72) and scale scores (ranging from 0 to 24). The ASI-3 demonstrates a consistent three-factor structure and strong convergent, discriminant, and criterion validity across clinical and nonclinical samples, as well as good internal consistency reliability for each of the three subscales: physical concerns ($\alpha = 0.79-0.86$), cognitive concerns ($\alpha = 0.76-0.89$), and social concerns ($\alpha = 0.73-0.86$; Taylor et al., 2007).

Depression and Anxiety Stress Scale – 21 Item (DASS-21). In order to assess symptoms of depression, anxiety, and stress, participants completed the Depression Anxiety Stress Scale – 21 item version (DASS-21; Lovibond & Lovibond, 1995). Both versions of the DASS (21-item version and 42-item version; Lovibond & Lovibond, 1995) demonstrate consistent factor loadings for a 3-factor model (Clara, Cox, & Enns, 2001) and are comparable in distinguishing between diagnostic categories (Antony, Bieling, Cox, Enns, & Swinson, 1998). Items on the DASS-21 are rated from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time) on the relevance of each statement over the past week. The DASS-21 provides individual scale scores for depression, anxiety, and stress. The DASS-21 demonstrates strong internal consistency reliability for the total scale ($\alpha = 0.93$) and each subscale (α s = 0.82 to 0.90; Henry & Crawford, 2005), as well as adequate test-retest reliability (Brown, Chorpita, Korotitsch, & Barlow, 1997). The DASS-21 has good construct validity as well as good convergent and discriminant validity with other measures of depression and anxiety (Antony et al., 1998; Brown et al., 1997; Lovibond & Lovibond, 1995).

Demographic questionnaire. Participants completed a demographic questionnaire to provide information about age, gender, and racial/ethnic identity.

Pictorial Dot Probe Task

The pictorial dot probe task was developed using E-Prime 2.0 (Psychology Software Tools, Inc., Pittsburgh, PA) with responses recorded using PST Serial Response Box, which affords millisecond measurement precision. Pictorial stimuli for this task were 8 headache-specific negatively valenced pain-related facial expressions, 8 positively valenced happy expressions, and 8 neutral (control) facial expressions previously used in McDermott et al. (2013). Pictorial stimuli were drawn from a pool of 54 facial images obtained from online searches for pictures specific to headache-related pain expressions (e.g., holding one's temple or forehead with facial expression characteristic of pain), happy expressions (e.g., smiling or laughing), and neutral expressions (e.g., flat affect with limited facial expression). The 54 candidate images were reduced to 24 stimuli based on pilot testing among 18 independent raters with episodic migraine and 18 non-migraine controls (see McDermott et al., 2013 for a full description). Pictorial stimuli rated highest for headache and happy expressions and pictorial stimuli rated closest to neutral were retained to be used in the current dot probe task, heretofore referred to as "headache," "happy," and "neutral" facial expression stimuli. Headache facial expressions used in the current study are consistent with prototypical facial expressions of pain such as brow lowering, eyelid narrowing, nose wrinkling, and elevation of the upper lip (Botvinick et al., 2005; Prkachin, 1992). Pictorial stimuli were presented in black and white color scale to minimize the potential influence of color as a distractor and ensure uniformity in presentation between photos.

Pictorial dot probe task procedure. Participants completed the computerized pictorial dot probe task in a quiet room without distractions. At the beginning of each trial a fixation cross was presented in the center of the screen for 500 milliseconds (ms) followed by a blank screen

(i.e., interstimulus interval) for 250ms. Picture pairs were then presented side by side on the computer monitor for 500ms. Immediately following the removal of both pictorial stimuli, a single dot randomly replaced either the left or right image and remained until a response was made, which required participants to indicate as quickly as possible whether the dot appeared in the left or right location (i.e., by pressing the left or right key on the response box).

The pictorial dot probe task consisted of a single practice trial and 200 experimental trials, for a total of 13,400 experimental trials across all participants. Experimental trials consisted of headache-neutral facial expression pairings (80 trials), happy-neutral facial expression pairings (80 trials), and neutral-neutral facial expression pairings (40 trials). Including stimulus type (headache, happy, and neutral), image placement (left and right) and dot probe location (left and right), a total of 12 presentation permutations existed. Each image was randomly selected without replacement until all other images were presented. Pictorial facial expression images for were displayed approximately 115 millimeters (mm) in width by 100mm in height, and the distance between the inner edges of each picture pair was 90mm. The distance between the two dot probe locations (left and right) was 200mm.

Pictorial dot probe task scoring. Prior to analyses, dot probe reaction time (RT) data were cleaned for accuracy and response outliers. Incorrect responses (n = 80 trials) and RTs less than 200ms, greater than 2000ms, and then greater than 3 SDs above the sample mean (n = 196 trials) were excluded from further analyses; excluded responses comprised 2.1% of trials. Similar cleaning procedures for reaction time data have been validated previously for pictorial dot probe tasks with emotionally-valenced facial expression and threat stimuli (See Bradley, Mogg, White, Groom, & de Bono, 1999; Koster et al., 2004; McDermott et al., 2013).

Dot probe mean RTs were calculated separately for each condition (i.e., headache-neutral, happy-neutral, and neutral-neutral facial expression conditions). Within each presentation condition, mean RTs for congruent and incongruent trials were used to calculate congruency and incongruency indices. Congruent trials were those in which the dot replaced the target emotional stimuli (i.e., headache or happy facial expression), and incongruent trials were those trials in which the dot appeared in the opposite location as the target emotional stimulus (i.e., replacing the neutral facial expression). For the neutral-neutral condition, a single mean RT score was calculated. In order to calculate the average RT for trials in which the dot replaced the emotional stimulus, the formula $(erdr + eldl)/2$ was used to calculate the congruency index from congruent trials, in which e is the target emotional stimulus, l is the left position, r is the right position, and d is the dot. The formula $(eldr + erdl)/2$ was used to calculate the incongruency index (i.e., average RT for trials in which the dot replaces the neutral stimulus). In order to further reduce RT data in the form of a single outcome score for each participant, a bias index was calculated using the formula $[(eldr - erdr) + (erdl - eldl)]/2$. The resulting bias index represents the mean difference in reaction time between incongruent and congruent trials. Higher bias index scores indicate increased selective attention toward emotional stimuli (i.e., headache or happy stimuli) compared to neutral stimuli.

Paced Auditory Serial Addition Task – Computerized Version (PASAT-C)

The PASAT-C (Lejuez, Kahler, & Brown, 2003) was used to elicit negative affect prior to the dot probe task. The PASAT-C sequentially presents a series of one- or two-digit numbers in the middle of a computer monitor. Participants are required to quickly sum each number with the number previously presented. After indicating the sum using response options presented on the screen, participants must disregard this summed answer and sum a newly-presented number

with the last number presented. Correct responses thus are sums of two numbers rather than a running total of all number values presented. Each correct response earns a point, and a running point total is displayed at the top of the screen. Incorrect or omitted responses result in an aversive “explosion” sound, and no points are earned. The PASAT-C consists of 3 separate levels presented iteratively, each enhanced in difficulty by increased speed of number presentation. The first level presents numbers on a 3-second interstimulus interval (low difficulty) and lasts 3 minutes; the second level presents numbers on a 2-second interstimulus interval (medium difficulty) and lasts 5 minutes; and the third level presents numbers on a 1-second interstimulus interval (high difficulty) and lasts 7 minutes. The third level includes an option to quit at any time, but participants are encouraged to continue as long as possible to afford an individualized measurement of distress tolerance (i.e., time to task withdrawal).

Considerable evidence exists supporting the validity of the PASAT-C in eliciting emotional distress and negative affect. The PASAT task is effective in altering mood state by increasing negative affect and decreasing positive affect among individuals in a neutral or happy mood state prior to the task (Holdwick & Wingenfeld, 1999). Specifically, the PASAT-C reliably elicits increased distress and negative affect such as anxiety, anger, frustration, and irritability across clinical and non-clinical samples (e.g., Bornovalova et al., 2008; Gratz et al., 2011; Lejuez et al., 2003; Tull, Gratz, Coffey, Weiss, & McDermott, In Press).

To provide a comparable control condition (i.e., similar task duration and computer-based requirements to the PASAT-C), participants assigned to the neutral mood condition completed a “Math Task” consisting of simple computer-based mathematical operations for a time period equivalent to PASAT-C. Similar to the PASAT-C, the Math Task required simple addition of two numbers of one or two digits (e.g., $11 + 3 = ?$), but the operations were viewable in their

entirety (i.e., rather than one number at a time), participants were allowed to solve the equations at their own pace, and an aversive sound was not administered after an incorrect response (only a message reminding them to solve each equation accurately).

Procedure

Potential young adult participants were identified following their completion of a larger online survey battery in exchange for modest course credit. As part of this larger battery, they completed a demographic questionnaire and a computerized version of the SDIH-R. Participants whose responses to the computerized SDIH-R were indicative of episodic migraine (with or without aura; ICHD-II 1.2.1 and 1.1 respectively) or chronic migraine (ICHD-II 1.5.1) were contacted to participate in the current study. After providing written informed consent, they were individually administered the SDIH-R in person to confirm migraine diagnosis and then completed the PASS-20, the PANAS-NA (Time 1 [T1]), the ASI-3, and the DASS-21. Participants were then randomly assigned to complete either the negative affect mood induction condition (i.e., PASAT-C) or the neutral mood condition (i.e., control Math Task). After administration of the PASAT-C or Math Task, participants completed a second PANAS-NA (T2) followed by the pictorial dot-probe task.

