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Pain tolerance and thresholds in women with dyspareunia: Do pain and sex primes have differential effects?

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PAIN TOLERANCE AND THRESHOLDS IN WOMEN WITH DYSPAREUNIA:

DO PAIN AND SEX PRIMES HAVE DIFFERENTIAL EFFECTS?

by

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ABSTRACT

**Pain tolerance and thresholds in women with dyspareunia:
Do pain and sex primes have differential effects?**

by

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Dyspareunia, defined as recurrent pain in the genital/pelvic region during sexual intercourse, is one of the most common types of female sexual dysfunction, affecting approximately 15% of women between the ages of 18 and 24. Women with dyspareunia display similar cognitive and emotional styles evidenced in other chronic pain conditions (e.g. hypervigilance for pain information, catastrophization, and negative affect); however, dyspareunia is a unique pain disorder in that it directly involves sexual functioning. This pairing of pain and sex raises the issue of conditioning. Is it possible that because intercourse is painful for women with dyspareunia, the presentation of any sexual stimuli would evoke similarly negative reactions as do pain stimuli (e.g. fear, avoidance, negative affect or decreased sexual responding)? The primary purpose of this study was investigate the extent to which sexual stimuli might have become conditioned to affect pain perception. We attempted to do this by trying to tease apart the impact of sexual and pain primes on the experience of experimentally-induced pain in women with dyspareunia in comparison to controls. Sixty no-dysfunction control women and 38 women with dyspareunia were randomly assigned to be exposed to pain or sex primes prior to the administration of a cold-pressor test assessing pain threshold and tolerance. A

secondary aim of the study was to compare sexual function and cognitive-affective variables such as pain catastrophization, somatosensory amplification and overall mental health between women with dyspareunia and non-pain controls. The relationship between pain threshold and tolerance and cognitive-affective variables were also explored. Results indicated that overall, women with dyspareunia had lower pain threshold and tolerance levels than no-dysfunction women; however, there was no effect of priming condition on pain perception, nor any interaction as a function of condition and group. Women with dyspareunia displayed lower levels of sexual function and higher levels of pain catastrophization than controls. For all women, pain tolerance and threshold were related to pain catastrophization. For women with dyspareunia, pain characteristics such as reported sexual pain intensity, distress, and duration were significantly correlated with sexual function and pain catastrophization variables. Results are interpreted to indicate that women with dyspareunia display a general sensory dysregulation and heightened levels of pain-related fear, similar to other chronic pain conditions. Dyspareunia may thus best be conceptualized as a pain disorder that interferes with sexual function. Our findings further highlight that sex and pain may not be one and the same for women with dyspareunia and that current Cognitive Behavioral Therapy protocols are well advised in 1) encouraging women to engage in non-penetrative sexual activity to increase sexual function; and 2) targeting maladaptive cognitions related to pain to help women cope with and ultimately decrease their pain experience.

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CHAPTER 1

Introduction

Dyspareunia, defined as recurrent pelvic or genital pain during sexual intercourse, is experienced by approximately 15% of women (Schultz et al., 2005) and is one of the most common types of female sexual dysfunction encountered in both general and gynecological practice (Wouda et al., 1998). To date, this disorder is ill understood. Various etiologies have been proposed, ranging from malformations of the genitals, to chronic infections, to prior aversive sexual experiences (Meana & Binik, 1994). It is often the case, however, that a clear cause for any one woman's dyspareunic pain is hard to isolate, even when physiological pathology seems to exist. For example, even in certain subtypes of dyspareunia wherein the pain is felt in a very small and specific genital region [i.e., Provoked Vestibulodynia (PVD), formerly known as Vulvar Vestibulitis Syndrome (VVS), a condition in which severe pain is elicited upon light stimulation of the vulvar vestibule (see Figure 1)], we still do not know how or why this tiny area becomes hyperalgesic.

What we do know is that women with the most common type of dyspareunia (PVD/VVS) suffer from a higher sensitivity to touch and pain in the genital region as compared to women without dyspareunia, even when the stimulation is of a non-sexual nature. The fact that this pain can be independent of sexual activity has led many researchers and clinicians to view dyspareunia as a pain disorder rather than a sexual dysfunction, albeit one that interferes directly with sexual functioning. As is the case in

other pain disorders, the genitally localized pain in certain types of dyspareunia appears to be accompanied by a more general sensory dysregulation. Women with dyspareunia are more sensitive to touch and pain stimuli at non-genital sites, such as the arm, leg, and inner thigh. The presence of this overall heightened sensitivity to touch and pain is likely to have cognitive and emotional correlates. Research on chronic pain conditions, such as lower back pain and fibromyalgia, demonstrates that patients with these pain syndromes have an attentional bias to pain, and higher levels of negative affect and catastrophizing as compared to pain-free individuals. Women with dyspareunia also exhibit these cognitive and emotional pain correlates. In comparison to control women, women with dyspareunia tend to pay more attention to pain-relevant information than to other types of emotional material (e.g., threat or sexual), display more fear of pain and higher vigilance to pain, evidence more somatic complaints and preoccupation with these, have higher levels of anxiety and depression, and are more prone to catastrophize pain.

Given the importance of cognitive variables in the experience of dyspareunia, Cognitive Behavioral Therapy (CBT) has become a widely-used treatment for persistent pain during intercourse. CBT for dyspareunia aims to reduce the pain experienced during sexual intercourse. It also targets both the cognitions associated with pain and the sexual difficulties that result from experiencing pain during sex. One common CBT intervention for dyspareunia de-emphasizes penetrative activities and, instead, asks couples to focus on sexual activities that do not involve pain (e.g., kissing, manual stimulation, oral stimulation). This CBT component is based on the notion that women with dyspareunia are able to tease apart the sex from the pain that usually accompanies it. The outcome literature, however, shows that while CBT has shown some effectiveness in decreasing

pain, it does not appear to be as successful in increasing sexual activity (Bergeron et al., 2001). This may be explained by the theoretically sound but untested hypothesis that, due to a classical condition process of sex being paired with pain over time, women with dyspareunia may come to associate all sexual activity with pain and its cognitive correlates (fear, anxiety, hypervigilance, catastrophization). Pain and sex may thus become indistinguishable. In order to increase our effectiveness in un-coupling the pain from the sex, it might be fruitful to investigate the possibility that sex may be acting as a pain stimulus. Do women with dyspareunia respond in similar manners to both pain and sex stimuli, indicating that pain and sex have become one and the same? Or, alternately, do pain stimuli produce different effects from sexual stimuli, indicating that sex has not yet attained the same cognitive status as pain?

This study will aim to investigate one dimension of these questions: the effect of pain and sex stimuli on the experience of experimentally induced pain via a cold-pressor test. The following literature review will first acquaint readers with the characteristics of genital pain in women with dyspareunia, as well as the general sensory dysregulation exhibited by women who suffer from this disorder. Next, cognitive and emotional factors associated both with chronic pain and dyspareunia will be reviewed, along with a brief explication of cognitive interventions and their efficacy.

CHAPTER 2

Understanding Genital Pain in Women with Dyspareunia

Dyspareunia is a sexual dysfunction that has been documented for many years. It may be the earliest recognized sexual dysfunction, according to a detailed clinical description in ancient Egyptian scrolls (Costatalens & Colorado, 1971). Until the end of the 19th century, dyspareunia was considered a physical problem of unknown etiology. As psychology emerged as a science in the 20th century, interest in dyspareunia did not appear to flourish (Meana & Binik, 1994). Much as in the case of other health and psychological problems experienced exclusively by women, dyspareunia was relegated to the realm of hysteria. Although the explosion of research on sexuality in the 1960s and 70s did extract dyspareunia from explanations linked to hysteria, research on dyspareunia remained scarce (Meana & Binik, 1994). It was not until the 1990s that dyspareunia finally caught the interest of the research and clinical communities and that some light was shed on this perplexing disorder.

Meana, Binik, Khalifé, and Cohen (1997a) were the first to systematically research the genital pain reported by women with dyspareunia. They obtained descriptions of the pain symptomatology in 112 women with dyspareunia (19-65 years old) through the administration of a standardized interview and pain measures. They also had women undergo gynecological exams and a series of cytological cultures. The majority of women in the study reported that the onset of their pain occurred at the moment of penile entry, with the pain experienced in two main areas: the introitus (vulvar

entry to the vagina), inside the vagina, or in both of these areas simultaneously. Descriptions of the intensity of the pain revealed that it was rated as equally or more severe than the pain associated with a number of recognized pain syndromes that had long held the attention of the medical establishment. Based on the physical findings from the gynecological exams, four diagnostic groups were identified. The first group, comprising 24% of the sample, had no physical findings that could reasonably be linked to their pain. The second group (46%) suffered from vulvar vestibulitis syndrome (VVS; currently referred to as provoked vestibulodynia [PVD]). This syndrome is characterized by a reliably hyperalgesic area in the vulvar vestibule thought to be linked to nerve dysfunction (Bohm-Starke, 2001). The vulvar vestibule is an area in the genitals located posterior to the glans clitoris between the labia minora, and contains the vaginal and urethral openings (see Figure 1). The third group, comprising 13% of the sample, had vulvar/vaginal atrophy associated with menopausal estrogen deficiency and the fourth group (17%) had mixed physical findings (more than one physical problem that could reasonably be linked to pain during intercourse). The qualitative descriptions of the pain offered by women in these four groups were also quite different. The authors concluded that dyspareunia was probably a heterogeneous disorder that was characterized by a pain comparable with other serious pains on a number of dimensions, including its intensity and persistence (Meana et al., 1997a).

After determining that the genital pain experienced by women with dyspareunia was recurrent, persistent, distressing and that its presentation varied depending on hypothesized etiology, Meana and colleagues (1997b) compared women with dyspareunia to women with no genital pain on a number of factors hypothesized to be

relevant to the etiology of dyspareunia in the literature at that time. They compared the pain-free controls and the women with dyspareunia on physical pathology, pain associated with genital contact other than intercourse, psychological well-being, relationship adjustment, and sexual functioning. Women with dyspareunia were found to have more physical pathology and a more complicated gynecological history than women without coital pain. They also reported pain with gynecological exams, tampon insertion and finger insertion more than did controls. Importantly, they did not report a greater number of other non-genital pains, as had often been assumed in a literature that had all too often considered these women to be somatizers. Women with dyspareunia did report more deficits in sexual function; lower frequencies of intercourse and masturbation, less desire and arousal, and fewer orgasms than control women. In addition, women with dyspareunia had a greater number of psychological symptoms, notably interpersonal sensitivity, depression and phobic anxiety. They also reported lower levels of relationship adjustment and more negative attitudes about sexuality than control women, but did not report a higher incidence of physical or sexual abuse (Meana et al, 1997b).

With the pain of dyspareunia established as severe and not simply a symptom of somatization disorder, the next step for researchers was to systematically examine the properties of this pain, much as had been traditionally done for other pain syndromes. Pukall and colleagues (2002) examined tactile and pain thresholds in the genital region of women with VVS/PVD and age- and contraceptive-matched, pain-free controls. Thirteen women with VVS/PVD and 13 control women underwent a gynecological examination and sensory testing. The gynecological examination consisted of the cotton-swab test which constitutes the main gynecological diagnostic tool for VVS/PVD (Friedrich, 1987).

With a cotton-swab, a gynecologist palpated six randomly ordered sites around the vulvar vestibule. Pain ratings were recorded during the examination (Pukall, Binik, Khalifé, Amsel, & Abbott, 2002). Sensory testing included assessing touch and pain thresholds in the genital region (labia and various sites on the vulvar vestibule) using modified Von Frey filaments. The Von Frey filament method of assessing sensitivity consists of pressing a calibrated filament to the skin with just enough pressure to make the filament buckle. A thin filament will buckle with little pressure while a thicker one will require more pressure to buckle. This is a method of standardizing the quantification of sensory sensitivity.

Results indicated that in women suffering from VVS/PVD, the thresholds for both tactile and pain sensation in the vulvar vestibule were dramatically lower than in control women, with the vestibular *pain* thresholds of women with VVS/PVD being closer to the vestibular *tactile* thresholds of control women than to the latter's pain thresholds. In other words, what felt like touch to control women felt like pain to the women with VVS/PVD. Even more pointedly, the stimulus levels at which women with VVS/PVD reported tactile sensations were imperceptible to control women. Furthermore, they displayed significantly lower tactile thresholds than control women even on the labia minora. The data indicated that the sensory pathology in VVS/PVD is not limited to pain, but extends to other somatosensory modalities as well (Pukall et al., 2002).

Because of methodological difficulties with the use of the cotton-swab test as well as the Von Frey filaments for diagnosing dyspareunia (e.g., different gynecologists applying different amounts of force during palpation or filament pressure), Pukall, Binik, and Khalifé (2004) developed a new instrument they called the vulvalgesiometer to

assess pain in the vulvar region. This device controls the amount of pressure applied and thus rules out variations in clinician exerted pressure. The use of this device has confirmed repeatedly that women with VVS/PVD have significantly lower pain thresholds in the vulvar vestibule than do control women (Pukall, Young, Roberts, Sutton, & Smith, 2007; Sutton, Pukall, & Chamberlain, 2009).

Other studies and experimental conditions have also confirmed consistent differences in touch and pain thresholds between dyspareunia and control women. Payne and colleagues (2007) examined whether sexual arousal influenced genital and non-genital sensation differentially in women with VVS/PVD and in controls. The authors used modified Von Frey filaments (the same used by Pukall and colleagues in 2002) to assess touch thresholds and a vulvalgesiometer to ascertain pain thresholds in the vulvar vestibule. Results again confirmed that women with VVS/PVD had lower vulvar and labia minora pain thresholds across all arousal conditions (baseline and in response to neutral and erotic films) as compared to the control group.

In an attempt to investigate central nervous system (CNS) correlates of genital pain, Pukall and colleagues (2005) examined the neural basis of heightened sensitivity to touch in women with VVS/PVD using functional magnetic resonance imaging (fMRI). Mild and moderate pressure was applied to the posterior portion of the vulvar vestibule using a vulvalgesiometer. All women with VVS/PVD described moderate pressure as painful and unpleasant, and almost half of the women with VVS/PVD described mild pressure as painful and unpleasant. In contrast, none of the stimuli was reported as painful by control women. During pressure described as painful by women with VVS/PVD, higher activation levels in the insular and frontal cortical regions were

evidenced in comparison to control women. The authors suggested that women with PVD exhibit an augmentation of genital sensory processing similar to that observed for a variety of syndromes causing hypersensitivity, including fibromyalgia, idiopathic back pain, irritable bowel syndrome, and neuropathic pain (Pukall et al., 2005).

Bohm-Starke, Hilliges, Brodda-Jansen, Rylander, and Torebjörk (2001) performed sensory testing in the vestibular mucosa of 22 women with VVS/PVD and 20 control subjects. Von Frey filaments were used for punctate mechanical stimulation. In addition, an area of the vestibular mucosa was warmed or cooled using a thermal stimulator, vibratory evoked pain was tested by a hand-held vibrating stimulator, and the vaginal introitus was dilated using a small soft rubber balloon. The authors found that compared to the control participants, women with VVS/PVD had allodynia (pain elicited by stimuli that are not normally painful) to testing with Von Frey filaments in the vestibule. When dilating the vaginal introitus, participants were instructed to indicate when the first sensation of pain occurred, at which point the dilation was interrupted. The mean pressure at which the distension was interrupted in women with VVS/PVD was significantly lower than in control subjects. The authors concluded that patients with VVS/PVD have an increased innervation and/or sensitization of thermoreceptors and nociceptors in their vestibular mucosa (Bohm-Starke et al., 2001).

Lowenstein and colleagues (2004) examined touch and pain thresholds using Von Frey filaments, as well as hyperalgesia to heat in the vulvar vestibule among patients with moderate and severe VVS/PVD and healthy controls. The authors also examined pain sensitivity in response to very intense stimuli. The first, a heat stimulus, was applied at 43º C for one minute and the second, intense stimulus consisted of Von Frey filaments

exerting a log force value of 4.17. Participants were asked to rate the level of pain they felt. Heat pain thresholds, and tactile and pain thresholds were significantly lower in the VVS/PVD group than in the control group. Furthermore, the VVS/PVD women gave significantly higher pain intensity ratings to both types of extreme stimulation as compared to controls (Lowenstein et al., 2004).

In summary, recent research into the properties of the pain of dyspareunia has illustrated that many women suffering from this sexual pain problem experience pain in the vulvar vestibule and in other vaginal/vulvar regions and that they are more sensitive to touch and pain in the genital region than women who do not experience pain with intercourse. Results of the aforementioned studies suggest that there are structural and functional abnormalities of the peripheral sensory nerves in the vestibular mucosa in women with the most common type of pre-menopausal dyspareunia, VVS/PVD (Bohm-Starke, 2001). Somatosensory abnormalities characterized by decreased pain thresholds for mechanical and thermal stimuli are considered psychophysical evidence of peripheral sensitization and/or an increased number of nociceptors in the vestibular mucosa (Bohm-Starke, 2001). However, this increased sensitivity is not limited to genital sites. Much evidence for a more generalized sensory dysregulation in women with dyspareunia can be found in the literature.

CHAPTER 3

Sensory Dysregulation in Women with Dyspareunia

It is abundantly clear that many women with dyspareunia display a hypersensitivity to pain in the genital region. Of even greater interest is the fact that this hypersensitivity appears to generalize to non-genital regions. In addition to investigating genital tactile and pain thresholds in women with VVS/PVD, Pukall and colleagues (2002) examined sensory function at non-genital sites. With the same Von Frey filaments used to test touch and pain thresholds in the vulvar vestibule, the authors tested the inner thigh, the arm over the deltoid muscle, the volar surface of the forearm 4 inches above the wrist, and the tibia 5 centimeters below the knee on the dominant side of the participant (Pukall et al., 2002). They found that women with VVS/PVD had significantly lower tactile thresholds than control women on the deltoid and that trends toward lower thresholds over most other sites tested were evident. Furthermore, pain thresholds in the VVS/PVD group were substantially lower than in controls on the deltoid and the forearm. Pressure pain tolerance, defined as the highest pressure one can endure, was measured using a pressure tolerance meter (a device consisting of a rubber disk attached to the pole of a pressure gauge which indicates the amount of pressure being exerted usually in kg/cm^2). Pressure pain tolerance was assessed over the deltoid muscle and the tibia 5 cm below the knee. Pressure was increased manually until the supine participant said that it was no longer tolerable. Women with VVS/PVD tolerated less pressure in both areas than did controls. The data suggest that VVS/PVD involves a generalized sensory abnormality

that is not restricted to the vulvar region or even to pain. The authors propose that because VVS/PVD appears to involve a generalized alteration of cutaneous sensory sensitivity, generalized changes in somatosensory function may play as important a role as they do in other chronic pain conditions.