Analytic Strategy

To determine whether the mood manipulation was effective, a 2×2 repeated measures ANOVA was conducted with mood condition (negative affect mood induction vs. neutral mood condition) as the between-group variable and T1 and T2 negative affect as the within-group variable. Next, to determine the association between attentional bias outcomes and fear-avoidance factors, a series of correlational analyses were conducted between the bias indices (i.e., attentional bias index, congruency and incongruency indices) for the negative and neutral

mood conditions and scores on the self-report measures. A repeated measures ANOVA was conducted with headache (congruency and incongruency) and neutral indices to determine whether an attentional bias existed for headache versus neutral facial expressions. To examine group differences in attentional bias by mood condition, a MANOVA was conducted with the headache and happy attentional bias indices as dependent variables and negative affect (negative affect mood induction vs. neutral mood condition) as the between groups factor. In order to address potential covariates, a MANCOVA was conducted with the same dependent and independent variables while controlling for symptoms of anxiety, depression, and stress from the DASS-21. Finally, to provide an additional examination of between-group differences, a $2 \times 2 \times 2$ repeated measures ANOVA was conducted examining negative affect (negative affect mood induction vs. neutral mood condition) as the between-group variable and headache (congruency and incongruency) and happy (congruency and incongruency) indices as within-group variables.

A hierarchical linear regression was conducted to examine whether fear of pain, negative affect (negative affect mood induction vs. neutral mood condition), and anxiety sensitivity significantly predicted attentional bias toward headache pictorial facial stimuli and to examine the potential moderating effects of negative affect (primary study goal; H_2) and anxiety sensitivity (secondary study goal; H_3). Fear of pain, negative affect, and anxiety sensitivity were entered into the first step of the model. Next, two-way (fear of pain \times negative affect and fear of pain \times anxiety sensitivity) and three-way (fear of pain \times negative affect \times anxiety sensitivity) interaction variables were entered in the second step of the model. To examine this relationship beyond symptoms of depression, anxiety, and stress, a secondary hierarchical linear regression was conducted. Depression, anxiety, and stress scores were entered as independent variables in the first step of the model and fear of pain, negative affect, and anxiety sensitivity were entered

into the second step of the model. Two and three way interaction variables for negative affect and anxiety sensitivity were entered into the final step of the model.

CHAPTER 3

RESULTS

Statistical Analyses

Data cleaning and descriptive data. Prior to conducting analyses, data were examined for missing or out-of-range values, univariate and multivariate outliers, and violations of statistical assumptions: normality, linearity, homoscedasticity, and homogeneity of data. No missing or out-of-range values were identified. One univariate outlier was identified among independent variables (i.e., ASI-3) for one participant ($Z = 3.31$; $p < .001$); however, scores for this potential outlier were less than 2 standard deviations below mean subscale and total scores observed among clinical populations (see Taylor et al., 2007) and were thus retained. All other scores on independent variables were within acceptable parameters ($Zs = -1.92 - 3.17$; $ps > .001$). One univariate outlier was identified among dependent variables ($Z = -5.24$; $p < .001$). Further examination revealed significant errors in responding for this participant (i.e., < 85% accuracy on dot probe trials), and behavioral observations confirmed that this participant failed to complete the dot probe task correctly. A Mahalanobis test also identified this participant as a multivariate outlier ($D_i = 33.80$; $p < .001$). As a result, this participant was excluded from analyses. No additional multivariate outliers were identified.

PP plots and scatter plots were used to examine normality of data, linearity, and homoscedasticity and indicated no apparent violations of assumptions. Skewness and kurtosis

were found to be within expected ranges for all variables (skewness = -.27 – 1.40; kurtosis = -1.19 – 1.27) with the exception of the headache attentional bias index (skewness = -2.37; kurtosis = 10.63). In order to address the potential effects of skewness and kurtosis, headache attentional bias index scores were transformed using a base-10 logarithmic transformation. Results remained similar when using untransformed and transformed data and thus the untransformed data were retained in all descriptive and statistical analyses (Tabachnick & Fidell, 2007).

Descriptive data for migraine-related information and self-report measures are presented in Table 1.

Manipulation check. Results of a 2 (negative affect mood induction vs. neutral mood condition) \times 2 (T1 vs. T2 negative affect) repeated measures ANOVA demonstrated a significant mood condition \times time interaction, $F(1, 64) = 14.81, p < .001, \eta_p^2 = 0.19$, indicating that the PASAT-C was effective in eliciting negative affect. Negative affect increased significantly for those administered the PASAT-C ($M_{T1} = 14.06$ vs. $M_{T2} = 20.37$) but not for those in the neutral mood condition ($M_{T1} = 12.71$ vs. $M_{T2} = 13.13$; See Table 2).

Preliminary analyses. Correlational analyses between scores on the self-report measures and the bias indices for participants in both conditions are presented in Table 3. Headache attentional bias index was significantly associated with anxiety ($r = .37, p = .04$) for those in the neutral mood condition only. All other correlations with headache attentional bias index or happy attentional bias index were not significant. Results from the repeated measures ANOVA for headache and neutral trials demonstrated no differences between the headache congruency index, headache incongruency index, and neutral index, $F(2, 64) = 0.27, p = .76; \eta_p^2 = 0.08$, indicating an absence of within-subject attentional bias for headache facial expressions relative to neutral facial expressions. The MANOVA conducted to examine the effect of mood condition on

attentional bias was also non-significant, $F(2, 63) = 1.75, p = .18$, and post-hoc ANOVAs failed to yield any significant effect of mood condition on headache, $F(1, 64) = 0.06, p = .81$, or happy, $F(1, 64) = 3.35, p = .07$, attentional bias indices. When controlling for symptoms of anxiety, depression, and stress in the MANCOVA, a significant omnibus main effect of mood condition on attentional bias was not found, $F(2, 60) = 1.81, p = .17$. Results from the 2 (negative affect mood induction vs. neutral mood condition) \times 2 (headache congruency index vs. headache incongruency index) \times 2 (happy congruency index vs. happy incongruency index) repeated measures ANOVA demonstrated no significant effect for either the headache condition, $F(1, 64) = 1.09, p = .30; \eta_p^2 = 0.02$, or the happy condition, $F(1, 64) = 2.35, p = .13; \eta_p^2 = 0.04$. All two-way and three-way interactions were nonsignificant ($ps = .13 - .76$).

Primary analyses. To examine the role of fear of pain, negative affect, and anxiety sensitivity in attentional bias toward headache facial expression stimuli, two hierarchical linear regression analyses were conducted. In the first regression, fear of pain, negative affect, and anxiety sensitivity were entered in the first step of the model, but these variables in combination failed to significantly predict headache attentional bias, $R^2 = .02, F(3, 62) = 0.50, p = .68$. The second step of the model examining two-way and three-way interactions, $\Delta R^2 = .02, F(3, 59) = 0.50, p = .69$, as well as the overall model, $R^2 = .05, F(6, 59) = 0.81, p = .81$, were not significantly associated with attentional bias to headache pictorial stimuli. No significant independent effects were observed ($ps > .05$; see Table 4).

In the second hierarchical regression analysis examining this relationship beyond relevant covariates, depression, anxiety, and stress were entered into the first step of the model but failed to significantly predict headache attentional bias, $R^2 = .08, F(3, 62) = 1.67, p = .18$. The second step of the model examining fear of pain, negative affect, and anxiety sensitivity, $\Delta R^2 = .05, F(3,$

59) = 1.02, $p = .39$, and the third step examining two-way and three-way interactions, $\Delta R^2 = .02$, $F(3, 56) = 0.31$, $p = .82$, were also nonsignificant, only accounting for an additional 4.6% and 1.5% of the variance, respectively (*Overall* $R^2 = .14$, $F[9, 56] = 0.97$, $p = .47$). Independently a significant effect was observed only for anxiety ($B = 1.28$, $p = .04$; see Table 5).

CHAPTER 4

DISCUSSION

Accumulating evidence provides support for the role of selective attentional biases (Schoth et al., 2012) and subsequent attentional avoidance of threat stimuli (Yang et al., 2013) in the development and maintenance of chronic musculoskeletal pain conditions. However, research remains limited and inconsistent in understanding the role of attentional processes in migraine, a pain condition experienced intermittently and often with less predictability than musculoskeletal pain. These qualities unique to migraine may be particularly relevant when considering that *anticipation of pain* serves to facilitate attentional engagement (Van Damme, Lorenz, Eccleston, Koster, De Clercq, & Crombez, 2004) and that unpredictable pain influences the experience of pain (Vlaeyen & Linton, 2012). The present study sought to examine specific components of the fear-avoidance model in attentional biases in migraine. Utilizing a negative affect mood induction procedure, this study examined the role of negative affect in attentional bias to pain-related pictorial stimuli among individuals with migraine.

Factors Associated with Attentional Bias to Pain-Relevant Stimuli in Migraine

Contrary to hypotheses, neither fear of pain, nor negative affect, nor anxiety sensitivity demonstrated a significant effect on attentional processing of headache-related threat stimuli (H_1). Although the manipulation check confirmed that the PASAT-C was successful in producing negative affect, those who experienced heightened negative affect did not differ from

controls in biases to threat stimuli. These results were found also for attentional bias toward positively-valenced (i.e., happy) stimuli, suggesting that attentional processing remained consistent across emotionally-valenced stimuli. All interactions between fear of pain, negative affect, and anxiety sensitivity were nonsignificant and failed to identify negative affect (H₂) or anxiety sensitivity (H₃) as moderators in the relationship between fear of pain and attentional bias. In consideration of the strengths of the present study, these findings suggest that fear of pain, state-based negative affect, and anxiety sensitivity are not associated with differentially attending to headache-related stimuli.

While our negative affect mood manipulation was successful, experimentally induced acute negative affect may be limited in ecological validity. First, naturally occurring negative affect may influence behavior differently than experimentally induced negative affect, particularly if the former reflects a longstanding trait. Differing negative mood states (e.g., anxiety vs. depression) differentially affect behavior (Raghunathan & Pham, 1999) and attentional bias (Mogg & Bradley, 2005), and the sensitivity of behavior to these states may extend also to their origin. To this point, although most apparent among those in the neutral mood condition, trait anxiety emerged as the sole independent predictor of attentional bias toward headache stimuli in the current study, potentially highlighting the role of enduring negative mood states in attentional bias. Second, definitions and manipulation of negative affect vary considerably across studies, and this heterogeneity presents considerable challenges when drawing conclusions. The current findings must be considered in light of these potential shortcomings in ecological validity.

Extension of Findings to Current Research.

Current findings contribute to a small number of studies examining attentional biases in migraine, some of which have shown associations between attentional bias and physiological reactivity. For instance, individuals with migraine demonstrate visuocortical hyperexcitability and heightened reflexive visual-spatial orienting responses to sudden environmental stimuli (Mickleborough, Hayward, Chapman, Chung, & Handy, 2011); this hyperexcitability may foster hypervigilance toward threat stimuli, although direct evidence of this proposition is largely lacking. Using eye-tracking methodology, Lioffi, Scoth, Godwin, and Liversedge (2014) found that individuals with chronic daily headache displayed increased initial orienting toward pain stimuli compared to other facial expressions. A nonsignificant trend was observed for shorter fixations on pain expressions compared to angry expressions, possibly suggesting avoidance of threat stimuli following initial vigilance (Lioffi et al., 2014). Further investigation is warranted to more appropriately elucidate factors that may differentially affect attentional biases among individuals with migraine.

The effect of pain frequency on attentional biases in headache. Although pain severity has little relation to attentional bias (Crombez et al., 2013), results from the current study and those obtained by McDermott and colleagues (2013) suggest that individuals with less frequent migraine (i.e., less than 2-3 attacks per week) do not differentially attend to threat stimuli. These findings are contrary to those obtained by Scoth and Lioffi (2010), who observed attentional biases among individuals with chronic daily headache. Taken together, these studies suggest that attentional vigilance toward threat cues may manifest only among individuals with frequent headache attacks, though whether increased hypervigilance contributes to or develops from the experience of frequent headaches is unclear. Flexible attentional processing and the ability to effectively disengage from threat stimuli may serve an adaptive role among individuals with

episodic migraine, while difficulties disengaging attention may contribute to increased frequency and chronification of chronic daily headaches. Collectively, the extant literature on attentional biases in headache suggests that these biases are most pronounced among individuals with more frequent attacks, and subsequent interventions designed to modify attentional biases are likely of most value for those with chronic headache. However, direct comparisons (e.g., episodic vs. chronic migraine) and longitudinal investigations are warranted to confirm the effect of headache frequency on attentional bias in migraine.

The effect of stimuli presentation time course on attentional biases in headache.

Imminent threat cues (Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004) capture and hold attention, such that attentional bias for threat may be driven by difficulties disengaging from threat (Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Yiend & Mathews, 2001) rather than an initial orienting response (see Koster et al., 2004). Orienting versus maintaining attention is influenced by duration of stimulus presentation. Lioffi and colleagues (2009) observed pain-related attentional biases only when stimuli were presented for a relatively long exposure duration (1250ms vs 500ms), suggestive of maintained attentional biases rather than initial hypervigilance in orienting. Indeed, meta-analytic data suggest that attentional bias may be more pronounced with increased exposure time (Crombez et al., 2013; Schoth et al., 2010). The current study's use of a 500ms presentation duration predominantly quantifies initial orienting and thus may have failed to adequately assess difficulty disengaging from threat.

Treatment Implications

Exposure-based treatment for chronic pain and migraine. Because prolonged hypervigilance and avoidance of threat cues play significant roles in the maintenance and

exacerbation of pain (Norton et al., 2003; Vlaeyen & Linton, 2000; 2012), exposure-based treatments for chronic musculoskeletal pain have gained growing empirical support. These treatments stem from anxiety conceptualizations, which posit that fear is diminished through habituation and extinction that occurs after prolonged exposure to feared stimuli (see Deacon & Abramowitz, 2004). Consistent with this notion, among individuals with social phobia pretreatment hypervigilance toward threat predicts response to exposure-based treatments (Price, Tone, & Anderson, 2011), and symptom reduction following treatment is associated with reductions in threat-related attentional biases (Pishyar, Harris, & Menzies, 2008). Similarly, preliminary studies show reductions in attentional bias toward pain-related words after successful cognitive-behavioral treatment for chronic pain (Dehghani, Sharpe, & Nicholas, 2004).

Although exposure-based treatments do not have as long a history in pain as they do in anxiety, numerous studies have demonstrated the effectiveness of interoceptive and in-vivo graded exposure for treatment of chronic pain (De Peuter, Van Diest, Vansteenwegen, Van den Bergh, & Vlaeyen, 2011; Flink, Nicholas, Boersma, & Linton, 2009), including that accompanied by fear of movement/(re)injury (Boersma, Linton, Overmeer, Jansson, Vlaeyen, & de Jong, 2004; de Jong, Vlaeyen, Onghena, Goossens, et al., 2005; Vlaeyen et al., 2001). These effects, as well as increased physical activity and decreased pain-related vigilance, are maintained at a 1-year follow-up (Vlaeyen et al., 2002). Similar approaches have shown efficacy in complex regional pain syndrome type I (de Jong, Vlaeyen, Onghena, Cuypers, et al., 2005), posttraumatic neck pain (de Jong et al., 2008), and work-related upper extremity pain (de Jong, Vlaeyen, van Eijsken, Loo, & Onghena, 2012). Taken together, these studies provide support for

the efficacy of treatments designed to reduce hypervigilance and avoidance of feared stimuli in chronic pain.

Currently, however, few studies have examined exposure-based interventions for migraine, though experimental studies have demonstrated that prolonged exposure to some headache triggers (e.g., visual disturbance, noise, stress) may be more effective in reducing pain than avoiding triggers (Martin, 2000; 2001; 2010; Martin & MacLeod, 2009; Martin, Lae, & Reece, 2007; Martin, Reece, & Forsyth, 2006). Most recently, their group has shown preliminary yet modest value of exposure-based interventions with headache triggers in a randomized controlled trial (Martin et al., 2014), though these interventions did not include exposure to migraine pain or other pain-related threat cues. If further work replicates these findings, individuals with chronic migraine may benefit from exposure-based treatments designed to reduce hypervigilance and avoidance behaviors, and attentional bias may prove to be a useful measure of treatment prognosis or outcome.

Attention modification treatment for chronic pain and migraine. Consistent with the fear-avoidance model and tenets of exposure-based treatments, attention bias modification training has emerged as an innovative intervention for anxiety (March, 2010) with implications for the treatment of chronic pain. Attention bias modification training is typically computer-based and utilizes a dot probe paradigm to train patients to shift attention from threatening to neutral stimuli. Neutral and threat-related stimuli are presented but unlike the present study, the dot probe always follows the neutral stimuli. This innovative treatment relies on exposure-based principles of habituation and extinction. Meta-analytic studies confirm a large effect of attention bias modification on reducing attentional bias and a medium effect on anxiety (Beard, Sawyer, & Hofmann; Hakamata et al., 2010; Hallion & Ruscio, 2011). Preliminary applications to chronic

pain have shown reductions in pain frequency and severity, as well as in anxiety sensitivity and pain-related fear (Carleton, Richter, & Asmundson, 2011; Sharp et al., 2012). However, these applications are relatively new and their effects on pain-related attentional bias unclear.

Continued research is necessary to establish a more comprehensive understanding of role of attentional biases in headache prior to extending this intervention to individuals with migraine.

Though the current study suggests that attention bias modification is not likely to be of value in episodic migraineurs, perhaps this intervention will show promise with chronic migraine patients.

Strengths, Limitations, and Future Directions

A number of strengths are present in the current study. This is one of the few studies attempting to validate aspects of the fear-avoidance model as it pertains to migraine and the first to employ a mood manipulation to examine negative affect in chronic pain of any type. This study was appropriately powered and utilized a well-validated structured diagnostic interview to establish migraine diagnoses. Finally, the dot probe task used in the current study provides a more appropriate measurement of selective attention than other tasks that do not require allocation of attention to stimuli simultaneously presented (e.g., the Stroop task; MacLeod et al., 1986).

However, study conclusions should be considered in light of several limitations, particularly considering the null findings. These null findings may reflect procedural confounds within the dot probe task rather than a true lack of effects, although our study was appropriately powered for the assumed effect size. First, although a pilot testing procedure was conducted to select stimuli, the pictorial facial expressions may not have conveyed sufficient threat to participants (because they convey pain in another person). As stimulus threat level is positively

related to vigilance (Yiend & Mathews, 2001), perhaps an effect would have been identified if the stimuli conveyed more direct threat to the respondent. Second, the present study used different models for each facial expression, whereas prior studies have employed the same model across expressions (see Schoth & Lioffi, 2010). Third, as mentioned earlier the short stimulus presentation time of 500ms may not have been long enough to capture difficulty disengaging from threat. Fourth, although successful in eliciting negative affect, perhaps the PASAT-C increased participation burden such that the dot probe's validity as a measure of attentional biases was diminished, though the inclusion of a control Math Task would seem to argue against this possibility. Finally, the convenience sample of young, non-treatment seeking students with low frequency attacks may limit the generalizability of these conclusions. Although young adults frequently experience migraine that is significantly disabling (Smitherman, McDermott, & Buchanan, 2011), these findings may not generalize to clinical individuals with more frequent headache attacks.

Despite limitations, the current study contributes to a small but growing body of research examining attentional bias in headache and suggests that individuals who experience episodic migraine do not selectively attend to headache-related facial expressions, even when directly experiencing negative affect. To the extent that these null findings are not attributable to methodological limitations, they call into question the utility of the fear-avoidance model in conceptualizing episodic migraine. In light of the aforementioned limitations, future research should examine the effects of time course of stimulus presentation and include direct comparisons of episodic versus chronic headache subforms. To the extent that attentional bias is identified among chronic migraineurs, treatment studies exploring the utility of progressive exposure or attention bias modification may prove valuable. As attentional bias has been

implicated in numerous disorders other than anxiety and pain (e.g., drug-related cues; Tull, McDermott, Gratz, Coffey, & Lejuez, 2011), elucidating universal attentional processes may facilitate a more unified understanding of physical and psychological dysfunction.