Further studies have provided more evidence for the notion of generalized somatosensory changes in women with VVS/PVD. Using the same Von Frey filaments, Payne and colleagues (2007) also found that women with VVS/PVD had lower pain thresholds at the forearm compared to control women. These data replicated the generalized sensory abnormality found in other studies. Pukall, Baron, Amsel, Khalifé, and Binik (2006) assessed whether generalized pain sensitivity in women with VVS/PVD was higher than in controls by having 16 women with VVS/PVD and 16 control women undergo the Tender Point (TP) examination, typically used in the diagnosis of Fibromyalgia (FMS). The exam consists of the palpation of 9 bilateral non-vulvar areas by a blinded rheumatologist. Pain intensity and unpleasantness ratings (0 to 10) were recorded after each palpation. Women with VVS/PVD had significantly more painful TPs than control women. In addition, they reported significantly higher pain intensity and unpleasantness ratings. These results suggest that the mechanisms involved in VVS/PVD may extend beyond the genitals and point to a more generalized, and possibly centrally mediated mechanism. In an examination of systemic pain perception in women with VVS/PVD, Granot, Friedman, Yarnitsky, and Zimmer (2002) applied heat pain stimuli to participants' forearms and assessed pain and unpleasantness thresholds, as well as estimation of perceived intensity and unpleasantness of suprathreshold stimuli. Women with VVS/PVD had lower pain thresholds, lower unpleasantness thresholds, and a higher

magnitude estimation of suprathreshold pain than control women. In another study, Granot and Lavee (2005) assessed non-genital systemic pain perception with quantitative sensory testing by administering experimental pain stimuli to the forearm of 28 women with VVS/PVD and 50 controls. The VVS/PVD group demonstrated a lower pain threshold and a higher magnitude estimation of pain. In yet another study, Granot (2005) tested 98 women with VVS/PVD and 135 control participants using a heat thermode applied to the volar forearm of the non-dominant hand. The women in the VVS/PVD group exhibited enhanced pain perception in comparison with the control participants, as noted by their lower pain thresholds and higher visual analog scale (VAS) scores in response to the suprathreshold painful stimuli.

To date, the majority of studies examining generalized sensory dysregulation in women with VVS/PVD, the most common sub-type of dyspareunia, have investigated pain thresholds and evaluations of pain intensity. Only one study has examined pain tolerance in women with VVS/PVD. Johannesson, de Boussard, Jansen, and Bohm-Starke (2007) investigated whether patients with VVS/PVD and healthy women taking or not taking combined oral contraceptives (COC) displayed a diffuse noxious inhibitory control (DNIC) response to cold noxious stimulation. DNIC refers to a phenomenon whereby some neurons in the dorsal horn of the spinal cord are strongly inhibited when a painful stimulus is applied to any part of the body, distinct from their excitatory receptive fields. (Le Bars, Villanueva, Bouhassira, & Willer, 1992). Pressure pain tolerance (PPT), using a pressure algometer, was measured on the arm and leg before and during a cold-pressor test in 20 patients with VVS/PVD not using combined oral contraceptives (COC), 20 healthy women on COC and 20 healthy women not on COC. Results revealed that

general pressure pain thresholds (PPTs) in the VVS/PVD participants were lower prior to the cold noxious stimulus as compared to the healthy women irrespective of COC status. In response to the cold noxious stimulus, all women displayed a DNIC response indicating an endogenous pain inhibition (Johannesson, et al., 2007). There were no group differences. However, the VVS/PVD participants reported more bodily pain manifested as headache, muscle ache, low back pain and dysmenorrhea than healthy women in general. The authors concluded that the DNIC response indicating an endogenous pain inhibition was not exclusive to the VVS/PVD group but that baseline PPT's and general pain reports continue to imply a systemic hypersensitivity in women with vestibulodynia.

The fact that women with the most common type of dyspareunia display sensory dysregulation at various body regions (e.g., arm, leg) has important implications for the conceptualization and understanding of this complex disorder. The evidence of sensory dysregulation that generalizes beyond the vaginal, vulvar or genital region, reaffirms that dyspareunia may in fact be a) a serious pain syndrome akin to other pain syndromes that have long been taken much more seriously by health professionals, and b) not etiologically linked to psychosexual disturbances. Furthermore, the existence of an overall heightened sensitivity to touch and pain is likely to have cognitive and emotional correlates. Persistent, severe, and distressing pain alters one's relationship with one's body and is likely to create anxiety and result in a series of cognitive and behavioral strategies aimed at coping with the impending threat of pain. In the next section, evidence will be reviewed suggesting that women with dyspareunia cognitively process bodily sensations and pain stimuli differently than do control women.

CHAPTER 4

Cognitive, Emotional and Relational Factors Associated with Chronic Pain and Dyspareunia

As sexuality researchers focused their attention on the properties and physiological correlates of dyspareunia, they were also starting to ask questions about the cognitive profile of women living with this pain syndrome. Other chronic or recurrent pain syndromes appeared to be characterized by certain cognitive, emotional, and relational styles, as will be reviewed in this section. Perhaps dyspareunia would also have a cognitive signature.

Chronic Pain

Decades of research have demonstrated the mediating role of cognition and emotion in the phenomenology of chronic pain. The Gate Control Theory of Pain, proposed by Melzack and Wall (1965), was the first theory of pain to incorporate the central control processes of the brain (Melzack & Katz, 2004). It proposed that the transmission of nerve impulses from afferent fibers to spinal cord transmission cells is modulated by a gating mechanism in the spinal dorsal horn. The gating mechanism is influenced by the relative amount of activity in large and small diameter fibers, such that small fibers open the gate (i.e. facilitate transmission) whereas large fibers close the gate (inhibit transmission). In addition, the gating mechanism is influenced by nerve impulses that descend from the brain. When the output of spinal transmission cells exceeds a critical level, it activates the action system composed of neural areas that underlie the

complex, sequential patterns of behavior and experience that are characteristic of pain. Previous theories of pain had dismissed psychological factors as simply reactions to pain, yet the Gate Control Theory posited these factors as integral components of pain processing, thereby opening new avenues for pain control through psychological therapies (Melzack & Katz, 2004).

Numerous cognitive factors have been shown to be associated with the experience of chronic pain. Of interest to this review are attentional factors (including hypervigilance, anxiety sensitivity, and somatic preoccupation), negative affect, and pain catastrophization.

Attention.

Attentional factors in the experience of pain have been investigated extensively. The clinical presentation of many chronic pain patients involves a persistent, distressing and preoccupying pain that cannot be explained easily by observable biomedical phenomena (Crombez, Van Damme, & Eccleston, 2005). Patients are thought to display a 'hypervigilance' to pain and pain-associated information that emerges when a person's current goal is understandably related to avoidance and escape from pain. Patients may ruminate about the ineffectiveness of previous medical interventions and continue to seek ways to control their pain. They may fear pain or (re)injury during the accomplishment of daily activities. They may worry about pain and catastrophize about the negative impact of pain upon their life and identity (Crombez, Van Damme, & Eccleston, 2005). In these situations, hypervigilance to pain or pain-related information emerges (Aldrich, Eccleston, & Crombez, 2000). Hypervigilance models of pain perception propose that certain chronic pain patients have heightened sensitivity to experimentally induced pain,

showing increased attention to external stimulation and a preoccupation with pain sensations (McDermid, Rollman, & McCain, 1996).

Hypervigilance to pain is also thought to be an automatic process with recent experiments suggesting that hypervigilance is unintentional (Crombez, Van Damme, & Eccleston, 2005). A prime characteristic of these experiments is that the processing of pain or pain-related information is irrelevant or, sometimes, counterproductive to the task at hand. One example is the primary task paradigm, in which participants have to perform an auditory discrimination task as quickly as possible in the presence of painful distracters (Crombez, Eccleston, Baeyens, & Eelen, 1998). Although the processing of pain-related information was irrelevant and not instrumental for immediate escape and avoidance in this experimental paradigm, clear attentional effects were found such that a low-intensity stimulus interfered with the performance of an auditory discrimination task in participants who catastrophized about pain and were threatened by the possibility of high intense pain (Crombez et al., 1998). In other studies, participants were more attentionally engaged with and had difficulties disengaging attention from pain signals (Van Damme, Crombez, & Eccleston, 2004). In particular, the difficulty disengaging attention from pain-related information has been found to be characteristic of anticipating pain. Research has revealed that these attentional effects are threat-related and not unique to pain (Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004).

Other research has demonstrated that hypervigilance to pain is pervasive and often occurs with attentional interference in patients with chronic pain. Attentional interference in pain typically has been investigated using the Emotional Stroop Task and other related tasks (e.g., primary task paradigm, numerical interference task). In these

tasks, slower response times to a particular stimulus or class of stimuli indicate attentional interference, such that presented information detracts attention from the task at hand. Using a Stroop Task, Pearce and Morley (1989) demonstrated that patients with chronic pain showed more interference to words drawn from the McGill Pain Questionnaire (Melzack, 1975) than did no-pain controls. Using a computer version of the Emotional Stroop Task, a study investigating attentional bias to pain-related information in chronic low back pain patients demonstrated that these patients were slower in color naming of sensory pain words (i.e., flickering, stiff, shooting, etc.) as compared to neutral control words (Crombez, Hermans, & Adriaensen, 2000). Furthermore, the patients' current pain intensity was the best predictor of attentional bias to sensory pain words, such that the attentional bias to these words increased with pain intensity. These results highlight the notion that the mere representation of pain (in the form of words or even pictures) can activate a heightened emotional experience and elicit attention interference in patients with chronic pain.

Eccleston (1995) conducted two experiments examining the role of sustained and shifting attention in chronic pain processing using a numerical interference task. He found that chronic pain patients suffering high intensity pain showed significantly impaired performance on the attention-demanding task when compared with those suffering low pain and those with no chronic pain condition. He concluded that pain seems to negatively affect tasks that require central attentional control. Later studies, also investigating sustained and shifting attention in chronic pain processing, found that high pain intensity in combination with high somatic awareness produced the highest degree of interference on a numerical interference task (Eccleston, Crombez, Aldrich, &

Stannard, 1997). This highlights the interfering role of the cognitive attention to somatosensory experience found in patients with chronic pain. It has also been found that attentional interference caused by pain was best predicted by the interaction between pain intensity and pain related fear (Crombez, Eccleston, Baeyens, Van Houdenhove, & Van der Broeck, 1999).

Somatosensory amplification (the awareness of and concern about ordinarily benign somatic sensations) has also been associated with pain disorders. Somatosensory amplification involves bodily hypervigilance, the predisposition to focus on certain weak and infrequent bodily sensations, and a tendency to appraise them as pathological and symptomatic of disease, rather than normalize them (Barsky, Wyshak, & Klerman, 1990). In the case of chronic pain, there may be a process instated that sensitizes individuals to physiological events and heightens bodily awareness. Chronic pain patients tend to blur painful and non-painful experiences and interpret a wide variety of experiences in terms of pain, particularly affective distress (Robinson & Riley III, 1999).

Fibromyalgia is a good case in point. Patients with fibromyalgia, a chronic pain disorder affecting the musculoskeletal system, exhibit numerous somatic complaints, such as swelling feelings in soft tissues, chronic headaches, irritable bowel syndrome, primary dysmenorrhea, and paresthesias (sensations of tingling, pricking, or numbness of the skin). Certain syndromes with uncertain etiologies (irritable bowel, chronic headache, and primary dysmenorrhea) appear to be significantly more common in fibromyalgia patients compared with rheumatoid arthritis patients and normal controls (Yunus, Masi, & Aldag, 1989). McDermid, Rollman, and McCain's (1996) study of hypervigilance and somatic preoccupation in patients with fibromyalgia found that these patients had a

perceptual style of amplification. They had lower pain threshold and tolerance levels and reported experiencing physical symptoms more frequently than participants with rheumatoid arthritis and normal controls. Elevated levels of somatosensory amplification have also been found in patients with a history of myofascial face pain (Raphael, Marbach, & Gallagher, 2000).

Another individual dimension shown to be a mediating factor in the relationship between pain and attentional interference is sensitivity to anxiety. Anxiety sensitivity is the fear of anxiety-related bodily sensations such as tachycardia, shallow breathing, and perspiration. This sensitivity emanates from the misattribution of these sensations to impending harm or threat.

High anxiety sensitivity has been found to exacerbate fear of pain and promote escape-related behaviors (Asmundson & Taylor, 1996). When completing a dot-probe task designed to evaluate attentional allocation to cues thematically related to pain and injury, chronic pain patients did not differ from controls in their patterns of responses to dot-probes that were presented following pain- or injury-related cues (Asmundson, Kuperos, & Norton, 1997). Different results, however, emerged when the patients with chronic pain were divided based on their scores on the *Anxiety Sensitivity Index* (Reiss, Peterson, Gursky, & McNally, 1986). Those with low anxiety sensitivity shifted attention away from stimuli related to pain whereas those with high anxiety sensitivity responded similarly to all stimuli (i.e., they did not selectively attend to or avoid pain-related stimuli). Asmundson and colleagues (1997) concluded that the style of information processing in which one shifts attention away from cues related to pain may be related to coping strategies characterized by avoidance and distraction.

Using the cold-pressor test, individuals with high anxiety sensitivity reported more negative experiences and a greater interpretive bias with regard to pain than those with low anxiety sensitivity, leading Keogh and Cochrane (2002) to conclude that the tendency to misinterpret innocuous bodily sensations related to panic mediates the association between anxiety sensitivity and affective pain experiences. These findings confirm that anxiety sensitivity plays an important role in the perception of experimental pain and identify a potential cognitive mechanism by which this relationship may exist.

Catastrophizing about the negative effects of pain has also been found to enhance attentional interference to cognitive stimuli during the presentation of an electrocutaneous pain stimulus in individuals both with and without chronic pain (Crombez, Eccleston, Van den Broeck, Van Houdenhove, & Goubert, 2002). In addition to catastrophic thinking, negative affect can be seen as a moderating variable in the emergence of pain-related fear. Since persons with high negative affect are hypervigilant for all forms of threat, those who also experience pain may make pain the most salient threat potentially resulting in the emergence of pain-related fear (Crombez et al., 1999).

Negative affect.

As a multidimensional construct with both sensory and affective components (Robinson & Riley III, 1999), pain is associated with a variety of emotions, with an emphasis on depression, anxiety, and fear.

Estimates of the prevalence of mood disorders in patients with chronic pain vary considerably, due to the application of different diagnostic criteria and the use of different measures to assess depression across studies. A large scale population-based survey of

pain and depression in the USA found that 18% of individuals suffering from chronic pain could be classified as depressed (Magni, Rigatti-Luchini, Fracca, & Merskey, 1998). In a review of studies examining depression rates in chronic pain, Banks and Kerns (1996) concluded that patients with chronic pain display higher rates of depression as compared to the general population. The prevalence of major depression in patients with chronic low back pain has been found to be about three to four times higher than in the general population (Sullivan, Reesor, Mikail, & Fisher, 1992).

Anxiety also is strongly related to chronic pain, with numerous studies finding higher rates of general anxiety in chronic pain samples as compared to pain free controls (Atkinson, Slater, Patterson, Grant, & Garfin, 1991; Brown et al., 1996; Gaskin et al., 1992). The anxiety related construct termed fear/avoidance has been investigated extensively. The construct is based on learning theory models of the acquisition and maintenance of pain behaviors, one of which is the avoidance of painful activities. Asmundson and colleagues (1997) postulated that this avoidance of activity results in chronic pain syndromes characterized by a cycle of decreased activity, loss of self-efficacy, fear, and negative affect, all leading to further avoidance of painful activities.

How does negative emotion affect the perception and experience of pain? Negative affect appears to increase or maintain the report of chronic pain through sensory processes such as enhanced sensitivity to pain (Robinson & Riley III, 1999). Mood induction studies have shown increased reporting of aches and pains and decreased tolerance for experimentally induced pain in pain free controls (Salovey & Birnbaum, 1989; Zelman, Howland, Nichols, & Cleeland, 1991). In one study, Zelman, Howland, Nichols, and Cleeland (1991) had non-clinical volunteers undergo a baseline cold-pressor

challenge. Participants then were randomly assigned to undergo inducement of depressive, neutral, or elative mood and were then retested. Participants in the depressive condition had significantly lower pain tolerance than at baseline, while those in the elative condition significantly increased their tolerance time. In another study, Bruehl, Carlson, and McCubbin (1993) randomly assigned healthy undergraduate men to two conditions, five minutes of training in positive emotion induction or brief relaxation. Participants in the positive emotion induction condition reported lower ratings of pain, fear, and anxiety in response to a finger pressure task than did controls. Moreover, when compared to subjects taught brief relaxation, participants taught positive emotion induction reported being able to more effectively use the coping strategy during the painful task.

According to Pennebaker (1982), depressed patients also tend to interpret events negatively and are thus more likely to interpret a given sensation as painful. However, the issue of causal direction in the relationship between pain and negative mood has been debated. While the aforementioned studies seem to imply that pain is impacted by negative affect, some studies have suggested that chronic pain is caused by negative emotions (e.g., Blumer & Heilbronn, 1981; Burns, Wiegner, Derleth, Kiselica, & Pawl, 1996; Dworkin & Gatlin, 1991), while yet others have concluded that negative affect occurs as a result of chronic pain (Banks & Kerns, 1996; Gaskin, Grenne, Robinson, & Geisser, 1992). Given the mixed findings, some have concluded that the relationship between pain and negative emotion is not direct, with some variables influencing the comorbidity of pain and negative affect. Catastrophization is one of the mediating variables that has been investigated.

Catastrophization.

Defined by Sullivan, Bishop and Pivik (1995) as an exaggerated negative orientation toward painful stimuli, pain catastrophization is related to distress reactions to painful stimulation. Catastrophization consists of extremely negative thoughts about one's plight by which even minor problems are interpreted as major catastrophes (e.g., "No matter what I do, my pain will not change and may never go away") (Flor & Turk, 2006). In the literature of the past two decades, catastrophizing has been increasingly recognized as one of the most important psychological predictors of pain experience.