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APPENDIX

APPENDIX A: TABLES

Table 1. *Descriptive Information for Migraine and Psychological Variables*

	<i>Mean (SD)</i>
<hr/>	
Migraine Variables	
Pain intensity (0-10)	6.80 (1.28)
Frequency (headache days per month)	6.15 (4.92)
Attack Duration (hours)	10.64 (13.65)
Headache history (months with headache)	72.47 (55.28)
Fear of pain (PASS-20)	41.33 (17.86)
Anxiety sensitivity (ASI-3)	15.83 (11.57)
Depression (DASS-21)	3.06 (3.49)
Anxiety (DASS-21)	3.83 (3.81)
Stress (DASS-21)	7.88 (4.65)

Table 2. *Attentional Bias Indices and Negative Affect for Negative Mood Induction Condition (PASAT-C) and Control Condition (Math Task).*

	<i>PASAT-C (n=35)</i>		<i>Math Task (n=31)</i>	
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
Headache Bias Indices				
Attentional Bias Index	0.29	11.68	-0.43	11.74
Congruency Index	343.07	37.59	350.07	40.17
Incongruency Index	343.36	37.69	349.64	38.67
Happy Bias Indices				
Attentional Bias Index	-0.24	12.12	-5.59	11.58
Congruency Index	341.49	36.31	351.65	42.23
Incongruency Index	341.25	35.81	346.06	37.87
Neutral Index	344.20	37.10	350.95	42.40
Negative Affect^a				
Pre Task	14.06	4.58	12.71	3.68
Post Task	20.37	7.80	13.13	3.20

^aSignificant effect of condition (PASAT vs. Math Task) and time (Pre vs. Post) on negative affect; $p < .001$

Table 3. Correlations between Bias Incidences and Primary Variables of Interest for Negative Mood Induction ($n = 35$) and Neutral Mood Condition ($n = 31$).

	1	2	3	4	5	6	7	8	9	10	11
1. Headache Expression Congruency Index	---	.95**	-.15	.94**	.93**	-.07	.07	.06	.06	.15	.26
2. Headache Expression Incongruency Index	.96**	---	.16	.96**	.94**	-.12	.09	.11	.10	.21	.25
3. Headache Expression Bias Index	-.27	.02	---	.08	.03	-.16	.05	.14	.10	.19	-.04
4. Happy Expression Congruency Index	.91**	.92**	-.09	---	.94**	-.21	.06	.06	.06	.20	.24
5. Happy Expression Incongruency Index	.95**	.95**	-.12	.96**	---	.13	.07	.01	.09	.16	.25
6. Happy Expression Bias Index	-.20	-.23	-.04	-.49**	-.25	---	.02	-.17	.09	-.13	.02
7. Fear of Pain	-.03	-.07	-.14	-.04	.00	.15	---	.45**	.50**	.46**	.42*
8. Anxiety Sensitivity	.08	.09	.04	.02	.06	.13	.71**	---	.59**	.77**	.58**
9. Depression	.21	.29	.22	.34	.33	-.15	.44*	.39*	---	.52**	.77**
10. Anxiety	-.05	.06	.37*	.04	.03	-.05	.47**	.62**	.40*	---	.61**
11. Stress	.22	.33	.32	.30	.29	-.15	.42*	.60**	.70**	.63	---

Note. Correlations for participants in the negative mood induction are listed in the upper right half of the table (on the right side of the blank variables) and correlations for participants in the neutral mood condition are listed in the lower left half of the table.

* $p < .05$. ** $p < .01$.

Table 4. Hierarchical Linear Regression Analysis Examining Fear of Pain, Negative Affect, and Anxiety Sensitivity as Predictors of Attentional Bias to Headache-Related Pictorial Stimuli.

<i>Step</i>	<i>B</i>	<i>SE B</i>	β	<i>sr</i> ²	<i>R</i> ² (<i>Adj. R</i> ²)	ΔR^2	<i>Overall F</i>
<i>Step 1</i>					.02 (-.02)	.02	0.50
Fear of Pain	-0.10	0.10	-0.15	-.12			
Negative Affect (High vs. Neutral)	0.57	2.94	0.02	.02			
Anxiety Sensitivity	0.18	0.16	0.18	.15			
<i>Step 2</i>					.05(-.05)	.02	0.49
Fear of Pain	-0.36	0.40	-0.55	-.12			
Negative Affect (High vs. Neutral)	-3.91	8.59	-0.17	-.06			
Anxiety Sensitivity	-0.20	0.51	-0.20	-.05			
Fear of Pain × Negative Affect	0.12	0.26	0.38	.06			
Fear of Pain × Anxiety Sensitivity	0.01	0.01	0.47	.08			
Fear of Pain × Negative Affect × Anxiety Sensitivity	0.00	0.01	0.02	.00			

p* < .05. *p* < .01

Table 5. Hierarchical Linear Regression Analysis Controlling for Depression, Anxiety, and Stress, Examining Fear of Pain, Negative Affect, and Anxiety Sensitivity as Predictors of Attentional Bias to Headache-Related Pictorial Stimuli.

Step	B	SE B	β	sr^2	R^2 (Adj. R^2)	ΔR^2	Overall F
<i>Step 1</i>					.08 (.03)	.08	1.67
Depression	0.40	0.60	0.12	.08			
Anxiety	0.86	0.48	0.28	.23			
Stress	-0.31	0.51	-0.13	-.08			
					.12 (.03)	.05	1.35
<i>Step 2</i>							
Depression	0.67	0.63	0.20	.14			
Anxiety	1.23	0.57	0.41*	.27*			
Stress	-0.28	0.52	-0.11	-.07			
Fear of Pain	-0.14	0.10	-0.22	-.18			
Negative Affect (High vs. Neutral)	0.12	2.89	0.01	.01			
Anxiety Sensitivity	-0.10	0.20	-0.09	-.06			

* $p < .05$. ** $p < .01$

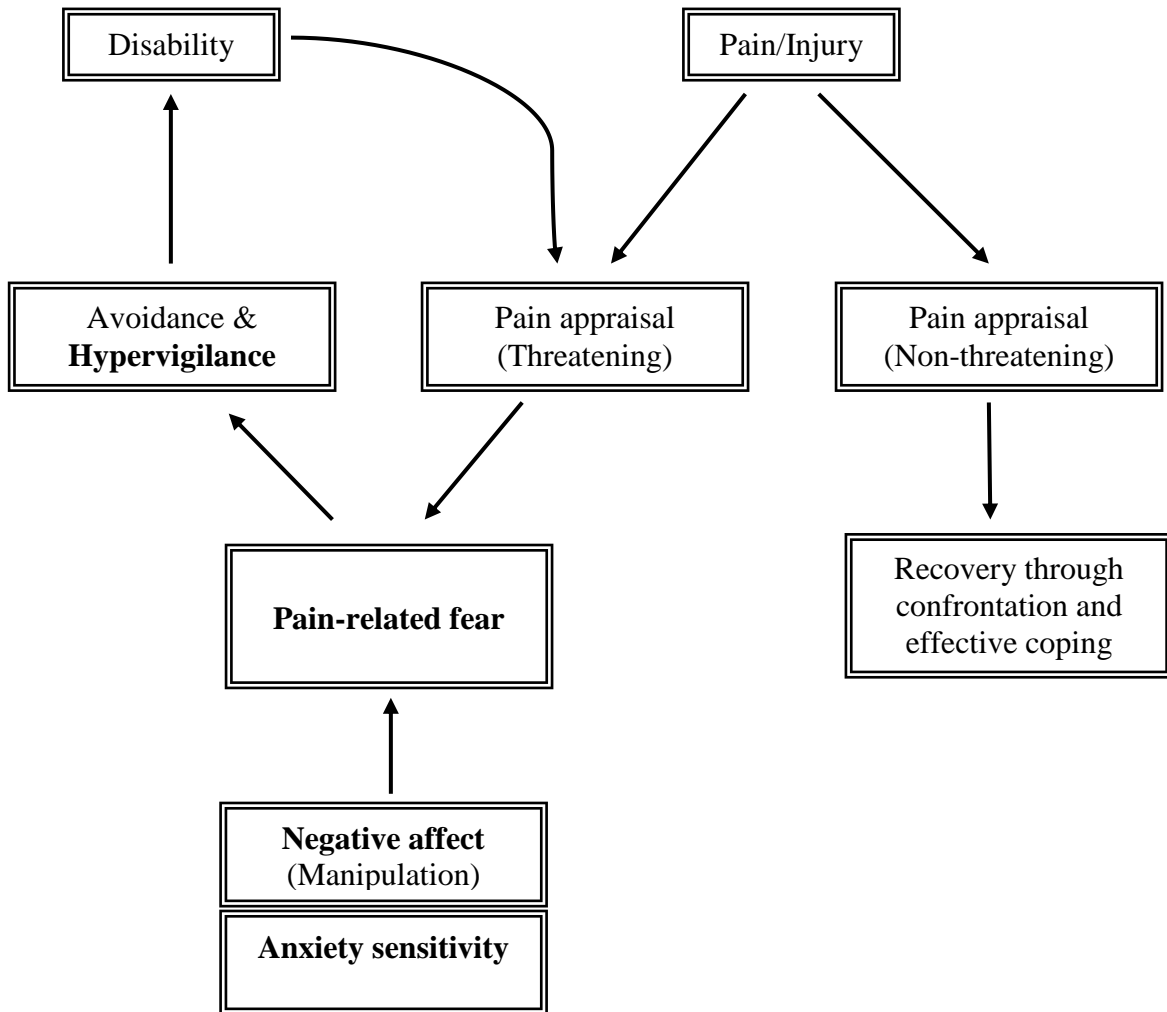
Table 5 (continued). Hierarchical Linear Regression Analysis Controlling for Depression, Anxiety, and Stress, Examining Fear of Pain, Negative Affect, and Anxiety Sensitivity as Predictors of Attentional Bias to Headache-Related Pictorial Stimuli.

<i>Step</i>	<i>B</i>	<i>SE B</i>	β	<i>sr</i> ²	<i>R</i> ² (<i>Adj. R</i> ²)	ΔR^2	<i>Overall F</i>
<i>Step 3</i>					.14 (.00)	.02	0.97
Depression	0.70	0.68	0.21	.14			
Anxiety	1.28	0.61	0.42*	.27*			
Stress	-0.34	0.55	-0.14	-.08			
Fear of Pain	-0.46	0.40	-0.70	-.15			
Negative Affect (High vs. Neutral)	-3.45	8.44	-0.15	-.06			
Anxiety Sensitivity	-0.27	0.52	-0.27	-.07			
Fear of Pain \times Negative Affect	0.17	0.26	0.54	.09			
Fear of Pain \times Anxiety Sensitivity	0.01	0.01	0.65	.12			
Fear of Pain \times Negative Affect \times Anxiety Sensitivity	-0.00	0.01	-0.44	-.09			

* $p < .05$. ** $p < .01$

APPENDIX B: FIGURES

Figure 1. *Fear and Avoidance Model of Chronic Pain* (Adapted from Vlaeyen & Linton, 2012)



APPENDIX C: ASSESSMENT MEASURES

Structured Diagnostic Interview for Headache-Revised (SDIH-R)

1. Do you ever get headaches?

- a. Yes b. No

2. On average, how many DAYS PER MONTH do you have a headache? (*select one number between 0 and 30*)

- | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |

3. If 0 is no pain, 5 is moderate pain, and 10 is the worst pain imaginable, what is the average pain intensity of these headaches? (*pick one number between 0 and 10*)

4. If left untreated or unsuccessfully treated, about how long would these headaches usually last?

- less than 30 minutes
- at least 30 minutes but less than 2 hours
- at least 2 hours but less than 4 hours
- between 4 hours and 3 days
- between 3 days and 7 days
- longer than 7 straight days

5. For approximately how long have you been having these headaches?

- Less than 3 months
- 3 months
- 4 months or more

6. About how many of these headaches have you had in your life?

- a. Less than 5
- b. 5 – 9
- c. 10 – 20
- d. More than 20

7. Which of the following best describes your pain?

- a. Pulsating/Throbbing b. Tight pressure (non-pulsating)

8. Is the pain typically experienced on one side or both sides of your head?

- a. Typically one side b. Typically both sides

9. Is the pain made worse by routine physical activities or cause you to avoid routine physical activities (like walking, bending over, or climbing stairs)?

- a. Yes b. No

10. Do you often feel nauseous or sick to your stomach during these headaches?

- a. Yes b. No

11. Do you often vomit or throw up during these headaches?

- a. Yes b. No

12. Are you often sensitive to light during these headaches?

- a. Yes b. No

13. Are you often sensitive to sound during these headaches?

- a. Yes b. No

14. Do you often experience any symptoms shortly before the headache pain actually begins, such as changes in your vision (blurry vision, seeing spots or zigzag lines), changes in your sensation (numbness, tingling), or changes in your speech?
- Yes
 - No *If “no” skip to question #16
15. If you answered “Yes” to the previous question, how many times have you experienced these symptoms before having a headache?
- 1
 - 2 – 5
 - 6 – 10
 - More than 10
16. Do you use any medications to treat these headaches?
- Yes
 - No *If “no” skip to question #20
17. If you use medication, how many days per week do you use any type of medication to treat your headaches?
- Less than 1 day per week
 - 1-2 days per week
 - 3 days per week
 - 4 or more days per week
18. How long have you been using these medications at this frequency?
- 3 months or less
 - More than 3 months
19. Did your headache develop or get worse when you started using these medications at this frequency?
- Yes
 - No
20. Did this headache develop shortly after a head injury or head trauma?
- Yes
 - No
21. Have you ever been diagnosed with cluster headaches?
- Yes
 - No
22. Do your headaches interfere with your work, school, or personal life?
- Yes
 - No

Pain Anxiety Symptoms Scale – 20 (PASS – 20)

Individuals who experience pain develop different ways to respond to that pain. We would like to know what you do and what you think about when in pain. Please use the rating scale below to indicate how often you engage in each of the following thoughts or activities.

Circle one number from 0 (NEVER) to 5 (ALWAYS) for each item.

	NEVER					ALWAYS
1. I think that if my pain gets too severe, it will never decrease.	0	1	2	3	4	5
2. When I feel pain, I am afraid that something terrible will happen.	0	1	2	3	4	5
3. I go immediately to bed when I feel severe pain.	0	1	2	3	4	5
4. I begin trembling when engaged in activity that increases pain.	0	1	2	3	4	5
5. I can't think straight when I am in pain.	0	1	2	3	4	5
6. I will stop any activity as soon as I sense pain coming on.	0	1	2	3	4	5
7. Pain seems to cause my heart to pound or race.	0	1	2	3	4	5
8. As soon as pain comes on, I take medication to reduce it.	0	1	2	3	4	5
9. When I feel pain, I think that I may be seriously ill.	0	1	2	3	4	5
10. During painful episodes, it is difficult for me to think of anything else besides the pain.	0	1	2	3	4	5
11. I avoid important activities when I hurt.	0	1	2	3	4	5
12. When I sense pain I feel dizzy or faint.	0	1	2	3	4	5
13. Pain sensations are terrifying.	0	1	2	3	4	5
14. When I hurt I think about the pain constantly.	0	1	2	3	4	5
15. Pain makes me nauseous (feel sick to my stomach).	0	1	2	3	4	5
16. When pain comes on strong I think I might become paralyzed or more disabled.	0	1	2	3	4	5
17. I find it hard to concentrate when I hurt	0	1	2	3	4	5
18. I find it difficult to calm my body down after periods of pain.	0	1	2	3	4	5
19. I worry when I am in pain.	0	1	2	3	4	5
20. I try to avoid activities that cause pain.	0	1	2	3	4	5

***Thank you for completing this questionnaire.
It will help us to better understand your pain problem.***

Positive and Negative Affect Scale – Negative Affect (PANAS-NA)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you felt this way at this very moment. Use the following scale to record your answers.

1	2	3	4	5
Very slightly or not at all	a little	Moderately	quite a bit	extremely

_____distressed

_____irritable

_____upset

_____ashamed

_____guilty

_____nervous

_____scared

_____jittery

_____hostile

_____afraid

Anxiety Sensitivity Index – 3 (ASI-3)

Please circle the number that best corresponds to how much you agree with each item. If any items concern something that you have never experienced (e.g., fainting in public), then answer on the basis of how you think you might feel *if you had* such an experience. Otherwise, answer all items on the basis of your own experience. Be careful to circle only one number for each item and please answer all items.

	Very little	A little	Some	Much	Very much
1. It is important for me not to appear nervous.	0	1	2	3	4
2. When I cannot keep my mind on a task, I worry that I might be going crazy.	0	1	2	3	4
3. It scares me when my heart beats rapidly.	0	1	2	3	4
4. When my stomach is upset, I worry that I might be seriously ill.	0	1	2	3	4
5. It scares me when I am unable to keep my mind on a task.	0	1	2	3	4
6. When I tremble in the presence of others, I fear what people might think of me.	0	1	2	3	4
7. When my chest feels tight, I get scared that I won't be able to breathe properly.	0	1	2	3	4
8. When I feel pain in my chest, I worry that I'm going to have a heart attack.	0	1	2	3	4
9. I worry that other people will notice my anxiety.	0	1	2	3	4
10. When I feel "spacey" or spaced out I worry that I may be mentally ill.	0	1	2	3	4
11. It scares me when I blush in front of people.	0	1	2	3	4
12. When I notice my heart skipping a beat, I worry that there is something seriously wrong with me.	0	1	2	3	4
13. When I begin to sweat in a social situation, I fear people will think negatively of me.	0	1	2	3	4
14. When my thoughts seem to speed up, I worry that I might be going crazy.	0	1	2	3	4
15. When my throat feels tight, I worry that I could choke to death.	0	1	2	3	4
16. When I have trouble thinking clearly, I worry that there is something wrong with me.	0	1	2	3	4
17. I think it would be horrible for me to faint in public.	0	1	2	3	4
18. When my mind goes blank, I worry there is something terribly wrong with me.	0	1	2	3	4

Scoring: Physical concerns = sum of items 3, 4, 7, 8, 12, 15. Cognitive concerns = sum of items 2, 5, 10, 14, 16, 18. Social concerns = sum of items 1, 6, 9, 11, 13, 17.

Source: Taylor, S. et al. (2007). Robust dimensions of anxiety sensitivity: Development and initial validation of the Anxiety Sensitivity Index-3. *Psychological Assessment*, 19.

Depression and Anxiety Stress Scale – 21 Item (DASS-21)

Choose the number which indicates how much the statement applied to you over the past week.

0 = Did not apply to me at all

1 = Applied to me to some degree, or some of the time

2 = Applied to me to a considerable degree, or a good part of the time

3 = Applied to me very much, or most of the time

- _____ 1. I found it hard to wind down.
- _____ 2. I was aware of dryness in my mouth.
- _____ 3. I couldn't seem to experience any positive feeling at all.
- _____ 4. I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion).
- _____ 5. I found it difficult to work up the initiative to do things.
- _____ 6. I tended to over-react to situations.
- _____ 7. I experienced trembling (e.g., in the hands).
- _____ 8. I felt that I was using a lot of nervous energy.
- _____ 9. I was worried about situations in which I might panic and make a fool of myself.
- _____ 10. I felt that I had nothing to look forward to.
- _____ 11. I found myself getting agitated.
- _____ 12. I found it difficult to relax.
- _____ 13. I felt down-hearted and blue.
- _____ 14. I was intolerant of anything that kept me from getting on with what I was doing.
- _____ 15. I felt I was close to panic.
- _____ 16. I was unable to become enthusiastic about anything.
- _____ 17. I felt I wasn't worth much as a person.
- _____ 18. I felt that I was rather touchy.
- _____ 19. I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat).
- _____ 20. I felt scared without any good reason.
- _____ 21. I felt that life was meaningless.