One of the most consistent findings has been that catastrophizing is associated with heightened pain experience (Sullivan et al., 2001). In zero-order correlations, catastrophizing accounts for 7 to 31% of the variance in pain ratings. The relation between catastrophizing and pain has been observed across measures and in diverse patient and non-clinical groups, as well as in clinical and experimental settings. The types of pains that have been investigated include mixed chronic pain, low back pain, rheumatoid arthritis, pain associated with aversive diagnostic procedures, surgery, dental procedures, and whiplash injuries.

Research has demonstrated that the tendency to catastrophize in response to pain contributes to negative emotional and physical outcomes (Sullivan et al., 2001). Pain catastrophizing has been associated with several pain-related outcomes. Sullivan, Bishop, and Pivik (1995) found that those who tend to catastrophize about pain (catastrophizers) reported significantly more negative pain-related thoughts, greater emotional distress, and greater pain intensity than non-catastrophizers. Catastrophizing is also positively

correlated with pain reports and pain tolerance in post-surgical pain patients (Butler, Damarin, Beaulieu, Schwebel, & Thorn, 1989).

Catastrophization has been shown to be associated with heightened pain behavior in women specifically. Sullivan, Trip and Santor (2000) examined gender differences in catastrophizing and pain in healthy students. Participants completed the *Pain Catastrophizing Scale* (PCS; Sullivan, Bishop & Pivik, 1995) prior to immersing one arm in ice water for one minute. The PCS assesses rumination about pain, feeling helpless in regards to one's pain, and the magnification of pain symptoms. Participants were later interviewed to assess the strategies they used to cope with their pain. Independent raters examined videotapes and coded participants' pain behavior (different motor and verbal responses emitted in response to the experience of pain) during and following the ice water immersion. Results showed that women reported more intense pain and engaged in pain behavior for a longer period of time than did men. For women, the helplessness subscale of the PCS contributed unique variance to the prediction of pain and pain behavior. For men, none of the PCS subscales contributed unique variance to the prediction of pain and pain behavior (Sullivan, Trip, & Santor, 2000).

This research demonstrating that pain catastrophizing contributes to a heightened pain experience led to the hypothesis that individuals who score high on measures of pain catastrophizing would also perceive other individuals as experiencing more intense pain (Sullivan et al., 2006). To test the hypothesis, 60 undergraduates viewed videotapes of individuals taking part in a cold-pressor procedure. Correlational analyses revealed a significant positive correlation between levels of pain catastrophizing and inferred pain intensity, such that increasing levels of catastrophizing were associated with estimates of

more intense pain in others. Follow-up analyses indicated that catastrophizing was associated with a heightened propensity to rely on pain behavior as a basis for drawing inferences about the pain experience of others.

Catastrophizing has also been associated with analgesic consumption. Jacobsen and Butler (1996) investigated the relation of cognitive coping and catastrophizing to acute postoperative pain and analgesic use in women who had just undergone breast cancer surgery. The authors found that increased catastrophizing was associated with higher ratings of postoperative pain and greater analgesic use. High catastrophizers used 1.75 times more analgesics than did low catastrophizers. Not surprisingly, daily activities have a negative relation to pain catastrophizing (Keefe, Brown, Wallston, Caldwell, 1989), while occupational disability rises with pain catastrophizing levels (Burton, Tillotson, Main, & Hollis, 1995; Sullivan & Stanish, 2003; Sullivan, Stanish, Waite, Sullivan, & Tripp, 1998).

The relation between catastrophizing and pain appears to emerge early in life, has been observed across a wide range of clinical and experimental pain-eliciting situations, and shows a remarkable consistency (Sullivan et al., 2001). Implicit in this work is the view that catastrophizing is causally related to pain, and the pattern of findings appears to support the causal or, at least, antecedent status of catastrophizing. For example, catastrophizing, assessed while individuals are in a pain-free state, prospectively predicts pain ratings made in response to aversive stimulation, with high catastrophizers reporting higher levels of pain (Sullivan & Neish, 1999). In another study, catastrophizing prospectively predicted pain ratings in patients with arthritis six months later, even when controlling for initial pain ratings (Sullivan et al., 2001).

Pain-related fear has also been shown to play a significant role in chronic pain disability. A series of studies conducted by Crombez, Vlaeyen, Heuts, and Lysens (1999) demonstrated that pain-related fear was more disabling than pain itself and that pain-related fear was related to poor behavioral performance on a task assessing the functional capacity of the trunk flexors and extensors. The authors discussed the origin of pain-related fear as stemming in part from catastrophic thinking and negative affect. This study found that pain catastrophizing was superior in predicting pain-related fear than biomedical status and pain severity. Another study demonstrated that pain-free volunteers with a high frequency of catastrophic thinking about pain became more fearful when threatened with the possibility of occurrence of intense pain than volunteers with a low frequency of catastrophic thinking (Crombez, Eccleston, Baeyens, & Eelen, 1998). Catastrophizing about the negative effects of pain has also been found to enhance attentional interference to cognitive stimuli during the presentation of an electrocutaneous pain stimulus in individuals both with and without chronic pain (Crombez, Eccleston, Van den Broeck, Van Houdenhove, & Goubert, 2002). In addition to catastrophic thinking, negative affect can be seen as a moderating variable in the emergence of pain-related fear. Negative affect is accompanied by threat hypervigilance. This association in people who experience pain is likely to result in pain being labeled as a salient threat that results in pain-related fear (Crombez et al, 1999).

Impact of chronic pain on relationships.

Having a chronic pain condition not only has implications for one's own cognitive and emotional reactions to the pain; it also impacts the partner. Spouses of individuals with chronic pain report elevated psychological distress when compared to spouses of

diabetic patients and healthy individuals (Bigatti & Cronan, 2002; Rowat & Knafl, 1985; Subramanian, 1991). Spouses can catastrophize their partner's pain and this has been correlated with psychological distress in those with chronic pain (Cano, Leonard, & Franz, 2005). Spouse pain catastrophizing may create a sense of exaggerated or heightened concern about their partner's pain that contributes to spouse psychological distress.

Solicitous spouse behaviors, such as expressions of concern or support and provision of assistance related to the patient's pain or disability, have also been found to affect the pain experience of those with chronic pain. Partner solicitous behaviors have been found to be associated with higher reported pain levels (Kerns, Haythornthwaite, Southwick, & Giller, 1990; Turk, Kerns, & Rosenberg, 1992) and greater interference of pain with activities (Flor, Turk, & Rudy, 1989) for maritally satisfied but not dissatisfied patients.

In summary, the chronic pain literature indicates that attentional, affective and relational factors play a mediating role in a number of pain syndromes. Although dyspareunia is an acute recurrent pain rather than a typically chronic one, it may be regulated by similar mediators and these may be important in our understanding of the disorder and its treatment. The following section reviews findings relating directly to the experience of recurrent pain with intercourse.

Dyspareunia

Although the literature on cognitive and emotional factors in dyspareunia is in its nascency and does not approach the type of coverage that other pain syndromes have received, multiple investigations are pointing in similar directions.

Attention.

A few studies have demonstrated an attentional bias to pain stimuli in women with dyspareunia. These studies have also examined hypervigilance to pain related information. In a multidimensional investigation of pain-hypervigilance in women with VVS/PVD, 17 women suffering from VVS/PVD and an equal number of age and education-matched control women completed an Emotional Stroop Task and memory recall task, in addition to a series of questionnaires assessing pain-hypervigilance, state and trait anxiety, fear of pain, and anxiety sensitivity (Payne, Binik, Amsel, & Khalifé, 2005). Stimuli for the Emotional Stroop Task consisted of four sets of ten words in the following categories: pain, social-threat, positive, and neutral words. Results showed that women suffering from VVS/PVD displayed hypervigilance for pain relevant information. Specifically, VVS/PVD women displayed greater Stroop interference for pain words as compared with control women, and also reported experiencing more hypervigilance to pain during intercourse on a self-report measure. The data provide evidence in support of a mediating role for anxiety and fear of pain in dyspareunia.

The authors of the aforementioned study discuss the implications of an attentional bias towards pain stimuli in women with VVS/PVD as being related to hypervigilance. They propose that hypervigilance to pain can increase the stimulus salience and perceived intensity, becoming an important factor in altered pain perception and maintenance. Furthermore, if attention is preferentially allocated to pain processing during sexual activities, then fewer attentional resources may be available for the processing of sexually arousing or pleasurable stimuli (Payne et al., 2005). Thaler, Meana, and Lanti (2009) also found an attentional bias for pain stimuli in women with dyspareunia. The latter

evidenced more false memories of pain words as compared to negatively valenced non-pain words, and falsely remembered more pain words than did control women. The incorrect recall or recognition of pain words in women with dyspareunia can reasonably be interpreted as indicative of an attentional bias towards pain-related words.

Payne and colleagues (2007) also examined pain hypervigilance and fear of pain. They administered the *Health Anxiety Inventory* (HAI; Salkovskis, Rimes, Warwick, & Clark, 2002), the *Pain Vigilance Awareness Questionnaire* (PVAQ; Mc-Cracken, 1997), and the *Pain Anxiety Symptoms Scale-20* (PASS-20; McCracken & Dhingra, 2002) to women with VVS/PVD and healthy controls. Women with VVS/PVD obtained higher scores on the HAI than controls and reported higher vigilance for both intercourse and non-intercourse pain on the PVAQ in comparison to healthy participant ratings for non-intercourse pain. Women with VVS/PVD also obtained higher scores on all four subscales of the PASS-20 (cognitive anxiety, escape/avoidance, fearful appraisal, and physiological anxiety) with respect to intercourse pain as compared with healthy participant ratings for non-intercourse pain, indicating a higher overall level of fear of pain in women with VVS/PVD as compared to controls. With respect to non-intercourse pain, women with VVS/PVD also endorsed higher ratings on cognitive anxiety, escape/avoidance, and physiological anxiety than did control women.

Somatosensory amplification and anxiety sensitivity have also been targeted. Insofar as somatic amplification relates to a cognitive bias focusing on minor bodily sensations, it relates directly to issues of attention. In a cross-sectional study involving a large sample of college women, Meana and Lykins (2009) examined variables related to the experience of chronic pain. They administered questionnaires to 759 college women,

of which 101 reported experiencing pain on 50% or more of intercourse attempts (pain group). These women were compared to 536 women who reported experiencing no pain or pain on less than 10% of intercourse attempts (control group). Participants were administered the *Anxiety Sensitivity Index*; a measure of somatosensory amplification; and a health anxiety questionnaire. The authors found that women in the pain group scored significantly higher on the measures of anxiety sensitivity, health anxiety and somatosensory amplification as compared to the control group. Women with intercourse pain also displayed a cognitive style characterized by fear of health problems, a focus on somatic irregularities, and a propensity to interpret their occurrence as potentially catastrophic. This research adds to the body of data suggesting that women with dyspareunia have a tendency to hyper-attend to and over-interpret pain and somatic symptoms. The authors state that this cognitive style is likely to result in increased anxiety about intercourse and amplification of pain during sex, therefore impacting both the sensory and affective dimensions of pain (Meana & Lykins, 2009).

Granot and Lavee (2005) examined somatization in women with VVS/PVD using the short version of the *Brief Symptom Inventory* (BSI; Derogatis & Melisaratos, 1983). The somatization scale of this questionnaire asks participants to rate the frequency of complaints or symptoms in different areas of the body, including chest pain, headache, low back pain, vomiting, dizziness, flushes, or numbness. Women with VVS/PVD evidenced higher levels of somatization as compared to control women. These results relate theoretically although speculatively to an attentional focus on bodily sensations. Granot and Lavee (2011) examined the relationship between attachment style and somatization in women with dyspareunia. Using the *Brief Symptom Inventory* (BSI;

Derogatis & Melisaratos, 1983), they found higher somatization levels and a greater incidence of insecure attachment in the dyspareunia group as compared to control women. They also found that an increased level of somatization and a higher level of avoidance predicted a higher probability for dyspareunia, leading the authors to conclude that women with higher frequencies of complaints in various bodily areas and insecure attachment style are more likely to report pain during intercourse (Granot & Lavee, 2011).

Brauer and colleagues (2007) examined somatization using the somatization subscale of the *Symptom Checklist-90* (SCL-90; Derogatis & Cleary, 1977) and found higher levels of somatization in women with dyspareunia as compared to controls. Sutton, Pukall and Chamberlain (2009) also found higher levels of physical and functional somatization (i.e., functional impairment related to physical symptoms) in women with PVD as compared to controls.

Negative affect.

Some studies indicate that women with dyspareunia report more anxiety than controls. Nunns and Mandal (1997) assessed anxiety in women with VVS/PVD using the *State-Trait Anxiety Inventory* (STAI; Speilberger, 1983). The authors found that both trait and state anxiety scores were higher for women with VVS/PVD as compared to controls. Payne and colleagues (2005) found higher levels of both state and trait anxiety, as measured by the STAI, in women with VVS/PVD. Brauer, ter Kuile, Laan, and Trimbos (2009) also found higher levels of both state and trait anxiety in women with superficial dyspareunia. Granot and Lavee (2005) assessed anxiety level with the validated Hebrew version (Teichman & Malineck, 1978) of the STAI and found that VVS/PVD women

demonstrated higher levels of trait anxiety, but not state anxiety, than control women. Pukall and colleagues (2007) also found higher levels of trait, but not state, anxiety in women with VVS/PVD. Using the BSI, Meana and colleagues (1997b) found higher levels of phobic anxiety in their sample of dyspareunia women. However, not all studies have found higher anxiety levels in dyspareunia samples. Payne et al., (2007) found no significant differences between women with VVS/PVD and controls on the STAI.

Levels of depression have also been assessed in women with dyspareunia, with some studies indicating higher levels of depression in dyspareunia samples (Brauer et al., 2009; Dunn, Croft, & Hackett, 2002; Jantos & White, 1997). Meana and colleagues (1997b) found higher levels of depression, as well as interpersonal sensitivity, in their sample of women with dyspareunia. Other studies, such as Payne and colleagues (2005; 2007) found no difference between VVS/PVD samples and controls on the Beck Depression Inventory.

Negative affect, as assessed by the neuroticism scale of the *NEO-FFI* (Costa & McCrae, 1992), has also been investigated in women with dyspareunia. The neuroticism scale taps into the tendency to experience negative emotions such as anxiety, hostility, depression, self-consciousness, impulsiveness, and vulnerability. Meana and Lykins (2009) found higher levels of neuroticism in their dyspareunia sample as compared to their control group of women. Granot (2005) examined Harm Avoidance, which is characterized by the tendency to respond intensely to previously established signals of aversive stimuli and to learn to passively avoid punishment, novelty, and frustrating non-reward. He found higher levels of Harm Avoidance in his sample of women with VVS/PVD.

Catastrophization.

In their study of women with VVS/PVD, Pukall and colleagues (2002) inquired about pain catastrophization using the PCS (Sullivan, Bishop, & Pivik, 1995). Women with VVS/PVD completed the questionnaire in relation to their sexual pain and in relation to a regularly experienced non-genital pain. Women with VVS/PVD reported significantly more catastrophizing thoughts related to intercourse pain as compared to their non-intercourse pain (Pukall et al., 2002). Payne and colleagues (2007) administered the PCS, once to healthy participants with reference to a recurrent non-intercourse pain identified during a semi-structured interview, and twice to VVS/PVD participants: once with reference to their intercourse pain and a second time with reference to a non-intercourse pain. Women with VVS/PVD reported higher pain catastrophizing than controls for non-intercourse pain, and their catastrophizing of intercourse pain was higher than controls' catastrophizing of non-intercourse pain. Women with VVS/PVD also catastrophized as much about intercourse pain as they did about non-intercourse pain. Sutton, Pukall and Chamberlain (2009) administered the PCS to women with PVD and controls and asked them to complete it in reference to their most intense, regularly experienced pain. They found that 84% of the women with PVD listed intercourse pain as their worst pain and women with PVD had higher levels of pain catastrophization than control women. Brauer and colleagues (2009) also found higher levels of pain catastrophizing of non-genital pain in women with dyspareunia as compared to control women. Recent research has demonstrated how variables such as pain catastrophization are related to pain experienced during intercourse for women with dyspareunia. Desrochers and colleagues (2009) examined the extent to which fear avoidance variables

(catastrophizing, anxiety, fear of pain, hypervigilance) and self-efficacy differentially influenced changes in levels of experimentally induced pain and intercourse pain. They also investigated the association of these variables with sexual dysfunction in women with PVD. They found that higher catastrophizing, fear of pain, hypervigilance and lower self-efficacy together accounted for 15% of the variation in increased intercourse pain intensity. Among these, only catastrophizing contributed unique variance to intercourse pain (Desrochers, Bergeron, Khalifé, Dupuis, & Jodoin, 2009)

Not all studies have found higher levels of catastrophization in women with dyspareunia. Granot and Lavee (2005) examined pain catastrophization in women with VVS/PVD. Women were asked to complete the PCS in relation to a heat stimulus applied to their forearm during the study (experimental pain). There was no difference between VVS/PVD and control women on pain catastrophizing in relation to this experimental pain. In general though, there are a growing number of studies showing that the tendency to catastrophize during painful stimulation contributes significantly to enhancing the pain experience and increasing emotional distress (Granot & Lavee, 2005). Possible mechanisms of action for this phenomenon were proposed by Sullivan et al. (2001) who suggested that catastrophizing represents a multidimensional trait in which activation, appraisal, attention, and coping play a role in the experience of pain.

Pain related fear has also been linked to sexual arousal deficits. Brauer, ter Kuile, Janssen, and Laan (2007) investigated the effects of pain-related fear on sexual arousal in women with superficial dyspareunia and women without sexual complaints. To induce pain-related fear, participants were told that they had a 60% chance of receiving painful stimuli while being exposed to one of two erotic film clips. Elevated levels of skin

conductance and higher ratings of experienced threat during the pain threat condition indicated that fear was successfully elicited. In addition, pain-related fear impeded genital arousal in all women. Women in both groups reported significantly less positive affect and more negative affect when threatened. The authors concluded that pain-related fear reduces genital and subjective sexual responding in women with and without sexual problems.

What can be gleaned from the preceding findings is that women with dyspareunia display many of the same cognitive styles evidenced in patients with other types of chronic pain conditions. The existing data illustrates an attentional bias for pain stimuli as well as negative affect, with an emphasis on anxiety and catastrophization about pain. Not surprisingly there is also evidence that pain-related fear interferes with sexual arousal in all women. This brings us to one of the unique characteristics of dyspareunia as a pain syndrome: its direct association with sex. The sexual involvement of this pain syndrome cannot be ignored as a possible further complication in the experience of pain. Pain stimuli and pain-related information seem to be especially salient and important for women with dyspareunia, but one wonders the extent to which this salience has generalized to sexual activity itself. Is it possible that sexual stimuli have come to provide the same cognitive and affective interference as pain stimuli? An exploration of how women with dyspareunia respond to sexual material may be the best way to investigate this question.

Impact of chronic pain on relationships.

Data on relationship characteristics and/or psychosexual functioning of partners of women with dyspareunia are scarce, with very few published studies focusing on these

issues. Van Lankveld, Weijenborg, and ter Kuile (1996) established the psychosexual profiles of 43 women with vestibulodynia and their partners and compared them with existing norms. Results indicated that partners were satisfied with their romantic relationships and that they had little sexuality-related distress. The potential impact of the partner on the woman's pain experience was not evaluated in this study.

Another study (Desrosiers et al., 2008) examined the psychosexual profiles of women with vestibulodynia and their partners, in addition to exploring whether partner-related variables correlated with women's pain and associated psychosexual functioning. Using 43 couples in which the woman suffered from vestibulodynia, the authors found that women with vestibulodynia and their partners did not differ from population norms with regard to global sexual functioning, dyadic adjustment and psychological adjustment. However, mean frequency of intercourse was lower than the standard for this age group. Also, women had significantly poorer sexual functioning than men. In addition, partner solicitousness and hostility were significantly associated with higher levels of pain during intercourse. The authors concluded that partner responses may play a role in the experience of pain in women with vestibulodynia, although the psychosexual and relationship characteristics of these couples do not differ from population norms.

Rosen and colleagues (2010) examined whether partner responses to women's pain experience - from the perspective of both the woman and her partner - were associated with pain intensity, sexual function, and sexual satisfaction in 191 couples in which the women suffered from PVD. The authors found that higher solicitous partner responses were associated with higher levels of women's vulvovaginal pain intensity for both partner-perceived responses and for woman-perceived partner responses. However,

women's perceptions of greater solicitous partner responses predicted greater sexual satisfaction. Partner-perceived responses did not predict women's sexual satisfaction and partner responses were not associated with women's sexual function. The authors concluded that partner responses to pain may affect pain intensity and sexual satisfaction in women with PVD (Rosen, Bergeron, Leclerc, Lambert, & Steben, 2010).

Jodoin and colleagues (2008) examined whether male partners' attributions for PVD are possible predictors of their dyadic adjustment, sexual functioning, sexual satisfaction, and psychological distress, as well as of women's pain and sexual functioning. Thirty-eight women with vestibulodynia and their male partners participated. Results revealed that all negative attribution dimensions and higher levels of women's pain intensity predicted increased psychological distress in male partners. Higher levels of both internal and global attributions were associated with men's poorer dyadic adjustment, whereas global and stable attributions were related to their lower sexual satisfaction. Attributions failed to significantly predict sexual functioning in male partners and women's pain and sexual functioning. The authors concluded that evaluation and treatment of sexual pain problems should involve both partners and should explore the role of negative attributions.

A review by Smith and Pukall (2011) examined whether PVD is associated with reduced relationship adjustment and decreased sexual satisfaction for women and partners. The research to date suggests that while PVD is associated with sexual dissatisfaction in women, the findings for relationship adjustment were not as clear. Controlled studies did not indicate reduced relationship adjustment; however, studies using qualitative or nonvalidated methods highlight that women with PVD experience

stress in their relationships and perceive that their PVD has a negative impact on their relationships and sexuality. The authors of the review state that perhaps the sexual aspects of the relationship, as opposed to the overall relationship, are more negatively affected by PVD and that by assessing overall relationship satisfaction, studies to date have not tapped in to the specific ways couples are affected by PVD. In terms of the impact of PVD on male partners, some studies have found that partners do not report reduced levels of relationship adjustment, although some partners may experience decreased sexual satisfaction. The authors of the review concluded that little research has comprehensively examined how partners may be affected by PVD.

Sex-related arousal, cognition and affect.

The main body of evidence suggesting that sexuality is impacted in dyspareunia emanates from the literature on sexual functioning in this population. Studies have shown that women with dyspareunia report greater sexual dissatisfaction (Gates & Galask, 2001), lower frequencies of intercourse and self-stimulation, lower levels of desire, arousal, pleasure, lubrication, and less success at achieving orgasm (Brauer, ter Kuile, Gates & Galask, 2001; Janssen, & Laan, 2007; Jantos & White, 1997; Meana, Binik, Khalifé, & Cohen, 1997; Nunns & Mandal, 1997; Payne et al., 2007; Reissing, Binik, Khalifé, Cohen, & Amsel, 2003; Thaler, Meana, & Lanti, 2009) as compared to women who do not have pain with intercourse. They also report more negative attitudes and thoughts about sexuality, more negative sexual self-concepts, and more depressive symptoms than controls (Gates & Galask, 2001; Meana & Lykins, 2009; Nunns & Mandal, 1997; Sutton, Pukall, & Chamberlain, 2009).

The reports of lower levels of sexual arousal in women with dyspareunia have sparked research examining genital arousal specifically. Researchers have been interested in determining whether women with dyspareunia would display less genital arousal to sexual stimuli than control women, as lack of sexual arousal has commonly been hypothesized to play an etiological role in dyspareunia (Bancroft, 1989; Hawton, 1985; Lazarus, 1989). Only one study has found that women with dyspareunia respond with lower levels of physiological sexual arousal to sexual stimuli. Wouda et al. (1998) found that they had reduced levels of genital arousal (vaginal pulse amplitude [VPA] as measured by vaginal photoplethysmography [VPP]) in response to an intercourse film clip compared to women without sexual complaints. Video clips depicting oral sex yielded similar genital responses in women with dyspareunia and in controls. There were no group differences, however, in self-reported subjective levels of sexual arousal.

Other studies have indicated that women with dyspareunia experience normal levels of genital arousal in response to sexual stimuli. Brauer, Laan and ter Kuile (2006) compared genital and subjective responses to visual sexual stimuli in women with dyspareunia and women without sexual complaints. The authors investigated whether women with dyspareunia were less genitally and subjectively responsive to noncoital (oral sex) as well as coital visual sexual stimuli, or whether they exhibited a conditioned anxiety response such that sexual arousal responses were lower only to stimuli that may induce fear of pain (i.e., coitus). Genital arousal was assessed as VPA using VPP. Self-reported ratings of subjective sexual arousal were collected after each erotic stimulus presentation. Women with dyspareunia had levels of genital arousal to the two different visual sexual stimuli comparable to women without sexual complaints. Contrary to

expectation, there was an indication that women with dyspareunia reacted with higher levels of genital arousal to the explicitly depicted coitus stimulus than did controls, whereas controls had higher genital responses to the oral sex stimulus. However, with respect to subjective sexual arousal, women with dyspareunia reported less positive feelings in response to both erotic stimuli.

Payne and colleagues (2007) assessed genital sexual arousal in women with VVS/PVD and control women via the measurement of surface skin temperature changes of the labia minora using a labial thermistor clip. In response to the erotic stimulus, both groups evidenced a significant increase in physiological sexual arousal. However, women with VVS/PVD reported a significantly lower desire to engage in intercourse after having viewed the erotic film and reported lower levels of desire and arousal on questionnaire measures.

Brauer, ter Kuile, Janssen, and Laan (2007) assessed sexual arousal with VPP in women with dyspareunia and pain-free controls. Participants were presented with erotic film clips, immediately after which each participant was asked to rate on a 7-point Likert scale the degree to which she was experiencing genital sensations (e.g., genital pulsing and throbbing), positive affect (e.g., excited and longing), and negative affect (e.g., disgust and shame). The authors found that genital arousal during the erotic films significantly increased compared to preceding baselines, indicating that the erotic films were effective in enhancing sexual arousal in both groups of women. However, yet again, the dyspareunia group reported significantly more negative feelings regarding exposure to the erotic stimuli than did the control group.

Brauer, ter Kuile and Laan (2009) also examined the effects of sexual stimuli appraisal on sexual arousal in women with superficial dyspareunia as compared to women with no sexual dysfunction. Participants viewed an erotic film clip and received instructions prior to viewing it that either the woman in the film was experiencing pain during intercourse, or that she was enjoying the penetrative activity. Genital arousal was measured via vaginal pulse amplitude. Appraisal of the erotic stimulus affected genital responding in that women who received the genital pain instruction had marginally significant lower genital arousal than those who received the sexual enjoyment instruction. Interestingly, the dyspareunia and control groups did not differ in genital arousal overall, but did report higher levels of negative affect to the erotic film (Brauer, ter Kuile, & Laan, 2009)

What can be concluded is that women with dyspareunia are not lacking in physiological sexual arousal, but rather that lack of subjective sexual arousal may be implicated in vulvar or vaginal pain during intercourse. Therefore, physiologically, sex is arousing to these women. However, cognitively and emotionally, sex may not be adequately arousing. As there have been no longitudinal studies investigating the development of dyspareunia, we do not know whether the lack of subjective arousal is a consequence or a cause of the pain. It seems more intuitive to posit that because sex is painful for women with dyspareunia, the presentation of sexual stimuli evokes similarly negative reactions as do pain stimuli (e.g. fear, avoidance, negative affect or decreased sexual responding). However, the issue of whether pain and sex have become indistinguishable has not been adequately addressed in the research literature.

One aforementioned study that did so aimed to elucidate whether there was a differential saliency between pain and sexual stimuli in women with dyspareunia (Thaler, Meana, & Lanti, 2009). The authors examined basic memory for pain and sex-related words in an experimental paradigm. Twenty women reporting pain during sexual intercourse and 20 women reporting no sexual dysfunction (controls) participated in a memory protocol designed to detect differences as a function of group membership and type of stimulus. Results indicated that all women had better recall for sex-related words; however, women reporting pain during sex evidenced more false memories for pain words than did control women, and pain words elicited more false memories than any other type of word for women with sexual pain. Sex did not appear to interfere with memory to the same extent. Results were interpreted to suggest that repeated activation through experience in women with persistent sexual pain may have contributed to the development of stronger semantic networks related to pain in comparison to no-pain controls. In addition, this repeated activation may have led to the development of stronger semantic networks for pain than for sex. These pain networks seemed to have been more easily triggered by pain-related stimuli in women with sexual pain than in no-pain controls. These results highlighted the notion that pain and sex may not be equivalent constructs for women with dyspareunia.

Lykins, Meana and Minimi (2011)) examined whether women with dyspareunia would respond to sexual stimuli as if they were attending to pain stimuli. In a study of visual attention and distraction in women with dyspareunia, the authors wanted to know whether women with dyspareunia would be distracted from sexual stimuli (as seen in other forms of sexual dysfunction), or whether they would demonstrate hypervigilance to

sexual stimuli because these stimuli elicit thoughts and expectations of pain (as the pain literature would suggest). Women with dyspareunia and women with no sexual dysfunction, as well as women with low sexual desire, were presented a series of erotic images, each containing a semantically-inconsistent object (e.g. a green alien, a beach ball or other objects that clearly do not reasonably belong in the image), and their eye movements were tracked as they looked at the images. Results revealed that women with dyspareunia looked fewer times and for less total time at the sexual scene regions (i.e., the bodies) than both women with low sexual desire and women with no sexual dysfunction. Women with dyspareunia were also found to have looked at the context scene region significantly more times and for longer periods of time than the no-dysfunction control women. The authors concluded that the results failed to support the attentional hypervigilance that would have been consistent with the pain disorder conceptualization because women with dyspareunia did not look more at the sexual scene regions (which one might have expected to act as pain stimuli) than the other groups. There appeared to be evidence of a cognitive avoidance process occurring in women with dyspareunia, such that sexual information may have triggered anxiety (due to fear of threat or harm), thus creating overall attentional avoidance of these scene regions. The aforementioned study was an interesting one because it examined hypervigilance to sexual stimuli, using these stimuli as a sort of proxy for pain stimuli. It may therefore not be surprising to see that women with dyspareunia did not display a hypervigilance to the sexual stimuli, because perhaps these stimuli are not analogous to pain stimuli. While pain and sex seem to be intertwined in dyspareunia, it may not be the case that presenting

women with sexual images or words activates the same cognitive associations as when presenting them with pain stimuli.

The coupling of sex and pain make treating dyspareunia a challenge. The mixed data also presents a perplexing picture of how pain and sex affect each other. Despite the current lack of clarity in the literature regarding this complex relationship, the most effective treatments to date have recognized the importance of both the pain and sexual aspects of the disorder and have targeted both in the hopes of reducing the genital pain and increasing sexual functioning and satisfaction in women with dyspareunia.

CHAPTER 5

Cognitive Interventions and their Use in Dyspareunia Treatment

The ultimate aim of investigating cognitive mediators of pain in dyspareunia is to inform treatment efforts and better help women suffering from this disorder. Very few studies have been conducted on the treatment of dyspareunia, cognitive or otherwise. In this next section, we will provide a brief review of the handful of cognitive interventions that have been empirically tested, to provide further context for the aims of the current study. To date, treatment efforts have been multidisciplinary, targeting both the physical pain and the cognitions related to pain and sex in women with dyspareunia. Given the prominent role that cognitive variables such as catastrophizing, hypervigilance, and anxiety related thoughts play in the development, maintenance and exacerbation of the pain experienced in dyspareunia, it is reasonable for treatments to target cognitive processes in women who report pain during sex.

One common and widely used treatment for dyspareunia is Cognitive Behavioral Therapy (CBT), administered in either a group or individual format. The goals of CBT for pain and sexual dysfunction include 1) reconceptualizing genital pain as a multidimensional pain problem influenced by a variety of factors including thoughts. emotions, behaviors and couple interactions; 2) modifying those factors associated with pain during intercourse with a view to increasing adaptive coping and decreasing pain intensity; 3) improving the quality of sexual functioning and 4) consolidating skills (Bergeron & Lord, 2010). Typically, this treatment involves implementing numerous

strategies targeting both the pain and the sexual aspects of the disorder. CBT for dyspareunia often begins with education and information about dyspareunia and its impact on desire and arousal. Education concerning a multifactorial view of pain and education about sexual anatomy is also typically provided. Treatment then teaches women how to do progressive muscle relaxation, abdominal breathing, Kegel exercises and vaginal dilatation. Distraction techniques focusing on sexual imagery and rehearsal of coping self-statements are taught to women, along with communication skills training, and cognitive restructuring (Bergeron & Binik, 1998). Such techniques aim to: reduce the fear of pain during intercourse and other maladaptive affective and cognitive responses, increase sexual activity level, and reduce pain (Bergeron & Binik, 1998).

Only one controlled treatment study of dyspareunia exists and this study demonstrates the effectiveness of CBT for the treatment of this disorder. Bergeron and colleagues (2001) compared group cognitive-behavioral therapy, surface electromyographic biofeedback (sEMG), and vestibulectomy in the treatment of dyspareunia resulting from VVS/PVD. Seventy-eight women were randomly assigned to one of three treatment conditions and assessed at pretreatment, post-treatment and 6-month follow-up via gynecological examinations, structured interviews and standard questionnaires pertaining to pain and sexual functioning. Surface electromyographic biofeedback, a treatment often used with other pain conditions, aims to reduce the instability and hypertonicity (increased tension) of the pelvic floor muscles (Bergeron et al., 2001). In sEMG, the participant inserts a small sensor into the vagina which reads the muscle activity of the pelvic floor muscles. The participant is taught to relax the muscles through live feedback about the amount of tension in the muscles. Participants in the

Bergeron and colleagues (2001) study received eight 45 minute sessions over a 12 week period and were instructed to practice the technique at home. The vestibulectomy treatment consisted of a minor day surgical procedure of 30 minutes performed under general anesthesia which involved the removal of the tissue in the vestibular area of the vulva (Bergeron et al., 2001). Group CBT consisted of 8 two-hour sessions delivered over a 12 week period and employed the techniques and strategies listed in the previous paragraph. Specifically, various cognitions were targeted as part of the treatment. Women in the CBT groups were asked to identify the negative, automatic thoughts that occur when they are anticipating pain, when they are experiencing pain, and after an episode of painful intercourse. Participants learned about the concepts of catastrophizing and hypervigilance and about their association with pain intensity. These women were then taught to replace their maladaptive cognitions with more positive ones, and were taught to use coping self statements (i.e., "Worrying won't help; I won't get overwhelmed; I need to take some slow, deep breaths and relax"). The cognitive interventions used in this treatment showed promising results. Group CBT reduced anxiety by giving participants more control over their pain and by changing the meaning of the situation for them, thereby affecting cognitive and emotional factors (Bergeron et al., 2001). All three groups demonstrated statistically significant reductions on pain measures at post-treatment and 6-month follow-up and showed significant improvements on measures of psychological adjustment and sexual function from pretreatment to 6-month follow-up. Treatment gains (pain reduction and sexual function improvement) were maintained at the 2.5 year follow up (Bergeron, Khalifé, Glazer, & Binik, 2008).

Other non-controlled studies of CBT for dyspareunia demonstrate the treatment's effectiveness at reducing both pain and sexual dysfunction. In a prospective open clinical trial, 76 women with VVS/PVD underwent 12 group CBT sessions over a period of six months (Ter Kuile & Weijenborg, 2006). The treatment program consisted of education about pain in relation to anxiety, information about muscle contraction as a consequence of pain and fear of pain, and information about sexuality. More specific information was provided about how pain or the thought of it can affect sexual arousal, lubrication and sexual desire in general. Training in coping, self-statements and cognitive restructuring was provided along with the following exercises: progressive muscle relaxation, suggestive relaxation, suggestive pain transformation and analgesia, abdominal breathing, touching and vaginal dilatation by insertion of one and two fingers by the woman herself and later on by the partner, and sexual imagery. The authors state that the techniques aimed to reduce fear of pain during intercourse and other maladaptive affective and cognitive responses, increase sexual activity level and sexual arousal, and reduce vaginal muscle tension pain (Ter Kuile & Weijenborg, 2006). The results of this study indicate that cognitive-behavioral therapy is effective in treating patients with VVS/PVD. Women showed changes in perceived pain control, sexual satisfaction, and vaginal muscle tension and vestibular pain, as well as reduced pain during intercourse.