VITA

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EDUCATION

- July 2015
(Expected)** **Doctor of Philosophy, Clinical Psychology**
University of Mississippi (APA-accredited)
Oxford, Mississippi
Dissertation (Defended September 2014): Attentional Bias Toward Pain-Related Pictorial Stimuli among Individuals with Episodic Migraine following Negative Mood Induction (Chair: Todd A Smitherman, Ph.D.)
- July 2014-
Present** **Predoctoral Internship, Clinical Psychology**
University of Mississippi Medical Center &
G.V. (Sonny) Montgomery VA Medical Center (APA-accredited)
Jackson, Mississippi
- Dec 2011** **Master of Arts, Clinical Psychology**
University of Mississippi (APA-accredited)
Oxford, Mississippi
Thesis: Comorbid Anxiety and Depression among Adolescent Substance Use in a Community Sample (Chair: Todd A. Smitherman, Ph.D.)
- May 2007** **Bachelor of Arts, Psychology**
University of Maryland, College Park
College Park, Maryland
-

RESEARCH EXPERIENCE

**Aug 2009-
July 2014**

Graduate Research Assistant

Migraine and Behavioral Health Lab
Department of Psychology
University of Mississippi, Oxford, MS
Supervisors: Todd A. Smitherman, Ph.D. & John Young, Ph.D.

**Aug 2010-
Sept 2012**

Graduate Research Assistant

Department of Psychology
St. Jude Children's Research Hospital, Memphis, TN
Funding: NCI-CA R01-85406; PI: Vida L. Tyc, Ph.D.
Funding: NICHD R21 HD061296; PI: James L. Klosky, Ph.D.
Supervisors: Vida L. Tyc, Ph.D., Jody S. Nicholson, Ph.D., & James L. Klosky, Ph.D.

**Aug 2009-
May 2010**

Research Assistant

Personality and Emotion Research and Treatment Laboratory
Department of Psychiatry and Human Behavior
University of Mississippi Medical Center, Jackson, MS
Funding: R21 DA022383; PI: Matthew T. Tull, Ph.D.
Supervisors: Matthew T. Tull, Ph.D. & Kim L. Gratz, Ph.D.

**July 2008-
July 2009**

Research Assistant

Center for Addictions, Personality, and Emotion Research
Department of Psychology
University of Maryland, College Park, MD
Funding: R03 DA023001; PI: Matthew T. Tull, Ph.D.
Funding: R01 DA026424l; PI: Stacey B. Daughters, Ph.D.
Supervisors: Matthew T. Tull, Ph.D., Stacey B. Daughters, Ph.D., & Carl W. Lejuez, Ph.D.

**Sept 2006-
May 2007**

Research Assistant

Decision Attention and Memory Laboratory
Department of Psychology
University of Maryland, College Park, MD
Supervisor: Michael R. Dougherty, Ph.D.

**Sept 2004-
May 2005**

Research Assistant

Department of Psychology
University of Maryland, Baltimore County
Supervisor: Lowell D. Groninger, Ph.D.

TEACHING EXPERIENCE

- Spring 2014** **Instructor of Record**
Department of Psychology, University of Mississippi, Oxford, MS
Courses: Abnormal Psychology
Learning
- Fall 2013** **Instructor of Record**
Department of Psychology, University of Mississippi, Oxford, MS
Courses: Abnormal Psychology
Learning
- Spring 2013** **Guest Lecturer**
Department of Psychology, University of Mississippi, Oxford, MS
Course: Learning
Topic: Applications of operant learning theory
Instructor of Record: Scott A. Gustafson, Ph.D.
- Fall 2009** **Guest Lecturer**
Department of Psychology, University of Mississippi, Oxford, MS
Course: General Psychology
Topic: Introduction to behavioral medicine and health psychology
Instructor of Record: Todd A. Smitherman, Ph.D.
- Summer 2006** **Teaching Assistant**
Department of Psychology, University of Maryland, College Park, MD
Course: Statistical Methods in Psychology
Instructor of Record: Barry D. Smith, Ph.D.
-

CLINICAL EXPERIENCE

- July 2014-
Present** **Pre-doctoral Psychology Intern (Resident)**
University of Mississippi Medical Center & G.V. (Sonny) Montgomery
VA Medical Center, Jackson MS
Rotations: Community-based Dual Disorders Residential Treatment
Program (Harbor House Residential Substance Abuse Treatment Center),
Addictive Disorders Treatment Program, and General Psychotherapy
Clinic
Supervisors: Scott F. Coffey, Ph.D., Julie A. Schumacher, Ph.D., Daniel
C. Williams, Ph.D., & Andrew C. Voluse, Ph.D.

- June 2014-
Present** **Graduate Student Supervisor**
University of Mississippi Medical Center, Jackson MS
Supervisors: Scott F. Coffey, Ph.D., & Julie A. Schumacher, Ph.D.
- June 2010-
June 2014** **Graduate Therapist**
Psychological Services Center
University of Mississippi, Oxford, MS
Supervisors: Todd, A. Smitherman, Ph.D., Thomas W. Lombardo, Ph.D.,
& Kelly G. Wilson, Ph. D.
- July 2012-
July 2013** **Primary Mental Health Care Therapist**
Communicare (community mental health care center), Oxford, MS
Supervisor: Alan M. Gross, Ph.D., & Dixie Church, M.A., L.C.S.W.
- July 2008-
June 2009** **Diagnostic Interviewer**
Warren-Yazoo Mental Health and Residential Drug Treatment Services
University of Mississippi Medical Center, Jackson, MS
Supervisor: Matthew T. Tull, Ph.D.
- July 2007-
June 2008** **Diagnostic Interviewer**
Salvation Army Harbor Light Drug Treatment Center
University of Maryland, College Park, MD
Supervisors: Matthew T. Tull, Ph.D., & Carl W. Lejuez, Ph.D.

AWARDS AND HONORS

- 2014** University of Mississippi Department of Psychology Graduate Research Achievement Award
- 2009-2014** University of Mississippi Graduate Fellowship
- 2013** University of Mississippi Nominee for the Conference of Southern Graduate Schools Master's Thesis Award

AD-HOC REVIEWING

Annals of Behavioral Medicine
Behaviour Research and Therapy
Cognitive Therapy and Research
Headache
Journal of Abnormal Psychology
Journal of Behavior Therapy and Experimental Psychiatry
Psychotherapy: Theory, Research, Practice, Training
Traumatology

PROFESSIONAL MEMBERSHIPS

Nov 2007-Present	Association for Behavioral and Cognitive Therapies (ABCT)
Aug 2010-Present	American Psychological Association (APA)
April 2012-April 2013	Society for Behavioral Medicine (SBM)

PUBLICATIONS

Peer-Reviewed Journal Articles:

Nicholson, J. S., **McDermott, M. J.**, Huang, Q., Zhang, H., & Tyc, V. L. (in press). Smoking ban adoption after a randomized controlled trial targeting second-hand smoke exposure reduction. *Nicotine & Tobacco Research*.

Bordieri, M. J., Tull, M. T., **McDermott, M. J.**, & Gratz, K. L. (in press). The moderating role of experiential avoidance in the relationship between posttraumatic stress disorder symptoms severity and cannabis dependence. *Journal of Contextual Behavioral Science*.

Dixon-Gordon, K. L., Gratz, K. L., **McDermott, M. J.**, & Tull, M. T. (in press). The role of executive attention in deliberate self-harm. *Psychiatry Research*.

Hum, A. M., Nicholson, J. S., **McDermott, M. J.**, Klosky, J. L., & Tyc, V. L. (in press). Tobacco use and exposure among preadolescents and adolescents undergoing cancer treatment. *Journal of Pediatric Health Care*.

Klosky, J. L., Simmons, J. L., Russell, K. M., Foster, R. H., Sabbatini, G. M., Canavera, K. E., Hodges, J. R., Schover, L. R. & **McDermott, M. J.** (in press). Fertility as a priority among adolescent males newly diagnosed with cancer and their parents. *Supportive Care in Cancer*.