In another non-controlled treatment outcome study, Weijmar Schultz and co-workers (1996) compared the effectiveness of cognitive behavioral therapy (CBT) to surgery (vestibulectomy) followed by CBT for the treatment of dyspareunia resulting from VVS/PVD. The authors initially randomized 14 women diagnosed with VVS/PVD over the two treatment modalities. However, as soon as it became evident that the two

treatment modalities were equally effective, the authors no longer felt it ethical to continue assigning patients to the surgical intervention. Therefore, the study became a nonrandomized trial in which women were given the choice of whether or not to undergo surgery prior to CBT. The majority (82%) of the 34 women in this part of the study chose the behavioral approach without the preceding surgery. In the randomized (n = 14) as well as in the non-randomized part (n = 34) of the study, differences in self-reported pain during intercourse after the two treatments (CBT versus CBT and surgery) were non-significant. The authors concluded that the behavioral approach should be the first choice of treatment for VVS, and that surgical interventions should be considered only as an additional form of treatment when no further benefit can be gained from CBT (Weijmar Schultz et al., 1996).

More recently, 97 women with vestibulodynia were randomly assigned to a 13-week trial of group CBT or corticosteroid applications (Bergeron, 2008). Both groups evidenced significant pain reduction at six-month follow-up, but women in the CBT condition reported significantly less pain than those in the topical treatment condition. In addition, the CBT intervention yielded significantly more improvements in sexual functioning, treatment satisfaction, and pain catastrophization. Further analyses revealed that for the topical treatment condition, higher levels of baseline avoidance predicted worse pain and sexual functioning outcomes, whereas higher levels of painful intercourse self-efficacy predicted better outcomes. For the CBT condition, higher levels of baseline fear of pain and catastrophization contributed to higher pain intensity at follow-up, whereas higher levels of painful intercourse self-efficacy were associated with less pain. Results are interpreted to indicate fear-avoidance variables and painful intercourse self-

efficacy are significant predictors of topical and CBT treatment outcomes for women with PVD (Desrochers, Bergeron, Khalife, Dupuis, & Jodoin, 2010).

Another group of researchers (Masheb, Kerns, Lozano, Minkin, & Richman, 2009) conducted a randomized trial comparing 10-week individual CBT versus supportive therapy for women with vulvodynia. At one-year follow-up, all participants had significant decreases in pain, although those assigned to CBT had greater improvements in pain during gynecological exams, better sexual functioning and greater treatment satisfaction (Masheb et al., 2009).

Despite some promising findings regarding the efficacy of CBT in treating dyspareunia, there still exists a paucity of data in this area. CBT is a treatment that contains multiple ingredients, all of which aim to decrease pain and increase sexual pleasure. However, we do not know which of these ingredients are contributing the most to the improvements seen in patients who undergo CBT. Is the challenging and replacing of cognitive distortions related to pain the active ingredient, or does the focus on increasing desire and arousal help alleviate the symptoms of dyspareunia? Perhaps it is the specific blending of all of the components that actually produces change. Moreover, CBT assumes that the sexual and pain components of dyspareunia can remain somewhat separate. We ask women with dyspareunia to engage in non-intercourse sexual activities to help them increase desire and arousal, all on the assumption that non-intercourse activities do not trigger thoughts of pain in the same way that intercourse activities do. The first step in determining the active ingredients in CBT may be to determine how intertwined the sexual and pain components of dyspareunia have become for these women.

CHAPTER 6

Aims of the Study

It has been well established that women with dyspareunia display a hypersensitivity to touch and pain in the genital region. In addition, they evidence sensory dysregulation, with higher sensitivity to touch and pain at non-genital regions as compared to women without the disorder. Cognitively, it appears that women with dyspareunia also display a hypervigilance to pain stimuli, amplify bodily sensations, and catastrophize the experience of pain. Emotionally, they are more distressed than women without pain, consistently exhibiting higher levels of fear, depression, anxiety and general negative affect. There is also evidence indicating that all of these factors are likely to interfere with sexual desire, arousal and orgasmic capacity.

What is less clear is the extent to which sex or its intimation has been indelibly paired and associated with pain in these women. While women with dyspareunia evidence higher levels of sexual dysfunction than control groups and report not being as subjectively aroused by visual erotic stimuli as other women, we do not know the extent to which thinking about sex activates thoughts of pain, or vice versa.

From a classical conditioning perspective, pairing pain and sex can create a conditioned reaction to sex. For most people, the presentation of pain (the unconditioned stimulus) evokes negative cognitive and emotional reactions (e.g. fear, avoidance, hypervigilance and catastrophization – the unconditioned responses). For women with dyspareunia, pain gets paired with sex repeatedly over the course of many weeks, months

or even years, possibly turning sex into the conditioned stimulus. Subsequently, it is theoretically possible that the presentation of the conditioned stimulus (any form of sexual activity, even types that do not cause physical pain) may elicit the same reactions that pain does (e.g. fear, avoidance of sexual activity, increased autonomic arousal, etc.), even in the absence of actual pain. These responses can become the conditioned responses to sex and sex can then act as a pain stimulus. Clinical anecdotes support this classical conditioning hypothesis, with reports of women with dyspareunia refusing to engage in any manner of sexual interaction, even non-penetrative sex which is unlikely to directly induce pain.

Current treatments simultaneously target both the pain and the sexual disturbances in an understandable wide-net approach to help these women. We do not, however, know exactly what the active ingredients are in these treatments. CBT for dyspareunia tends to de-emphasize intercourse and encourage non-penetrative sexual activities; however, we do not know if or the extent to which sex, in general, has become akin to a pain stimulus. If it has, this would need to be addressed in treatment. If sex and pain have become paired in a classical conditioning paradigm, then treatment would need to focus on counterconditioning the pain and sex association. Sex would need to be paired with something positive, such as pleasure, or feelings of calmness and control. However, this counterconditioning might need to be conducted on all forms of sexual activity (e.g. kissing, rubbing, manual and oral stimulation) if even non-penetrative sex has become akin to a pain stimulus. Separating the pain from the sex seems a germane endeavor in an attempt to better understand the mechanisms that maintain the pain and the sexual

disturbances. This understanding would be helpful in the design of more effective and custom tailored or prescriptive interventions.

This study will attempt to initiate the empirical endeavor to tease apart the impact of pain and sexual stimuli on the experience of pain in women with dyspareunia. More specifically, we aim to use a simple and strongly validated experimental paradigm to investigate the differential impact of sex and pain primes on pain tolerance and thresholds in women with dyspareunia and in pain- and sexual dysfunction-free controls. Using a cold-pressor task, which has been shown to be sensitive to pain threshold and tolerance differences in clinical populations, the general aims of this study are:

1) To investigate generalized differences in peripheral (i.e. non-genital) pain thresholds between women with dyspareunia and controls.
2) To investigate generalized differences in pain tolerance between women with dyspareunia and controls.
3) To compare the impact of sexual and pain primes on peripheral pain thresholds and pain tolerance.
4) To investigate differences in pain catastrophization, somatosensory amplification, negative affect, and sexual functioning between women with dyspareunia and control women.

General Hypotheses

1) Women with dyspareunia will evidence lower pain thresholds than control women (main effect for group).
2) Women with dyspareunia will evidence lower pain tolerance than control women (main effect for group).

3) Pain and sexual primes will decrease pain threshold and tolerance in all women as compared to the neutral primes (main effect for primes).
4) Primes will have different effects on women with dyspareunia than on women without (prime X group interaction).Women with dyspareunia will evidence higher pain thresholds and tolerance in the neutral prime condition as compared to the sexual prime and pain prime conditions, with pain thresholds and tolerance in the sexual and pain prime conditions not being significantly different from each other. In contrast, control women will evidence higher pain thresholds and tolerance in the neutral prime condition as compared to the pain prime condition, but not compared to the sexual prime condition. Additionally, control women will have higher pain thresholds and tolerance in the sexual prime condition as compared to the pain prime condition.
5) Women with dyspareunia will have higher levels of pain catastrophization, somatosensory amplification, negative affect, and sexual dysfunction than control women.

CHAPTER 7

Method

Participants

Recruitment.

Participants were recruited in various ways. Women between the ages of 18 and 29 were recruited via two different methods. Women in Psychology 101 classes at the University of Nevada, Las Vegas (UNLV) were offered research credit in exchange for completing the Female Sexual Function Index (FSFI: Rosen et al., 2000 - SEE APPENDIX I). This measure was used as a screening tool to select women with no sexual dysfunction (control group) and women with dyspareunia who were willing to participate in the study. So as to protect the participants' privacy in terms of how long it took them to complete the measure during class time, we asked all women to complete the entire questionnaire, whether or not they had had sex, and then to let us know at the end of the questionnaire if they had answered truthfully or not (a question added to the FSFI hand-out). Women who reported experiencing pain during sex, as well as women who indicated no pain during sex, were contacted to determine eligibility based on a telephone screening (SEE APPENDIX II). Participants were also recruited via an advertisement placed in the UNLV Psychology Subject Pool Website, as well as through flyers handed out in undergraduate psychology classes and posted on the UNLV campus and around the city of Las Vegas, calling for the participation of women who experience pain during intercourse, as well as women who experience no sexual difficulties. Upon

inquiring about the study via telephone, interested women were administered the telephone screening to determine their eligibility.

All interested potential participants (whether they had completed the FSFI upon screening or not) underwent a brief telephone screening interview. The inclusion criteria for the sexual pain group were: 1) Attempted vaginal penetration in the past 6 months; 2) Pain during intercourse occurring on more than 50% of attempts; 3) A minimum rating of 5/10 for pain intensity experienced during sex; and 4) A minimum rating of 5/10 for distress experienced as a result of painful intercourse, as determined by participant responses to the telephone screening interview. The rationale for the latter two criteria were that we wanted to ensure that the dyspareunia group's pain experience was sufficiently intense and frequent to potentially trigger the classical conditioning pairing of sex and pain that we had hypothesized might be occurring in these women. The inclusion criteria for the no sexual dysfunction (control) group were 1) Vaginal penetration in the past 6 months; 2) No pain during intercourse in the past 6 months; 3) No history of recurrent and persistent genital pain, as determined by participant responses to the telephone screening questionnaire. Exclusion criteria for both groups included: 1) under the age of 18 or over the age of 29; 2) not exclusively heterosexual; 3) currently pregnant.

A total of 245 women from Psychology 101 classes at UNLV were screened. Out of the 245 women, 103 (42%) indicated that they had answered the FSFI truthfully and were willing to be contacted to participate in the experimental phase of the study. Fifty-seven of these women indicated no sexual pain and no sexual dysfunction (control group), and attempts were made to contact all of them. Fourteen were successfully contacted and agreed to participate. The remainder of the control sample was recruited

via the advertisement placed on the UNLV Psychology Subject Pool Website. There was no significant difference in total FSFI score between those women who agreed to participate and those who did not agree or who could not be contacted ($t(38) = -1.79$, $p = .10$).

Out of the 103 women who answered the FSFI truthfully, 25 of the women (24.3%) indicated moderate to severe levels of sexual pain, and attempts were made to contact all of them. Three were successfully contacted, met the criteria for the dyspareunia group as per the telephone screening, and agreed to participate. The rest either did not meet the criteria, or we were unable to make contact with them. The remainder of the dyspareunia sample was recruited via the advertisement on the UNLV Psychology Subject Pool Website and via flyers handed out in undergraduate psychology classes and posted around the UNLV campus and the city of Las Vegas. There was no significant difference in total FSFI score or pain score between those women who agreed to participate and those who did not agree or who could not be contacted ($t(3,35) = -.54$, $p = .62$).

The final sample consisted of 38 women with dyspareunia as per our inclusion criteria and 60 control women with no sexual dysfunction.

Demographics and pain characteristics.

The validity of group assignment (control vs. dyspareunia) was confirmed by a significant group difference in FSFI total score (a measure of global sexual function with higher scores indicating better sexual function) (t (96) = 4.82, $p < .001$); with the dyspareunia group ($M = 21.84$, $SD = 6.17$) scoring significantly lower (more sexual dysfunction) than the control group ($M = 28.21$, $SD = 6.51$). There were also significant

differences in intercourse pain score (with higher scores indicating less pain) between the dyspareunia group (M = 2.60, SD = 1.18) and the control group (M = 5.19, SD = 1.52), ($t(96) = 8.90$, $p < .001$). In terms of the dyspareunia group, the mean intensity of pain experienced during sex was 6.53 on a 10-point scale (SD = 1.21), and the mean level of distress was 6.36 on a 10-point scale (SD = 1.41) and they had had this problem for mean of 35.91 months (approximately 3 years) (SD = 32.80).

In the dyspareunia sample, 52.6% of the participants reported experiencing pain between 50 and 75% of intercourse attempts, and 47.4% reported experiencing pain on greater than 75% of attempts. All women in the dyspareunia sample reported having had sexual intercourse in the past six months, with the mean number of times being 47.2 (SD = 29.14), averaging 7.8 times a month. Eleven of the dyspareunia participants (28.9%) reported experiencing chronic pain other than pain during intercourse, with 36.4% of these women reporting back pain as their other chronic pain. The remainder reported a variety of other pains (e.g. joints, knee, and migraines).

The mean age of the entire sample was 22.07 (SD = 3.20), with no significant difference in mean age between the dyspareunia group (M = 22.16, SD = 3.08) and the control group (M = 22.02, SD = 3.29). Ninety-five percent were right handed.

Ethnic and religious distributions are summarized in Table 1. We found a significant difference between the control and dyspareunia groups with regard to ethnicity, χ^2 (7, N = 98) = 15.73, $p < .05$. This difference seemed to be due to the fact that all of the Asian women (N = 6) and the Pacific Islander women (N = 4) were in the control group (N = 4), and all of the biracial women were in the dyspareunia group (N = 2). We did not, however, analyze results as a function of ethnicity as our sample was not

sufficiently large to do so. No significant group difference was found for religion, χ^2 (7, N = 98) = 5.17, p = .40.

Stimuli

Pictures from the International Affective Picture System (IAPS: Lang, Bradley, & Cuthbert, 1999) were used as priming stimuli. The IAPS provides a set of normative emotional stimuli for experimental investigations of emotion and attention. The IAPS is a large set of standardized, emotionally-evocative, internationally accessible, color photographs that includes contents across a wide range of semantic categories. The IAPS includes over 500 color photographs which have been judged along the dimensions of valence (pleasant-unpleasant), arousal (calm-aroused) and dominance (low-high), by large groups of male subjects, female subjects and children. Eight pictures depicting physical pain, 8 depicting sexual activity as well as 8 neutral pictures were used. The pain pictures depict people in physical pain and include images of mutilated bodies, scars, and dental work. The IAPS identification numbers for the pain pictures are: 3103, 3185, 3195, 3220, 8230, 9042, 9254, 9590. The sexual pictures depict nude men and women engaging in various forms of coupled sexual activity. The identification numbers for the sexual pictures are: 4647, 4669, 4672, 4692, 4694, 4695, 4800, 4810. The neutral pictures depict various household objects and foliage (e.g. mug, shoes, key ring, house). The identification for the neutral pictures are: 7009, 7010, 7032, 7037, 7059, 7224, 7491 7161. T-tests were performed on arousal and valence ratings obtained from the IAPS manual for the 3 sets of pictures. No significant difference was found on arousal ratings between the pain (M = 6.06, SD = .35) and sexual pictures (M = 6.10, SD = .26) (t(14) = .25, p = .805). Significant differences were found on arousal ratings between the pain and

neutral pictures (M = 2.91, SD = .61) (t(14) = 12.66, p = .001) and the sexual and neutral pictures (t(14) = 13.53, p = .001). In regards to valence, a significant difference was found between the pain (M = 2.28, SD = .36) and sexual pictures (M = 5. 16, SD = .53) (t(14) = 14.78, p = .001). A significant difference was also found between the pain and neutral pictures (M = 4.80, SD = .14) (t(14) = 18.65, p = .001) and between the sexual and neutral pictures on valence ratings (t(14) = 4.17, p = .001).

The pictures were displayed on a computer screen, one at a time. Each picture was presented for 5 seconds, with an inter-stimulus interval of 1 second. The series of pictures was then presented again, in the same order, so as to have the total exposure time of the stimuli be approximately 1.5 minutes.

Measures

Female Sexual Function Index (FSFI: Rosen et al., 2000) (SEE APPENDIX I).

The FSFI was administered to all participants to obtain information about sexual function. Some participants completed it as a screening tool used to recruit women who experienced pain during intercourse and women with no sexual dysfunction. Others completed it after they had self-identified as having pain with intercourse and expressed interest in participating in the study. The questionnaire is a brief self-report measure of female sexual function composed of 19 questions divided into 6 subscales: desire (questions 1-2), subjective arousal (questions 3-6), lubrication (questions 7-10), orgasm (questions 11-13), satisfaction (questions 14-16), and pain (questions 17-19). Each question pertains to a separate component of the subscale (i.e. frequency, difficulty, and satisfaction for orgasm). The questions addressing sexual pain inquire about the

frequency of discomfort or pain during vaginal penetration (question 17), frequency of discomfort or pain following vaginal penetration (question 18), and the level of pain during or following vaginal penetration (question 19). Possible responses to the items pertaining to frequency of pain include: Did not attempt intercourse, Almost always or always, Most times (more than half the time), Sometimes (about half the time), A few times (less than half the time), or Almost never or never. For the item regarding level of pain, participants can respond with: Did not attempt intercourse, Very high, High, Moderate, Low, or Very low or none at all. Participants will be selected if they respond with "Almost always or always" to items 17 and 18 and "High" or "Very high" to item 19. The FSFI has been found to have high test-retest reliability (r =.79 -.86) and high internal consistency (Cronbach's alpha values of.82 and higher) (Rosen et al., 2000). In our sample, the FSFI showed high internal consistency, with a Cronbach's alpha value of .95. The FSFI possesses acceptable discriminate validity as evidenced by a significant difference between scores of women with a sexual pain disorder and control groups and those with a pain disorder and all other sexual dysfunctions (Wiegel, Meston, & Rosen, 2005). Divergent validity has been found using the Locke-Wallace Marital Adjustment Test (Meston, 2003).

Pain Catastrophizing Scale (PCS: Sullivan, Bishop, & Pivik, 1995) (SEE APPENDIX III).

The PCS was administered after exposure to the cold-pressor test to assess for differences in catastrophizing based on the group. The PCS consists of 13 statements describing various thoughts and feelings that people may experience while in pain (e.g. ''I keep thinking how badly I want the pain to stop,'' ''I worry all the time about whether

the pain will end''). The PCS yields three factors of catastrophizing including rumination (four items), helplessness (6 items), and magnification (3 items). It is a reliable and valid measure of catastrophizing and has been used extensively in patients with pain. Test-retest reliability has been shown to be between.70 and.75 (Sullivan, Bishop, & Pivik, 1995). In our sample, the PCS showed high internal consistency, with a Cronbach's alpha of. 91. Participants were asked to rank each statement in reference to a regularly experienced non-coital pain according to a 5-point scale (0=not at all, 1=to a slight degree, 2=to a moderate degree, 3=to a great degree, and 4=all the time).

The Rand Mental Health Inventory-18 (MHI-18; Berwick, Murphy, Goldman, Ware, Barsky, & Weinstein, 1991) (SEE APPENDIX IV).

The MHI-18 measures psychological well-being and was designed for use with general populations. Four factors reflect the multidimensional nature of psychological well-being: anxiety, depression, loss of behavioral/emotional control, and general positive affect. The MHI contains 18 items accompanied by 6-point adjectival response scales ranging from 1 (all the time) to 6 (none of the time). Scoring of items is adjusted so that the highest achievable MHI-18 score (108) shows the least favorable health and the lowest possible score (18) is most favorable. Internal consistency coefficients have ranged from .83 to .92 for the four scales and 0.96 for the overall score. In our sample, the MHI showed high internal consistency, with a Cronbach's alpha of .94. One-year test-retest reliability ranged from .56-.64. In terms of validity, the depression and anxiety scales performed very favorably against a criterion diagnosis using the Diagnostic Interview Schedule (Weinstein, Berwick, Goldman et al; 1989).

Somatosensory Amplification Scale (SSAS; Barsky, Wyshak, & Klerman, 1990) (SEE APPENDIX V).

The SSAS is an 11-item self-report questionnaire assessing the tendency to experience ordinary bodily sensations as intense and disturbing. Respondents indicate the degree to which each statement is characteristically true of them on a Likert scale from 1 (*not at all*) to 5 *(extremely*), with higher scores indicating higher levels of distress about somatic symptoms. The SSAS evidences good reliability with test-retest coefficients of .79, Cronbach alphas ranging in the low .80s (Barsky et al., 1990; Sayar, Kirmayer, & Taillefer, 2003), and the ability to distinguish hypochondriacal patients as well as those who make frequent use of medical services from other patients (Barsky et al., 1990; Barsky & Wyshak, 1990). In our sample, the SSAS showed adequate internal consistency, with a Cronbach's alpha value of.71.

Demographic form (SEE APPENDIX VI).

Participants completed a questionnaire regarding demographic variables (e.g. age, ethnicity, religious affiliation, sexual orientation and handedness).

Apparatus

Cold-pressor test.

Cold-pressor pain, induced by the submergence of the hand in cold water, is suggested to be a method that mimics the effects of chronic conditions effectively because of its unpleasantness (Mitchell, MacDonald, & Brodie, 2004), and it has excellent reliability and validity (Edens & Gil, 1995). The procedure has been used in studies investigating a wide range of pain management techniques such as acupuncture, hypnosis, neutral distraction, and cognitive preparation (Mitchell et al., 2004). The cold-

pressor task is sensitive enough to show differences on pain threshold and tolerance between clinical and non-clinical samples (e.g., Brands & Schmidt, 1987).

The cold-pressor apparatus consisted of a portable ice chest measuring approximately 50x30x30 cm^3. The container was divided into two sections by a thick plastic screen containing holes. It was filled with water, with the ice placed on one side of the screen and the participants' hand immersed in the ice-free side. The water was maintained between 3 and 4º C and was kept circulating by a pump during immersion. Water temperature was measured using a digital thermometer immersed in the water. Mitchell, MacDonald, and Brodie (2004) have noted that there is a lack of standardization and control of water temperature among studies employing the cold-pressor task. Their results have demonstrated that small differences in water temperature have a significant effect on pain intensity and tolerance time. They suggest using a cold-pressor device that maintains a constant temperature of circulating water to ensure comparable and reliable results (Mitchell, MacDonald, & Brodie, 2004). Esteve and Camacho (2008) suggest a range of 2-4º C to allow for longer tolerance times. These authors state that temperatures of 0-2º C are frequently used to provoke more intense pain, and numbing effects usually appear quickly. During testing, participants were seated in a comfortable chair adjacent to the container where they were able to immerse their non-dominant hand comfortably into the container. A second, separate plastic container was filled with water at room temperature (20-22º C). Participants immersed their hand in the room temperature water for 3 minutes prior to completing the cold-pressor task, in order to stabilize their hand temperature.

Pain threshold.

Pain threshold is the point of first noticeable pain. Pain threshold was assessed by participant self-report. Participants were asked to indicate when they began to feel pain during the cold-pressor task. This time was recorded in seconds.

Pain tolerance.

Pain tolerance is the upper limit for endurance of painful stimulation. Pain tolerance was assessed by self-report. Participants were asked to remove their hand from the ice water when the pain became unbearable. The amount of time the participant was able to immerse their hand was recorded in seconds.

Procedure

Participants were recruited through three different means. In the first, the primary experimenter or a research assistant went into Psychology 101 classes at the University of Nevada, Las Vegas and announced that they were conducting a study on female sexuality. All willing female students were asked to complete the FSFI and were given research credit for completing the measure. On the last page, the students were invited to leave a name and contact phone number if they were interested in participating in the study for research credit. The completed FSFIs with contact information were scored and those who indicated that they had answered truthfully, endorsed the presence of dyspareunia or the absence of sexual dysfunction, and who agreed to be contacted were contacted by the primary experimenter or a research assistant. If the contacted participants continued to express a desire to participate, then a telephone screening (SEE APPENDIX II) containing questions related to sexual pain and sexual dysfunction was

administered, to determine eligibility criteria. If they met criteria for the dyspareunia or the control group, an appointment was set up for them to come to the lab for testing.

In the second method of recruitment, an advertisement was placed on the UNLV Psychology Subject Pool Website, inviting women who either experience pain during intercourse, or who do not experience pain during intercourse, to participate in a study regarding female sexuality. Those who wished to sign up for the experiment were required to either call the lab, or leave a contact phone number. These potential participants were contacted by either the primary experimenter or a research assistant and were administered the telephone screening to determine eligibility. If they met criteria for the dyspareunia or the control group, an appointment was set up for them to come to the lab for testing. In the third method of recruitment, a research assistant attended psychology 101 classes at UNLV and handed out flyers asking for women who experience pain during sex to participate in a research study. These same flyers were posted around campus and the city, to recruit women with dyspareunia. Interested women then contacted the experimenter and were administered the telephone screening to determine eligibility. If they met criteria for the dyspareunia group, an appointment was set up for them to come to the lab for testing.

Before arriving for their scheduled appointment, participants were randomly assigned to one of three conditions using a roll of a die (with the numbers 1 and 2 indicating the sexual prime group; the numbers 3 and 4 indicating the pain prime group; and the numbers 5 and 6 indicating the neutral prime group). Participants arrived at the lab and began the experiment by reading and signing the consent form which describes the nature of the experiment.

Next, the participant was presented with the eight pictures on a computer screen. The experimenter stated the following: "You will be viewing a set of pictures, which may cause you some discomfort. It is important, though, that you attend closely to the pictures, as I may ask you about them later". Participants in the sex prime group were presented the pictures depicting sexual activity. The participants in the pain prime group were presented the pictures depicting physical pain. The participants in the neutral prime group were presented the neutral pictures.

The cold-pressor test was then administered. Participants were shown the cold-pressor device. Each participant then immersed their non-dominant hand in the container filled with room-temperature water for 3 minutes to regulate the hand temperature. Before they introduced their non-dominant hand into the container of cold water, participants were instructed on the procedures of the cold-pressor task. They were told that they will immerse their hand in the water and will be asked to indicate when they begin to feel pain. They were then told to remove their hand once the pain becomes unbearable. The experimenter used a stopwatch to measure threshold and tolerance times. According to Edens and Gil (1995), exposure time should never be longer than 300 seconds to avoid excessive exposure to the cold water, which could cause lesions on the arms. For this reason, immersion time was limited to 5 minutes. The participants were not be informed of this limit to reduce the risk of competitiveness and to avoid any misconception that their hand was expected to be submerged in the cold water for that specific length of time.

After the cold-pressor test was completed, participants completed the PCS, FSFI, SSAS and the MHI-18. Participants also completed a short questionnaire regarding

demographic variables (e.g. age, ethnicity, religious affiliation). The participants were then given a debriefing form containing information about the study, and for the dyspareunia participants, a form containing referrals to health care professionals, information about treatment options, and suggested readings on dyspareunia and female sexuality. Participants were encouraged to ask questions about the study or about dyspareunia. All participants recruited from the Psychology 101 classes were given 1.0 course credits for participation.

Data Analysis and Hypotheses

Descriptive analyses were computed for participant socio-demographic and background variables.

Pain threshold.

Pain threshold times were analyzed using a 3 (Condition: sex prime, pain prime, neutral prime) X 2 (Group: Control vs. Dyspareunia) ANOVA. Post-hoc tests were performed to determine main effects, interaction and simple effects.

Hypothesis #1: There will be a main effect for group such that women with dyspareunia will have lower pain thresholds than control women regardless of prime condition.

Hypothesis #2: There will be a main effect for prime such that all women will have lower pain thresholds in the pain prime than in the sexual or neutral prime conditions.

Hypothesis #3: There will be a Group x Condition interaction such that primes will have differential effects depending on whether women have dyspareunia. We expect that women with dyspareunia will evidence higher pain thresholds in the neutral prime condition as compared to the sexual prime and pain prime conditions, with pain thresholds in the sexual and pain prime conditions not being significantly different from

each other. Whereas, we expect that control women will evidence higher pain thresholds in the neutral prime condition as compared to the pain prime condition, but not compared to the sexual prime condition. We also expect control women to have higher pain thresholds in the sexual prime condition as compared to the pain prime condition.

Pain tolerance.

Pain tolerance times were analyzed using a 3 (Condition: sex prime, pain prime, neutral prime) X 2 (Group: Control vs. Dyspareunia) ANOVA. Post-hoc tests were performed to determine main effects, interaction and simple effects.

Hypothesis #4: There will be a main effect for group such that women with dyspareunia will have lower pain tolerance than control women regardless of prime condition.

Hypothesis #5: There will be a main effect for prime such that all women will have lower pain tolerance in the pain prime than in the sexual or neutral prime conditions.

Hypothesis #6: There will be a Group x Condition interaction such that primes will have differential effects depending on whether women have dyspareunia. We expect that women with dyspareunia will evidence higher pain tolerance in the neutral prime condition as compared to the sexual prime and pain prime conditions, with pain tolerance in the sexual and pain prime conditions not being significantly different from each other. Whereas, we expect that control women will evidence higher pain tolerance in the neutral prime condition as compared to the pain prime condition, but not compared to the sexual prime condition. We also expect control women to have higher pain tolerance in the sexual prime condition as compared to the pain prime condition.

Sexual function.

Sexual functioning was analyzed using an independent samples t-test to determine group (control vs. dyspareunia) differences on total scores on the FSFI minus the pain subscale.

Hypothesis #7: Women with dyspareunia will have lower overall sexual functioning (lower scores on the FSFI) than control women.

Pain catastrophization.

Pain catastrophization was analyzed using an independent samples t-test to determine group (control vs. dyspareunia) differences on total scores on the PCS.

Hypothesis #8: Women with dyspareunia will have higher pain catastrophization scores than control women.

Mental health.

Overall mental health was analyzed using an independent samples t-test to determine group (control vs. dyspareunia) differences on total scores on the MHI-18. Depression and anxiety subscale scores were analyzed via independent samples t tests.

Hypothesis #9: Women with dyspareunia will have lower overall mental health (higher scores on the MHI-18), as well as higher scores on the depression and anxiety subscales as compared to control women.

Somatosensory amplification.

Somatosensory amplification was analyzed using an independent samples t-test to determine group (control vs. dyspareunia) differences on total scores on the SSAS.

Hypothesis #10: Women with dyspareunia will have higher somatosensory amplification scores than control women.

CHAPTER 8

Results

Overview of Analyses

The analyses are organized according to the hypotheses proposed in the aims of the study, followed by exploratory analyses.

The first set of analyses presented refer to the primary hypotheses of the study (1-6) regarding pain tolerance and threshold as potentially varying as a function of group membership and prime condition. The results of two 3 (condition: pain prime, sex prime or neutral prime) x 2 (group: control or dyspareunia) ANOVAs for the two dependent variables, pain threshold and pain tolerance, are presented. Results of *t*-tests examining group differences in the cognitive-affective and sexual function measures (pain catastrophization [PCS], somatosensory amplification [SSAS], mental health [MHI], and sexual function [FSFI]) and accompanying hypotheses 7-10 then follow.

In terms of exploratory analyses, we investigated relationships between pain threshold and tolerance and our cognitive-affective and sexual function measures in the no-dysfunction sample and then in the dyspareunia sample. Multiple regression analyses were conducted to examine whether overall sexual function (minus the pain subscale) and cognitive-affective variables significantly predicted pain threshold and tolerance levels in the no-dysfunction sample and then in the dyspareunia sample. Finally, the dyspareunia group was split into participants who reported experiencing pain during sex on 50-75% of attempts, and those who reported pain on > 75% of attempts. The results of two 2 (Dyspareunia Pain Frequency: Low vs. High) X 3 (Condition: Pain prime, Sex prime or

Neutral prime) ANOVAs on pain threshold and pain tolerance are presented. Finally, the results of *t*-tests examining high/low pain group differences in the cognitive-affective and sexual function measures are presented.

Pain threshold

Means and standard deviations for pain threshold are shown in Table 2 as a function of group and condition. A 2 (Group: Dyspareunia vs. Control) X 3 (Condition: Pain prime, Sex prime or Neutral prime) ANOVA was conducted with pain threshold as the dependent variable.

There was a main effect for Group, F (1,92) = 5.61, p = .02, η_p^2 = .06, such that women with dyspareunia had lower pain thresholds than control women. There was no main effect for Condition, and no significant Group X Condition interaction (see Table 3 and Figure 1).

Thus, in terms of pain threshold, Hypothesis #1 was confirmed (that the dyspareunia group would have lower pain thresholds than controls) while neither Hypothesis #2 (that the pain prime condition would evidence lower thresholds than the sex prime condition) and Hypothesis #3 (that there would be a Group X Condition interaction whereby the dyspareunia group would evidence higher pain thresholds in the neutral prime condition as compared to the sexual prime and pain prime conditions, while the control group would evidence higher pain thresholds in the neutral prime condition as compared to the pain prime condition, but not compared to the sexual prime condition) were supported.

Pain tolerance

Means and standard deviations for pain tolerance are shown in Table 2 as a function of group and condition. A 2 (Group: Dyspareunia vs. Control) X 3 (Condition: Pain prime, Sex prime or Neutral prime) ANOVA was conducted with pain threshold as the dependent variable.

There was a main effect for Group, F (1,92) = 6.47, p = .01, η_p^2 = .07 such that women with dyspareunia had lower pain tolerance than control women. There was no main effect for Condition, and no significant Group X Condition interaction (see Table 4 and Figure 2).

Thus, in terms of pain tolerance, Hypothesis #4 was confirmed (that the dyspareunia group would have lower pain tolerance than controls) while neither Hypothesis #5 (that the pain prime condition would evidence lower tolerance than the sex prime condition) and Hypothesis #6 (that there would be a Group X Condition interaction whereby the dyspareunia group would evidence higher pain tolerance in the neutral prime condition as compared to the sexual prime and pain prime conditions, while the control group would evidence higher pain tolerance in the neutral prime condition as compared to the pain prime condition, but not compared to the sexual prime condition) were supported.

Cognitive-affective and sexual function measures

Means and standard deviations for sexual function variables, pain catastrophization, mental health, and somatosensory amplification are shown in Table 5 as a function of group.

Sexual function.

Sexual function was analyzed using an independent samples t-test to determine group (control vs. dyspareunia) differences on total Female Sexual Function Index (FSFI) scores minus the pain subscale (FSFI minus pain). A significant difference was found, $t(96) = 3.25$, $p < .01$, Cohen's $d = 0.67$, with the dyspareunia group having lower scores (M =19.24, SD = 5.80) than the control group (M = 23.02, SD = 5.51), indicating poorer overall sexual function in the dyspareunia group. Hypothesis #7, which stated that women with dyspareunia would have lower overall sexual functioning than control women, was therefore supported.

Pain catastrophization.

Pain catastrophization was analyzed using an independent samples t-test to determine group (control vs. dyspareunia) differences on total scores on the Pain Catastrophization Scale (PCS). A significant difference was found, $t(96) = 2.30$, $p < .05$, Cohen's $d = 0.48$, with the dyspareunia group having higher overall PCS scores (M = 23.03, SD = 10.49) than the control group (M = 17.92, SD = 10.89). Thus, hypothesis #8 was confirmed, as women with dyspareunia did have higher overall PCS scores than control women.

Total scores for the Pain Catastrophization subscales (Rumination, Magnification, and Helplessness) were analyzed using independent samples t-tests to determine group (control vs. dyspareunia) differences. A significant difference was found on the Helplessness subscale $t(96) = 2.80$, $p < .01$, Cohen's $d = 0.58$, with the dyspareunia group having higher scores (M = 9.74, SD = 5.11) than the control group (M = 6.78, SD = 5.13).

No significant group differences were found on the Rumination and Magnification subscales.

Mental health.

Mental health was analyzed using an independent samples t-test to determine group (control vs. dyspareunia) differences on total scores on the Rand Mental Health Inventory (MHI-18). Depression and anxiety subscale scores were analyzed via independent samples t tests. No significant group difference was found on total MHI-18 scores, nor on the depression or anxiety subscales. There was thus no support for hypothesis #9, as women with dyspareunia did not have higher overall MHI scores (worse mental health), nor did they have higher scores on the anxiety or depression subscales as compared to control women.

Somatosensory amplification.

Somatosensory amplification was analyzed using an independent samples t-test to determine group (control vs. dyspareunia) differences on total scores on the Somatosensory Amplification Scale (SSAS). No significant group difference was found. There was thus no support for hypothesis #10 which stated that women with dyspareunia would have higher total SSAS scores than control women.

Relationship of cognitive-affective and sexual function measures to pain tolerance and thresholds

Although a large number of correlations were run in the following two sections, thereby elevating the probability of Type I error, we here report all correlations with an alpha < .05 given the exploratory nature of the analyses. The Bonferroni corrected alpha would be <.0006 for the no-dysfunction sample and <.0004 for the dyspareunia sample.

No-dysfunction sample.