McDermott, M. J., Tull, M. T., Gratz, K. L., Houle, T. T., & Smitherman, T. A. (2014). Comorbidity of migraine and psychiatric disorders among substance dependent inpatients. *Headache: The Journal of Head and Face Pain*, 54, 290-302. DOI: 10.1111/head.12171

McDermott, M. J., Drescher, C. F., Smitherman, T. A., Tull, M. T., Heiden, L., Damon, J. D., Hight, T. L., & Young, J. (2013). Prevalence and sociodemographic correlates of lifetime substance use among a rural and diverse sample of adolescents. *Substance Abuse*, 34, 371-380. DOI: 10.1080/08897077.2013.776000

- McDermott, M. J.**, Nicholson, J. S., & Tyc, V. L. (2013). Accuracy and concordance in reporting for secondhand smoke exposure among adolescents undergoing treatment for cancer and their parents. *Journal of Adolescent and Young Adult Oncology*, *2*, 125-129. DOI: 10.1089/jayao.2012.0026
- McDermott, M. J.**, Peck, K., Walters, A. B., & Smitherman, T. A. (2013). Do episodic migraineurs selectively attend to headache-related visual stimuli? *Headache: The Journal of Head and Face Pain*, *53*, 356-364. DOI: 10.1111/head.12011
- Tull, M. T., Gratz, K. L., Coffey, S. F., Weiss, N. H., & **McDermott, M. J.** (2013). Examining the interactive effect of posttraumatic stress disorder, distress tolerance, and gender on residential substance use disorder treatment retention. *Psychology of Addictive Behaviors*, *27*, 763-773. DOI: 10.1037/a0029911
- Tull, M. T., Kiel, E. J., **McDermott, M. J.**, & Gratz, K. L. (2013). The effect of trauma cue exposure on cocaine cravings among cocaine dependent inpatients with and without posttraumatic stress disorder: Exploring the mediating role of negative affect and discrete emotional states. *Journal of Experimental Psychopathology*, *4*, 485-501. DOI:10.5127/jep.028812
- Smitherman, T. A., **McDermott, M. J.**, & Buchanan, E. M. (2011). Negative impact of episodic migraine on a university population: Quality of life, functional impairment, and comorbid psychiatric symptoms. *Headache: The Journal of Head and Face Pain*, *51*, 581-589. DOI: 10.1111/j.1526-4610.2011.01857.x
- Tull, M. T., **McDermott, M. J.**, Gratz, K. L., Coffey, S. F., & Lejuez, C. W. (2011). Cocaine-related attentional bias following trauma cue exposure among cocaine dependent inpatients with and without posttraumatic stress disorder. *Addiction*, *106*, 1810-1818. DOI: 10.1111/j.1360-0443.2011.03508.x
- Jakupcak, M., Tull, M. T., **McDermott, M. J.**, Kaysen, D., Hunt, S., & Simpson, T. (2010). PTSD symptom clusters in relationship to alcohol misuse among Iraq and Afghanistan war veterans seeking post-deployment VA health care. *Addictive Behaviors*, *35*, 840-843. DOI: 10.1016/j.addbeh.2010.03.023
- McDermott, M. J.**, Tull, M. T., Soenke, M., Jakupcak, M., & Gratz, K. L. (2010). Masculine gender role stress and posttraumatic stress disorder symptom severity among inpatient male crack/cocaine users. *Psychology of Men and Masculinity*, *11*, 225-232. DOI:10.1037/a0016671
- McDermott, M. J.**, Tull, M. T., Gratz, K. L., Daughters, S. B., & Lejuez, C. W. (2009). The role of anxiety sensitivity and difficulties in emotion regulation in posttraumatic stress disorder among crack/cocaine dependent patients in residential substance abuse treatment. *Journal of Anxiety Disorders*, *23*, 591-599. DOI:10.1016/j.janxdis.2009.01.006

Book Chapters:

McDermott, M. J., & Drescher, C. F. (in press). Drugs, illicit – Primary prevention strategies. In K. Heggenhougen and S. R. Quah (Eds.), *International Encyclopedia of Public Health*.

Tull, M. T., Weiss, N. H., & **McDermott, M. J.** (in press). Posttraumatic stress disorder and impulsive and risky behavior: An overview and discussion of potential mechanisms. In C. Martin, V. R. Preedy, and V. B. Patel (Eds.), *Comprehensive Guide to Post-Traumatic Stress Disorders (PTSD)*.

Klosky, J. L., Foster, R. H., Hodges, J., Peasant, C., Gamble, H., **McDermott, M. J.**, & Rao, K. P. (2012). Human papilloma virus vaccination and the primary prevention of cancer: Implications for survivors of childhood cancer. In Y. Quintana (Ed.), *Cure4Kids Global Summit: Advancing cancer education and healthy living in our communities: Studies in health technology and informatics* (pp. 33-42). Fairfax, VA: IOS Press, Inc.

Manuscripts under Review:

Tull, M. T., Gratz, K. L., **McDermott, M. J.**, Bordieri, M. J., Daughters, S. B., & Lejuez, C. W. *Examining the role of emotion regulation difficulties in the relation between posttraumatic stress disorder symptoms and the implicit association between trauma- and cocaine-related cues*. Manuscript under review.

Manuscripts in Preparation:

McDermott, M. J., & Connolly, K. M. *Examining mediators of treatment outcome for veterans treated for co-occurring PTSD and addiction*. Manuscript in preparation.

McDermott, M. J., Fulwiler, J. C., Tull, M. T., Gratz, K. L., & Smitherman, T. A. *Migraine and PTSD symptoms among inpatients with substance use disorders: Examining the interactive effect of gender*. Manuscript in preparation.

McDermott, M. J., Smitherman, T. A., Heiden, L., Damon, J. D., Hight, T. L., & Young, J. *Comorbid depression and anxiety as predictors of adolescent substance use in a rural and ethnically diverse community sample*. Manuscript in preparation.

PRESENTATIONS

Symposium Presentations:

McDermott, M. J., Fulwiler, J. C., Tull, M. T., Gratz, K. L., & Smitherman, T. A. (November, 2014). *Migraine and PTSD symptoms among inpatients with substance use disorders*. In **M. J. McDermott** (Chair), *New directions in the multidisciplinary study of PTSD: An examination of novel and understudied risk and resiliency factors*. Symposium presented at the 48th annual meeting of the Association for Behavioral and Cognitive Therapies, Philadelphia, PA.

Dixon-Gordon, K. L., **McDermott, M. J.**, Tull, M. T., & Gratz, K. L. (November, 2013). *Assessing the unsaid: Developing an implicit measure of fear of emotions*. In M. T. Tull and K. L. Dixon-Gordon (Chairs), *New frontiers in the study of emotion regulation: Innovative laboratory-based methods for the study of emotional responding and regulation*. Symposium presented at the 47th annual meeting of the Association for Behavioral and Cognitive Therapies, Nashville, TN.

Tull, M. T., Gratz, K. L., Coffey, S. F., Weiss, N. H., & **McDermott, M. J.** (November, 2012). *Examining the interactive effect of posttraumatic stress disorder, distress tolerance, and gender on residential substance use disorder treatment retention*. In K. A. Johnson and S. G. Farris (Chairs), *Emotion and addictive behavior: Basic research and innovative clinical applications*. Symposium presented at the 46th annual meeting of the Association for Behavioral and Cognitive Therapies, National Harbor, MD.

Foster, R. H., Hodges, J. R., **McDermott, M. J.**, Martin-Elbahesh, K., Pleasant, C. J., & Klosky, J. L. (April, 2012). *Examining the congruence of fertility-risk communication among families and providers in the pediatric oncology setting*. In K. Tercyak and C. J. Heckman (Chairs), *Pediatric oncology: Survivorship and prevention*. Symposium presented at the 33rd annual meeting of the Society of Behavioral Medicine, New Orleans, LA.

Klosky, J. L., Foster, R. H., Hodges, J. R., **McDermott, M. J.**, Martin-Elbahesh, K., & Pleasant, C. J. (April, 2012). *Differences in fertility risk perception among providers and families newly diagnosed with adolescent cancer: Implications for fertility preservation*. In K. Tercyak and C. J. Heckman (Chairs), *Pediatric oncology: Survivorship and prevention*. Symposium presented at the 33rd annual meeting of the Society of Behavioral Medicine, New Orleans, LA.

McDermott, M. J., Gratz, K. L., Tull, M. T., & Lejuez, C. W. (November, 2009). *The role of cognitive factors in the development and maintenance of deliberate self harm*. In A. L. Chapman and C. Schmahl (Chairs), *The role of universal cognitive and neurobiological factors in deliberate self-harm*. Symposium presented at the 43rd annual meeting of the Association for Behavioral and Cognitive Therapies, New York, NY.

Tull, M. T., **McDermott, M. J.**, Gratz, K. L., Coffey, S. F., & Lejuez, C. W. (November, 2009). *The effect of trauma-cue exposure on drug-related attentional bias among crack/cocaine users with PTSD*. In R. C. Smith (Chair), *Treatment of comorbid PTSD and stimulant use disorders: Focus on functional relations and maintaining mechanisms*. Symposium presented at the 43rd annual meeting of the Association for Behavioral and Cognitive Therapies, New York, NY.

McDermott, M. J., Tull, M. T., & Lejuez, C. W. (June, 2008). *Drug cravings following trauma cue exposure among crack/cocaine dependent patients with and without PTSD*. In J. Roache and X. Liu (Chairs), *Extinction/reinstatement: On again, off again*. Symposium presented at the 70th annual conference for the College on Problems of Drug Dependence, San Juan, Puerto Rico.

Invited Presentations:

McDermott, M. J. (June, 2012). *Secondhand smoke exposure among adolescents undergoing treatment for cancer*. Presented at St. Jude Children's Research Hospital Psychology Rounds, Memphis, TN.

McDermott, M. J., & Young, J. (August, 2010). *Trends in lifetime and current substance use rates among Mississippi adolescents*. Presented at the State Epidemiological Outcomes Workgroup, Jackson, MS.

Poster Presentations:

Nicholson, J. S., **McDermott, M. J.**, Huang, Q., Zhang, H., & Tyc, V. L. (November, 2014). *Smoking ban adoptions in the home and car for parents of children under treatment for cancer: The mediating role of self-efficacy (SE)*. Poster presentation at the 48th annual meeting of the Association for Behavioral and Cognitive Therapies, Philadelphia, PA.

Gerard, A. E., Davis, C. N., Zachary, K. F., **McDermott, M. J.**, & Smitherman, T. A. (April, 2014). *Examining acceptance as a predictor of PTSD symptoms among a large university sample*. Poster presented at the 2014 UM Conference on Psychological Science, Oxford, MS.

McDermott, M. J., Fulwiler, J. C., Tull, M. T., Gratz, K. L., & Smitherman, T. A. (November, 2013). *Comorbid migraine and PTSD among inpatients with substance use disorders: Examining the interactive effect of gender*. Poster presented at the 47th annual meeting of the Association for Behavioral and Cognitive Therapies, Nashville, TN.