Bivariate correlations were conducted to investigate the relationship of overall sexual function and cognitive-affective variables to pain threshold, pain tolerance and intercourse frequency (sex frequency) within the no-dysfunction sample (see Table 6). Pain threshold and pain tolerance were near significantly correlated (r = .25; p = .055). In addition, pain threshold was significantly correlated with PCS magnification, r = .29, p < .05, and MHI anxiety, r = .26, p < .05. Pain tolerance was significantly negatively correlated with PCS rumination, r = -.45, p <. 01, PCS helplessness, r = -.34, p <. 01, and PCS total, r = -.35, p <. 01. No other variables correlated significantly with pain threshold, pain tolerance or with intercourse frequency.

Multiple regression analyses.

A multiple regression analysis using the enter method was conducted to test if total scores on the FSFI (minus pain items), PCS, SSAS and MHI together significantly predicted participants' pain threshold levels. The overall model was not significant (see Table 7).

Another multiple regression analysis using the enter method was conducted to test if total scores on the PCS, SSAS and MHI significantly predicted control participants' pain tolerance levels. Using the enter method, a significant model emerged, F (4,55) = 3.32, p < .05. The model explains 14% of the variance (adjusted R^2=.14). Table 8 provides the information for the predictor variables entered into the model. PCS total score was a significant predictor, while FSFI minus pain, SSAS total score, and MHI total score were not.

Dyspareunia sample

Bivariate correlations were conducted to investigate the relationship of overall sexual function, cognitive-affective measures, pain characteristics and pain threshold and tolerance within the dyspareunia sample (see Table 9). Of interest was whether pain threshold, tolerance, and pain characteristics were significantly correlated with the cognitive affective measures and sexual function. Pain threshold and pain tolerance were significantly correlated $r = .38$, $p < .05$ with each other. However, pain threshold and pain tolerance were not significantly correlated with overall sexual function or any of the cognitive-affective measures.

Certain pain characteristics did correlate with cognitive-affective variables. Level of reported pain intensity and FSFI pain were significantly negatively correlated, $r = -.52$, $p<.01$, indicating that the higher the pain intensity, the lower the FSFI score (with lower FSFI scores indicating more pain). Level of reported pain distress correlated with PCS total score ($r = .33$, $p < .01$), SSAS total score ($r = .46$, $p < .01$), and MHI anxiety ($r = .33$, $p < .05$). Pain duration (the length of time a woman had been experiencing pain during sex) was negatively correlated with PCS rumination, $r = -.44$, $p < .01$, PCS helplessness, $r = -.41$, $p < .01$, PCS magnification, $r = -.48$, $p < .01$, and PCS total, $r = -.51$, $p < .01$, indicating that the longer a woman had been experiencing pain during sex, the lower her levels of pain rumination, helplessness and magnification, and overall pain catastrophization.

Intercourse frequency correlated significantly with MHI depression, $r = -.46$, $p < .01$ and MHI total score, $r = -.41$, $p < .05$, indicating that the more frequently a woman engaged in sex, the lower her levels of depression and the better her overall mental

health. Intercourse frequency also correlated with FSFI satisfaction, $r = .56$, $p < .01$, and FSFI total minus the pain subscale, $r = .36$, $p < .05$, indicating that more frequent sex was correlated with higher levels of sexual function.

Multiple regression analyses.

Multiple regression analyses using the enter method were conducted to test if total scores on the FSFI (minus pain), PCS, SSAS and MHI significantly predicted dyspareunia participants' pain threshold levels. The overall models were not significant for either pain threshold or pain tolerance (see Tables 10 and 11).

Group differences between high and low frequency dyspareunia pain.

The dyspareunia group was split into participants who reported experiencing pain during sex on 50-75% of attempts, and those who reported pain on 75% or more of attempts. A 2 (Dyspareunia Pain Frequency: Low vs. High) X 3 (Condition: Pain prime, Sex prime or Neutral prime) ANOVA was conducted for pain threshold and pain tolerance. For both pain and tolerance thresholds, there was no main effect for Pain Frequency Group, nor for Condition, and there was no Pain Frequency Group X Condition interaction (see Tables 12 and 13).

There were also no Pain Frequency Group Differences in FSFI total minus pain score, PCS total scores, SSAS total scores, or MHI total, depression or anxiety scores.

CHAPTER 9

Discussion

In our attempt to investigate the impact of sexual and pain primes on pain perception in women with dyspareunia as compared to control women, we found the following results. Overall, women with dyspareunia had lower pain threshold and tolerance levels than no-dysfunction women. We found no effect of priming condition on pain perception, nor any interaction as a function of condition and group. We found that for all women, pain tolerance and threshold were related to pain catastrophization and mental health variables. Women with dyspareunia also exhibited lower overall sexual function and higher pain catastrophization as compared to control women. Finally, in the dyspareunia sample, certain pain characteristics were related to cognitive-affective variables in interesting ways. Following will be an interpretation and discussion of each of these results.

Group differences in pain threshold and tolerance

The major finding of this study is that women with dyspareunia displayed lower peripheral pain threshold and tolerance levels as compared to control women. These findings are supported by previous research, demonstrating overall sensory dysregulation in women with dyspareunia (Granot, Friedman, Yarnitsky, & Zimmer, 2002; Granot & Lavee, 2005; Johannesson, de Boussard, Jansen, & Bohm-Starke, 2007; Payne et al., 2007; Pukall et al., 2002; Pukall et al., 2006). These studies all showed that women who experience pain in the genital region during sexual intercourse are more sensitive than

control women to pain stimuli in non-genital regions. While effect sizes were not reported for other studies, we found medium effect sizes for group differences in pain threshold and tolerance (η_p^2 = .06-.07).

Our group differences in pain threshold and tolerance are unique and important in comparison to previous studies demonstrating a sensory dysregulation in women with dyspareunia. We were able to demonstrate this peripheral sensitivity with a highly general pain paradigm (i.e., the cold-pressor test). While other studies have utilized more focused and specific forms of experimental pain induction such as pressure algometers or dolorimeters (Giesecke et al., 2004; Pukall et al., 2002), Von Frey filaments (Pukall et al., 2002; Payne et al., 2007), and heat pain stimuli (Granot, 2005; Granot et al., 2002; Sutton et al., 2009), our group differences emerged using cold temperature pain induction in the hand, which is a very general measure of pain perception. Furthermore, most of these aforementioned studies used samples of women with PVD, a specific sub-type of dyspareunia. Our study is one of the first to demonstrate sensory dysregulation in a sample of women with various forms of dyspareunia and provides further evidence highlighting that central pain mechanisms may be involved in women with dyspareunia.

These findings also speak to the ongoing debate about the classification of dyspareunia in the upcoming DSM-5. Some researchers, (e.g., Binik, 2005; 2010), argue that dyspareunia would be better classified as a pain disorder that interferes with sexual functioning, and have used previous data showing sensory dysregulation in support of their argument. Our findings of a heightened sensitivity to peripheral pain in a heterogeneous sample of women with dyspareunia further support this push to view dyspareunia as a serious pain condition that is not etiologically linked to psychosexual

disturbances. Indeed, the current proposal for the DSM-5 criteria for dyspareunia include labeling it as "genito-pelvic pain/penetration disorder", with five dimensions as the focus of assessment: percentage success of vaginal penetration; pain with vaginal penetration; fear of vaginal penetration or of genitopelvic pain during vaginal penetration; pelvic floor muscle dysfunction; and medical co-morbidity (Binik, 2010). This classification scheme for dyspareunia places the pain symptoms of the disorder in the forefront, highlighting their importance and privileging them over the fact that they happen to interfere with sexual intercourse.

Evidence of pain sensitivity that generalizes beyond the vaginal, vulvar or genital region reaffirms that dyspareunia may, in fact, be a pain syndrome akin to other pain syndromes that have long been taken much more seriously by health professionals. Our findings have important implications for the treatment of dyspareunia in that they point to the necessity of treating dyspareunia as a potentially centrally mediated pain condition, similarly to other chronic pains (e.g., chronic low back pain, migraines, phantom limb pain). That conceptual shift away from sexual dysfunction rooted in negative attitudes toward sexuality or sexual trauma broadens the assessment and treatment playing field.

Approaching dyspareunia treatment from a multidimensional, multidisciplinary perspective has now been accepted by most experts in the field, as exemplified by the recent recommendations of the Third International Consultation on Sexual Medicine relating to women's sexual pain disorders (van Lankveld et al., 2010). To date, these multidisciplinary treatment efforts have targeted both the physical pain and the cognitions related to pain and sex in women with dyspareunia. Growing evidence indicates that pelvic floor physical therapy (PFPT), which targets the increased tension in the pelvic

floor muscles that play an important role in maintaining and exacerbating genital pain in dyspareunia, is effective in reducing genital pain during intercourse, as well as during gynecological exams (Goldfinger, Pukall, Gentilcore-Saulnier, McLean, & Chamberlain, 2009). Furthermore, Cognitive Behavioral Therapy (CBT) has been shown to be effective in reducing dyspareunic pain in part by targeting the maladaptive cognitions related to pain that may arise as a result of suffering from a pain condition. In fact, CBT for dyspareunia incorporates many pain management interventions used with any number of chronic pain conditions entirely unrelated to sexuality. Pairing physical therapy with CBT appears to provide women with dyspareunia the best chance for successful reductions in pain intensity and concomitant improvements in sexual function (Bergeron et al., 2001; Bergeron, Khalifé, Glazer, & Binik, 2008). Even when pain reduction is not attainable, CBT can help women adopt a different, less catastrophizing stance toward the pain, thereby relieving distress.

Effect of pain and sex primes on pain perception

We did not find any significant main effects for prime condition (sex or pain), nor an interaction between condition and group. Our lack of results in this regard was quite unexpected. In terms of our pain primes, previous research has demonstrated changes in cold-pressor pain in response to cognitive interventions that instruct participants to distract from pain (e.g., Baker & Kirsch, 1991; Blitz & Dennerstein, 1971; Michael & Burns, 2004; Van Damme, Crombez, De Wever, & Goubert, 2008). These interventions involving various strategies to cope with pain such as distraction, imagining pleasant events, or cognitive restructuring, have shown to attenuate the pain experience in both chronic pain patients and in controls. Conversely, the presentation of stimuli signaling

pain should increase attentional focus towards pain and decrease thresholds and tolerance to experimentally induced pain. This has been demonstrated in studies showing that the mere representation of pain stimuli (in the form of words or even pictures) can activate a heightened emotional experience and elicit attention interference in patients with chronic pain (Crombez, Hermans, & Adriaensen, 2000). This has been shown to lead to an increased sensitivity to pain. Furthermore, when presented with images of an unpleasant nature (e.g., fear or disgust-inducing), participants report higher pain intensity ratings (Rhudy, Williams, McCabe, Rambo, & Russell, 2006) and exhibit decreased pain tolerance levels (Greenstein, 1984; Meagher, Arnau, & Rhudy, 2001).

The aforementioned findings provided us with the theoretical basis for our hypothesis that the presentation of pain stimuli would lower pain threshold and tolerance levels in our dyspareunia and control women. Our unexpected lack of effect in the pain prime condition leads us to wonder why our stimuli did not exert the effect we had expected. One possible explanation could relate to the timing of the presentation of the images in relation to the cold-pressor task. One published study that utilized a highly similar methodological set-up to our study was conducted by Meagher and colleagues in 2001. They examined the impact of viewing unpleasant (fear or disgust), pleasant (erotic or nurturing), and neutral photographic slides on cold-pain perception in healthy men and women. In their experiment, participants viewed one of three slide shows immediately before undergoing a cold-pressor task. These authors used pictures from the International Affective Picture System (IAPS: Lang, Bradley, & Cuthbert, 1999), and had the participants immerse their hand in the cold water after the slide-show presentation. They found that viewing fear and disgust slides decreased pain intensity and unpleasantness

thresholds, but only the fear slides decreased pain tolerance. According to the results from Meagher and colleagues' (2001) study, presenting visual stimuli prior to having participants complete the cold-pressor test should have induced changes in pain perception.

However, a major, and possibly instrumental, difference between our study and Meagher et al.'s (2001) concerns the issue of timing - the delay between stimulus presentation and the cold-pressor test. We had our participants immerse their non-dominant hand for 4 minutes into a container of room temperature (20-21°c) water after viewing the image slide show, and prior to the cold-pressor test. As shown in many studies utilizing the cold-pressor, it is imperative to stabilize participants' hand temperatures to ensure that all participants begin the cold-pressor test with the same hand temperature. Meagher and colleagues (2001) had participants immerse their hand in the room temperature water while viewing the visual stimuli. It is possible that having had participants complete this hand immersion post visual stimuli presentation created too long a delay between stimulus presentation and the cold-pressor test. This delay may have significantly decreased the effectiveness of the priming, as participants would have had too much time for other thoughts or stimuli to interfere with the effects of the visual stimuli. Other studies examining the effects of various types of cognitive interventions on pain perception had participants complete the cold-pressor task immediately following the intervention (e.g. Baker & Kirsch, 1991; Horowitz & Telch, 2007; Michael & Burns, 2004). Therefore, it seems prudent to administer the cold-pressor test in as close proximity to the experimental manipulation as possible to detect changes in pain perception directly attributable to the stimuli. We decided to administer the room

temperature water bath to participants post stimuli presentation due to our concern that having them complete this task while viewing the images would either be a distraction away from the images, or would act as a prime for the cold-pressor test that would follow. While participants were informed that they would be undergoing a cold-pressor test, we did not want them thinking about or worrying about this test while viewing the stimuli. We now think it might have been wiser to introduce the room-temperature water either during the presentation of visual stimuli, or prior to it, so as not to interfere with the potentially priming effects of the stimuli.

Another possible explanation for why our pain pictures did not effect changes in pain perception in comparison to neutral pictures lies in the length of time during which the stimuli were presented. The images we presented to participants were obtained from the IAPS. The IAPS is a large set of standardized, emotionally-evocative color photographs that have been judged along the dimensions of valence (pleasant-unpleasant), arousal (calm-aroused) and dominance (low-high), by large groups of men and women. We used eight photos depicting physical pain, eight depicting sexual activity and eight neutral pictures. The pictures were displayed on a computer screen, one at a time. Each picture was presented for five seconds, with an inter-stimulus interval of one second. The series of pictures was then presented again, in the same order, so as to have the total exposure time of the stimuli be approximately 1.5 minutes. We thought that this length of stimulus presentation would be sufficient to create the priming effects we had anticipated, and to produce the resulting expected differences in pain threshold and tolerance. Perhaps our lack of significant differences between pain and other conditions

came as a result of the participants not being exposed to the stimuli for a long enough interval.

Brauer, de Jong, and colleagues (2009) used photos from the IAPS to examine whether women with dyspareunia showed negative affective associations with sexual stimuli. Participants completed a modified Pictorial Affective Simon Task (AST) to assess automatic affective responses to images. Participants were presented with 12 erotic and 12 non-erotic images, six of a positive valence and 6 of a negative valence. The women were instructed to respond with "positive" or "negative" to stimuli, depending on whether they were presented in a landscape format or a portrait format. Participants were supposed to ignore the valence of the stimuli and respond solely based on the physical orientation of the image. Images were presented over 192 trials, thereby exposing the participants to each image numerous times. In using this modified version of the Pictorial Affective Simon Task, Brauer and colleagues (2009) exposed their participants to the stimuli over repeated trials and over a longer period of time than in the our study. While Brauer, de Jong and colleagues did not examine the effects of the erotic images on pain perception, it could be surmised that had we presented our participants with our stimuli over more trials and over a longer period of time, we would have had a much greater likelihood of inducing the priming effects we were hoping for. Furthermore, had our participants viewed our stimuli over a longer period of time, perhaps it would not have made a difference that we introduced a delay between the stimuli and cold-pressor by having them stabilize their hand temperature during that interval. The longer exposure to our stimuli may have rendered their effects sufficiently strong enough to change pain perception even after such a delay.

While we had a theoretical basis to predict that our pain primes would decrease pain threshold and tolerance levels in all women, we were uncertain as to what the effects of our sexual primes would be. This was primarily an exploratory question. We had some reason to believe that women with dyspareunia would exhibit a different reaction to sexual stimuli than control women, based on the voluminous data demonstrating how sexuality is impacted in dyspareunia. Studies have shown that women with dyspareunia report greater sexual dissatisfaction (Gates & Galask, 2001), lower frequencies of intercourse and self-stimulation, lower levels of desire, arousal, pleasure, lubrication, and less success at achieving orgasm (Brauer, ter Kuile, Gates & Galask, 2001; Janssen, & Laan, 2007; Jantos & White, 1997; Meana, Binik, Khalifé, & Cohen, 1997; Nunns & Mandal, 1997; Payne et al., 2007; Reissing, Binik, Khalifé, Cohen, & Amsel, 2003; Thaler, Meana, & Lanti, 2009) as compared to women who do not have pain with intercourse. They also report more negative attitudes and thoughts about sexuality, more negative sexual self-concepts, and more depressive symptoms than controls (Gates & Galask, 2001; Meana & Lykins, 2009; Nunns & Mandal, 1997; Sutton, Pukall, & Chamberlain, 2009). Based on the scarce amount of data on the effects of sexual stimuli on sensation, we could have expected to see either decreases or increases in pain sensitivity contingent on our sexual stimuli. Whipple and Komisaruk (1985) demonstrated a decrease in finger pain sensitivity in response to vaginal self-stimulation (pressure applied to the anterior vaginal wall) in healthy women. King and Alexander (2000) found increases in pain sensitivity of the hand in response to auditory sexual stimuli in women. However, the prediction that exposure to sexual stimuli would impact

pain sensitivity was necessarily speculative as there has been no research on the impact of sexual stimuli on pain perception.

There are two possible explanations for why we did not see either increases or decreases in pain threshold and tolerance in women with dyspareunia as a result of our sexual stimuli. The first explanation relates to the aforementioned delay between the presentation of the stimuli and the administration of the cold-pressor test, as well as to the possibility that the stimuli were not presented for a sufficiently long duration to evoke priming effects.

The second explanation is an interesting one, albeit based on null findings which always requires interpretative caution. It speaks to the fundamental question of the impact and role of sex in the experience of dyspareunia, a disorder that involves both pain and sex. It is possible that sexual stimuli, at least in the form of images, do not prime pain perception one way or another for women with dyspareunia and therefore do not produce changes in peripheral pain sensation. Our study was the first to examine the effect of visual sexual stimuli on pain threshold and tolerance in women with dyspareunia. One previous study, conducted by Meagher and colleagues (2001), failed to show any changes in cold-pressor pain intensity ratings or tolerance levels in healthy women in response to viewing erotic images from the IAPS. Another study examining the impact of sex stimuli on women with dyspareunia also failed to find an effect. Thaler et al. (2009) examined basic memory for pain- and sex-related words in women with dyspareunia and in no-pain controls. Women with dyspareunia evidenced more false memories for pain words than did control women, and pain words elicited more false memories than any other type of word for women reporting sexual pain. Sex, however, did not appear to interfere with

memory to the same extent as did pain. Sexual stimuli in that study did not have an impact on women with dyspareunia in the same way that pain stimuli did.