Moynahan, V. L., **McDermott, M. J.**, Tull, M. T., Gratz, K. L., Houle, T. T., & Smitherman, T. A. (June, 2013). *Comorbidity of Migraine and Affective Disorders among Substance Dependent Inpatients*. Poster presented at the annual meeting of the International Headache Society and The American Headache Society, Boston, MA.

- Viana, A. G., Stevens, E. N., **McDermott, M. J.**, Clayton, T. C., Odom, K. L., & Falnes, K. (April, 2013). *Parental anxiety and coping strategies in response to children's negative affect: Associations with children's cognitive biases and anxiety symptoms*. Poster presented at the biennial meeting of the Society for Research in Child Development, Seattle, WA.
- Walters, A. B., **McDermott, M. J.**, Young, J., & Smitherman, T. A. (November, 2012). *Psychiatric comorbidity among primary episodic headache subtypes*. Poster presented at the 46th annual meeting of the Association for Behavioral and Cognitive Therapies, National Harbor, MD.
- McDermott, M. J.**, Foster, R. H., Hodges, J. R., Martin-Elbahesh, K., Pleasant, C. J., & Klosky, J. L. (April, 2012). *Fertility considerations among at-risk adolescents newly diagnosed with cancer*. Poster presented at the 33rd annual meeting of the Society of Behavioral Medicine, New Orleans, LA.
- McDermott, M. J.**, Magdovitz-Frankfurt, P., Nicholson, J. S., & Tyc, V. L. (April, 2012). *Accuracy and concordance in reporting for secondhand smoke exposure among parents and their teens undergoing cancer treatment*. Poster presented at the 33rd annual meeting of the Society of Behavioral Medicine, New Orleans, LA.
- Rao, K. P., Hodges, J. R., Foster, R. H., Martin-Elbahesh, K., **McDermott, M. J.**, Pleasant, C. J., & Klosky, J. L. (April, 2012). *Barriers and benefits of human papillomavirus (HPV) vaccination among maternal caregivers of childhood cancer survivors*. Poster presented at the 33rd annual meeting of the Society of Behavioral Medicine, New Orleans, LA.
- McDermott, M. J.**, Hodges, J. R., & Klosky, J. L. (November, 2011). *Discrepancies in communication of treatment-related fertility risk and preservation options among male adolescents with cancer: A focus group approach*. Poster presented at the 45th annual meeting of the Association for Behavioral and Cognitive Therapies, Toronto, Canada.
- McDermott, M. J.**, Davis, R., Smitherman, T. A., Gratz, K. L., & Tull, M. T. (November, 2011). *Migraine among substance dependent individuals in residential substance abuse treatment*. Poster presented at the 45th annual meeting of the Association for Behavioral and Cognitive Therapies, Toronto, Canada.
- McDermott, M. J.**, Bordieri, M., Smitherman, T. A., Heiden, L., Damon, J. D., Hight, T. L., & Young, J. (November, 2011). *The role of anxiety and depression in lifetime tobacco and alcohol use among a large rural and ethnically diverse community sample of adolescents*. Poster presented at the 45th annual meeting of the Association for Behavioral and Cognitive Therapies, Toronto, Canada.
- McDermott, M. J.**, Bordieri, M., Smitherman, T. A., Heiden, L., Damon, J. D., Hight, T. L., & Young, J. (November, 2011). *Race and comorbid anxiety and depression as predictors of adolescent lifetime illicit substance use in a rural and ethnically diverse community sample*. Poster presented at the 45th annual meeting of the Association for Behavioral and Cognitive Therapies, Toronto, Canada.

- Klosky, J. L., **McDermott, M. J.**, Foster, R. H., Gamble, H., & Rao, P. (April, 2011). *Knowledge of human papillomavirus (HPV) and vaccination among families with daughters surviving childhood cancer*. Poster presented at the National Conference of the Society of Pediatric Psychology: Division 54 of the American Psychological Association, San Antonio, TX.
- Rao, P., Foster, R. H., Gamble, H., Hodges, J., **McDermott, M. J.**, & Klosky, J. L. (April, 2011). *Sociodemographic and medical differences in the provision of acquaintance-control references among maternal caregivers of childhood cancer survivors*. Poster presented at the National Conference of the Society of Pediatric Psychology: Division 54 of the American Psychological Association, San Antonio, TX.
- Drescher, C. F., **McDermott, M. J.**, Heiden, L., Damon, J. D., Hight, T. L., & Young, J. (November, 2010). *Current substance use trends for Mississippi youth*. Poster presented at the 44th annual meeting of the Association for Behavioral and Cognitive Therapies, San Francisco, CA.
- Jakupcak, M., Tull, M. T., **McDermott, M. J.**, Kaysen, D., Simpson, T., & Hunt, S. (November, 2010). *Associations between alcohol misuse and symptoms of PTSD and depression in Iraq and Afghanistan war veterans seeking post-deployment VA health care*. Poster presented at the 44th annual meeting of the Association for Behavioral and Cognitive Therapies, San Francisco, CA.
- McDermott, M. J.**, Drescher, C. F., Heiden, L., Damon, J. D., Hight, T. L., & Young, J. (November, 2010). *Trends in lifetime substance use among Mississippi adolescents*. Poster presented at the 44th annual meeting of the Association for Behavioral and Cognitive Therapies, San Francisco, CA.
- McDermott, M. J.**, Walters, A. B., Smitherman, T. A., Gratz, K. L., & Tull, M. T. (November, 2010). *The role of anxiety sensitivity and migraine symptoms in posttraumatic stress disorder among individuals in residential substance abuse treatment*. Poster presented at the 44th annual meeting of the Association for Behavioral and Cognitive Therapies, San Francisco, CA.
- Walters, A. B., Baskin, B. L., **McDermott, M. J.**, & Smitherman, T. A. (November, 2010). *Chronic daily headache in a college population: Psychiatric comorbidity and psychiatric impairment*. Poster presented at the 44th annual meeting of the Association for Behavioral and Cognitive Therapies, San Francisco, CA.
- Klosky, J. L., Hodges, J., Foster, R., **McDermott, M. J.**, & Nobel, A. (September, 2010). *Toward establishing the ecological validity of a sperm banking questionnaire among survivors of childhood cancer: A focus group approach*. Poster presented at the 3rd annual Oncofertility Consortium meeting, Chicago, IL.

- Klosky, J. L., Hodges, J., Foster, R., Nobel, A., & **McDermott, M. J.** (September, 2010). *Querying parents about preservation: Utilizing focus group methodology for informing parent questionnaires in the study of sperm banking decision-making among adolescents diagnosed with cancer.* Poster presented at the 3rd annual Oncofertility Consortium meeting, Chicago, IL.
- Brooks, R. J., **McDermott, M. J.**, Fulton, J. J., Johnson, K., Gratz, K. L., & Tull, M. T. (March, 2010). *Risky sexual behavior: effects of cocaine dependence, PTSD, and gender.* Poster presented at the annual meeting of the Southeastern Psychological Association, Chattanooga, TN.
- McDermott, M. J.**, Tull, M. T., Soenke, M., Brooks, R. J., & Gratz, K. L. (November, 2009). *The effect of posttraumatic stress disorder on residential substance abuse treatment drop-out: Examining the mediating role of emotion dysregulation.* Poster presented at the 43rd annual meeting of the Association for Behavioral and Cognitive Therapies, New York, NY.
- Matusiewicz, A. K., Gratz K. L., **McDermott, M. J.**, & Tull, M. T. (November, 2008). *Predicting PTSD symptom severity following exposure to a potentially traumatic event: The role of temperamental vulnerabilities, emotion dysregulation, and experiential avoidance.* Poster presented at the 42nd annual meeting of the Association for Behavioral and Cognitive Therapies, Orlando, FL.
- McDermott, M. J.**, Tull, M. T., Gratz, K. L., Matusiewicz, A. K., & Lejuez, C. W. (November, 2008). *Examining distinct dimensions of emotion dysregulation as predictors of PTSD among crack/cocaine users in residential substance use treatment.* Poster presented at the 42nd annual meeting of the Association for Behavioral and Cognitive Therapies, Orlando, FL.
- Soenke, M., Matusiewicz, A. K., **McDermott, M. J.**, Tull, M. T., & Gratz, K. L. (November, 2008). *An examination of childhood maltreatment, emotion dysregulation, and deliberate self-harm as a function of a borderline personality disorder and posttraumatic stress disorder diagnosis.* Poster presented at the 42nd annual meeting of the Association for Behavioral and Cognitive Therapies, Orlando, FL.
- Soenke, M., **McDermott, M. J.**, Gratz, K. L., Jakupcak, M., & Tull, M. T. (November, 2008). *The role of masculine gender role stress in posttraumatic stress disorder among male crack/cocaine users in residential substance abuse treatment,* Poster presented at the 42nd annual meeting of the Association for Behavioral and Cognitive Therapies, Orlando, FL.
- Weitzman, M. L., Gratz, K. L., **McDermott, M. J.**, Tull, M. T., & Lejuez, C. W. (November, 2008). *The interrelationship of trait vulnerabilities, childhood abuse, and childhood borderline personality symptoms.* Poster presented at the 42nd annual meeting of the Association for Behavioral and Cognitive Therapies, Orlando, FL.

Richards, J., Tull, M. T., Gorka, S., **McDermott, M. J.**, Daughters, S. B., & Lejuez, C. W. (June, 2008). *Examination of a brief adjunctive interoceptive-based intervention for heroin users with high anxiety sensitivity*. Poster presented at the 70th annual conference of the College on Problems of Drug Dependence, San Juan, Puerto Rico.

McDermott, M. J., Tull, M. T., Malouf, E. T., Daughters, S. B., Lejuez, C. W., & Gratz, K. L. (March, 2008). *Examining the role of anxiety sensitivity and emotion dysregulation in PTSD among crack/cocaine users*. Poster presented at the 28th annual conference of the Anxiety Disorders Association of America, Savannah, GA.

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