There is other research demonstrating that sexual stimuli do not act in ways that might be expected for women with dyspareunia. Brauer, de Jong, and colleagues (2009) showed women with dyspareunia sexual images to assess whether automatic negative associations are involved in dyspareunia. They found that while women with dyspareunia self-reported weaker positive (i.e., arousal and desire) and stronger negative (i.e., fear and aversion) associations with sexual images than did controls, both women with and without dyspareunia had primarily positive automatic affective associations with sexual stimuli. These findings show that sexual stimuli elicit different types of associations at the automatic, or non-conscious level than at the deliberate or conscious level. At the automatic level, women with dyspareunia and women without dyspareunia reacted similarly. Similarly to studies demonstrating that women with dyspareunia display comparable levels of genital, or physiological arousal, to sexual stimuli as controls, but show lower levels of self-reported arousal, Brauer, de Jong and colleagues' (2009) study highlights the complexities of the sexual response. Clearly, it does not unfold in predictable ways in women with dyspareunia. Theoretically, if the women in our study were showing positive automatic associations with the sexual stimuli, then it makes sense that these stimuli did not act akin to pain stimuli and did not produce noticeable differences in pain perception.

If sexual stimuli are not acting as conditioned pain stimuli for women with dyspareunia, then this can have important implications for the treatment of dyspareunia. CBT, as currently administered for women with sexual pain, operates on the assumption

that the sexual and pain components of dyspareunia are somewhat separate. If sexual stimuli do not act akin to pain stimuli, then CBT may be well-advised to have women with dyspareunia engage in non-intercourse sexual activities in the goal of increasing sexual desire and arousal because women with dyspareunia can separate the painful components of sex from the non-painful ones. Therefore, focusing on non-penetrative and non-painful sexual activities such as masturbation, caressing, kissing, and touching most likely helps women with dyspareunia connect with the pleasurable aspects of sexual activity and thereby increases sex drive and subjective arousal.

Relationship between pain catastrophization and pain perception

We conducted exploratory analyses to investigate relationships between pain threshold and tolerance, and pain catastrophization in our sample. As expected, we found that pain threshold and pain tolerance were significantly correlated, and that pain tolerance was significantly negatively correlated with pain catastrophization. Our findings add to the substantive body of literature demonstrating that pain catastrophizing is associated with heightened pain experience (Sullivan et al., 2001). Specifically, catastrophizing has been shown to be associated with increased pain, increased illness behavior, and physical and psychological dysfunction across numerous clinical and nonclinical populations (Gatchel, Peng, Peters, Fuchs, & Turk, 2007). Possible mechanisms of action for this phenomenon were proposed by Sullivan et al. (2001) who suggested that catastrophizing represents a multidimensional trait in which activation, appraisal, attention, and coping play a role in the experience of pain. Interestingly, catastrophizing, assessed while individuals are in a pain-free state, prospectively predicts pain ratings made in response to aversive stimulation (Sullivan et al., 2001).

In line with this notion, our participants completed the PCS while in a pain-free state. Their levels of catastrophization correlated with their response to the aversive stimuli from the cold-pressor, in that those who reported higher levels of catastrophization about pain in general had lower tolerance levels to the cold-pressor pain. Our findings add to the previously established evidence that a predisposition to catastrophize about pain is directly related to pain experience, and that pain-related cognitive distortions are an important part of the experience of pain for chronic pain patients and for healthy individuals. Therefore, targeting the pain-related distortions evidenced in patients with chronic pain, including women with dyspareunia, is an important part of treatment for chronic pain. A pain management approach to the treatment of dyspareunia, involving Cognitive Behavioral Therapy aimed at challenging catastrophic thoughts and pain-related fear, is well-advised, given the strong link between heightened pain experience and pain catastrophization. Challenging catastrophic thinking related to pain can be accomplished with (a) education about the actual physiological consequences of pain with intercourse, (b) reality testing with the partner and the therapist, and (c) exercises in which the client lists the evidence that supports and does not support her thoughts regarding what might happen when she has these sensations (Meana, 2009).

Group differences in sexual function and pain catastrophization.

We found a significant group difference in Female Sexual Function Index (FSFI) total scores (minus the pain subscale). Women with dyspareunia had lower total scores, indicating higher levels of sexual dysfunction. Numerous studies have used the FSFI to measure sexual function in women with dyspareunia as compared to control women, and

our finding is in line with previous research demonstrating poorer overall sexual function in women with dyspareunia as compared to pain-free controls (e.g. Brauer, ter Kuile, Gates & Galask, 2001; Brauer, ter Kuile, Laan, & Trimbos, 2009; Lykins, Meana, & Minimi, 2011; Payne et al., 2007, Sutton, Pukall, & Chamberlain, 2009a; Thaler, Meana, & Lanti, 2009).

In terms of pain catastrophization, we found that women with dyspareunia displayed higher levels of overall pain catastrophization than control women. In addition, we found that women with dyspareunia scored higher on the helplessness subscale of the PCS than controls. We did not find significant differences on the rumination and magnification PCS subscales. Again, our findings support previous research demonstrating higher levels of catastrophizing about pain in women with dyspareunia as compared to pain-free controls (Brauer, ter Kuile, Laan, & Trimbos, 2009; Payne et al., 2007; Sutton et al., 2009a). These differences provide further evidence that dyspareunia can best be conceptualized as a pain disorder, in that chronic pain patients presenting with various pain disorders consistently have higher levels of pain catastrophization than pain-free controls.

We did not find differences in somatosensory amplification as we had expected. While previous research has demonstrated that women with dyspareunia tend to exhibit higher levels of somatosensory amplification and somatization than controls (Brauer et al., 2007; Granot & Lavee, 2005, 2001; Meana & Lykins, 2009; Sutton et al., 2009a), we failed to replicate these findings in our sample. Furthermore, we did not find significant differences in overall mental health, or levels of depression and anxiety. Our lack of findings in this area is not that surprising considering that previous research has shown

mixed results with respect to whether women with dyspareunia display higher levels of depression, anxiety and general mental health issues (Brauer, ter Kuile, Laan, & Trimbos, 2009; Dunn, Croft, & Hackett, 2002; Granot & Lavee, 2005; Jantos & White, 1997; Pukall et al., 2007) or do not (Payne et al., 2005, 2007)..

Our findings lend further support to the notion that experiencing pain during sexual intercourse is associated with general deficits in sexual function. All aspects of the sexual response appear to be affected in women with dyspareunia. The experience of pain with intercourse either results in or is a consequence of lower desire and arousal. Only longitudinal studies will establish the causal direction, although it seems more intuitive to posit pain is the trigger for declines in other aspects of the sexual response than vice versa. Furthermore, our results indicate that experiencing chronic pain during sex is associated with a certain cognitive style in regard to the interpretation of pain in general. This cognitive style is characterized by fear of pain and distress reactions to painful stimulation. Again, the research literature is not in a position to determine whether such a cognitive style predisposes to dyspareunia or whether the experience of dyspareunia engenders such distortions. In relation to the ongoing debate about how to best conceptualize and thereby treat dyspareunia, our findings point to a conceptualization of dyspareunia as a legitimate pain disorder that impacts sexual and psychological functioning, and not as primarily a psychosexual mental health problem.

Relationship between pain characteristics and cognitive-affective variables in dyspareunia sample

In the dyspareunia sample, we found noteworthy associations between pain characteristics and certain cognitive-affective variables. Not surprisingly, self-reported

intensity of pain during intercourse and FSFI pain scores were significantly negatively correlated (lower FSFI scores indicate more pain). Also, pain distress was positively correlated with PCS total score, SSAS total score, and MHI anxiety, indicating that the more distressed a woman is about the pain she experiences during sex, the higher her levels of catastrophization, somatosensory amplification and anxiety.

More surprising was the finding that the length of time a woman had been experiencing pain during sex (i.e., number of months or years) was negatively correlated with PCS rumination, PCS helplessness, PCS magnification, and PCS total score. This indicated that the longer a woman had been experiencing pain during sex, the lower her levels of pain rumination, helplessness, magnification, and overall pain catastrophization. One could have reasonably hypothesized that over the long haul, pain may have resulted in sensitization but such did not appear to be the case in our study.

The literature on coping with chronic pain may be helpful in interpreting these findings. Van Damme, Crombez and Eccleston (2008) proposed a motivational perspective to chronic pain coping that is influenced by Brandtstädter and Rothermund (2002)'s dual process model. This model describes how as individuals age, they shift from engaging in assimilative coping (trying to solve problems that act as obstacles to goals) to accommodative coping (setting goals that are more achievable given the obstacle). Essentially, Van Damme et al., (2008) recast coping with chronic pain as consisting of attempts to pursue valued activities and life goals. When individuals first begin to experience chronic pain, they notice an interruption in certain activities. Individuals then appraise the importance of the interrupted activity and the nature of the obstacle. When the blocked goal is important, individuals may simply try to ignore pain

and try harder to accomplish their task (task persistence). The authors termed these attempts to diminish the impact of pain to re-engage in pre-pain activities and life goals as the 'assimilative route' (Van Damme, Crombez, & Eccleston, 2008).

Women with dyspareunia in our study can be viewed from the perspective of this model to be in the assimilative stage. Pain interferes and complicates sexual activity. However, many women may appraise the goal of having sexual intercourse with their partner to be sufficiently important to continue engaging in intercourse despite the pain. We found a relatively high frequency of sexual intercourse in our women with dyspareunia. They reported engaging in sexual intercourse an average of almost eight times per month. These women had clearly not abandoned attempts at having sexual intercourse with their partners, despite pain.

Our data is consistent with other evidence of women with dyspareunia continuing to engage in sexual intercourse despite the pain (de Jong, Van Lunsen, Robertson, Stam, & Lammes, 1995) and reporting similar frequencies and types of sexual activities as women without pain (Reed et al., 2000). In attempting to explain why women with dyspareunia continue to have sex despite the pain, Elmerstig, Wijma, and Berterö (2008) concluded that motives to engage in sex in spite of the pain might be driven by the wish to pleasure one's partner, to avoid anger, or to keep the ideal image of being a "normal" woman. The importance of the blocked goal of sexual intercourse may lead women with dyspareunia to engage in assimilative coping and try to ignore the pain while having sex. After first experiencing pain during intercourse, young women have been found to employ various personal pain management strategies in an attempt to control and cope with the pain (Donaldson & Meana, 2010). Furthermore, Van Damme and colleagues

(2008) stress that individuals do not easily disengage from assimilative coping. When initial coping attempts fail, they often try harder and increase their focus of attention on the problem to be solved, sometimes at the expense of other goals.

This could, in part, explain why catastrophization decreased over time for women with dyspareunia in our sample. In their attempts to cope with the pain and to continue to engage in sexual intercourse with their partners, women with dyspareunia begin catastrophizing less about the pain over time, and focus their attention on achieving their goals and coping with the pain. This notion is further supported by data showing that those who catastrophize about chronic pain persevere in searching for a solution for pain despite a low belief that such a solution is attainable (De Vlieger, Van den Bussche, Eccleston, & Crombez, 2006).

Recent research further supports the seemingly paradoxical relationship between catastrophization and onset of the pain. Donaldson and Meana (2010) found that young women's experience of early dyspareunia was characterized by confusion about the problem, a search for causal attributions, failed attempts at self-treatment, and accumulating negative consequences on well-being, sexual function, and relationships. They highlighted that experiencing sexual pain was quite distressing for these young women, and that this distress peaked close to the onset of the disorder, and may have lessened over time. Our sample, similarly drawn from the same undergraduate university population as Donaldson and Meana's (2010), showed higher levels of pain-related fear closer to the onset of their disorder, with a decrease in the intensity of this fear as time elapsed.

Another set of correlational findings from our study showed that reported intercourse frequency was positively correlated with FSFI satisfaction and FSFI total (minus the pain subscale), and was negatively correlated with MHI depression and MHI total score. These findings indicate that for women with dyspareunia, engaging in more frequent sex is associated with higher levels of sexual function, lower levels of depression and better overall mental health. These findings may be explained through an extension of the aforementioned motivational account of coping with chronic pain. In their attempts to cope with the sexual pain, women with dyspareunia continue to engage in intercourse, a valued activity. Perhaps they learn to focus on the non-painful and pleasurable aspects of the sexual encounter, leading to higher levels of sexual function, lower levels of depression and better mental health. On the other hand, it could also be that women who are better adjusted are better able to cope with sexual pain. Again, our study design cannot directly address causal direction in regard to this issue.

Limitations

There are a number of limitations to this study, some of which have already been addressed. First, our pain and sexual primes did not alter pain perception as expected. It is possible that this is attributable to the methodology of the study. As aforementioned, we may have allowed too much time to elapse between the presentation of our visual stimuli and the administration of the cold-pressor test. This may have significantly decreased or altogether eliminated the priming effect we were trying to create, thereby washing out any differences between conditions in terms of their potential effects on our dependent variables. It would have been advisable to first have established whether our

manipulation worked for our control sample, then made any changes to the protocol before running our dyspareunia sample through the study.

Another limitation concerns the duration of the presentation of the visual stimuli. While no set standard specifies how much time participants need to be exposed to a visual stimulus in order to have the effects of that stimulus impact pain perception, we most likely could have presented our stimuli for a longer period of time to have maximized their effects on participants. Related to this point is the fact that we did not perform any sort of manipulation check to ensure that our participants actively attended to the stimuli and did not ignore them. We did inform participants prior to viewing the images that they should pay attention to what they see, as they may be asked about the stimuli later. We did not, however, actually test our participants' attention or memory for the images. It would have been prudent to have administered a short questionnaire to participants at the end of the study, asking them basic questions about the images to ensure that they did attend to them.

The size and characteristics of our sample may also have been somewhat problematic. Despite two years of active recruitment, we were unable to collect data from 60 women with moderate to severe dyspareunia, as was originally proposed. Our final sample consisted of 38 women with dyspareunia. Our difficulty in findings the 60 women was somewhat unanticipated, as prevalence estimates for dyspareunia in young women range from 10-25%. Recent data emanating from UNLV sheds some light on our difficulties in finding these women. Donaldson and Meana (2010) surveyed women with dyspareunia and used a sample from the UNLV undergraduate student population. Their study highlights the barriers these women face in seeking help for their sexual pain

problems. After the women in their sample first began experiencing pain during sex and this pain became recurrent, they reached a point at which they considered whether to seek professional help. The authors found that the majority of the women in their sample did not seek help for their pain. Some of the barriers to help-seeking included: the belief that the problem would disappear on its own; a lack of confidence that there is a medical solution to the pain; concern about being diagnosed with a sexual problem due to the stigma attached to sex; or the worry that a doctor would confirm their fear that the pain signaled a serious disease that is incurable. If women with dyspareunia in this population encounter so many barriers to seeking help for their problem, it is no wonder that they were reluctant or unwilling to volunteer to participate in a research study on sexual pain. We most likely failed to recruit 60 women with moderate to severe dyspareunia because these women did not want to come forth and admit they had a problem due to shame, embarrassment, fear, and skepticism about their being solutions to their problem. Our difficulties in recruiting women with dyspareunia resulted in our not having sufficient power to detect effect sizes for certain types of analyses. We had sufficient power to detect a large effect for our 2-way ANOVAs, a large effect for our T-tests, and a medium effect for our correlational analyses. However, we did not have enough power to detect small or medium effects for our ANOVAs.

Finally, we did not ask women who reported pain with intercourse whether or not they had sought or engaged in treatment for the problem. However, judging from the data provided by Donaldson and Meana (2010) drawn from the same population in the same city and university, it is unlikely that this group of young women had engaged in any serious treatment attempts.

Future Directions

The question of whether sexual and pain-related stimuli have a differential impact on women with dyspareunia remains an important one to address. Future research could attempt to answer this question by correcting some of the methodological issues encountered in our study. In order to rectify some of the issues that may have contributed to our null findings for priming condition, a future study could use the same IAPS stimuli and present them over a longer time interval (i.e., repeated trials of the same images, with the order of the presentation of slides randomized to control for order effects). While participants are viewing the images, they could be stabilizing their hand temperature in the warm water bath. The cold-pressor test could then be administered immediately following the stimuli presentation, and participants could use a visual analog scale to rate the intensity of the pain as well as the unpleasantness at various points during the cold-pressor task. Finally, after completion of the cold-pressor task, participants could complete a questionnaire designed to 1) verify that they attended to the stimuli by asking basic questions about the images they viewed; 2) inquire about affect induced by the images, to obtain data about participants' subjective affective experience.

Another way to tease apart the cognitive salience and impact of pain and sexual stimuli might be to examine the affective responses of women with dyspareunia to these stimuli. In addition to knowing whether pain and sexual primes have differential effects on pain perception, it would be important and useful to see what sort of emotional impact sexual and pain material create for women with dyspareunia. As Brauer and colleagues (2009) demonstrated, women with dyspareunia displayed positive automatic associations with sexual stimuli, while at the self-report level, they indicated having negative

associations to these stimuli. These findings show that sexual stimuli elicit different types of associations at the automatic or non-conscious level than at the deliberate or conscious level. It would be interesting to measure both automatic and self-reported affective responses to sexual and pain stimuli, to determine whether sexual stimuli activate the same sort of affective responses to pain stimuli.

Future research could also attempt to parse out the effects of different components of Cognitive Behavioral Therapy for dyspareunia and determine which are the most active ingredients for improvements in pain and sexual function. Our findings, in tandem with previous findings, highlight the importance of targeting both cognitive correlates, such as pain catastrophization, and sexual function variables for women suffering from dyspareunia. To date, no study has systematically examined which components of CBT seem to work best for addressing these problems. Is it the challenging of cognitions related to catastrophization and fear of pain, or the addressing of maladaptive coping responses to pain such as avoidance that really helps patients alter the way they think about their pain experience? Furthermore, is it the de-emphasizing of sexual intercourse and focusing on non-penetrative sexual activities, the exploration of sexual and relationship schema, or the enhancing of communication that leads to improvements in sexual functioning in women with dyspareunia? Future research could attempt to answer these questions, in the hopes of designing even more effective cognitive and behavioral treatments for sexual pain.

The results of the current study further contribute to our understanding of dyspareunia, a complex and multifaceted condition. Our findings show that women with dyspareunia display a heightened peripheral sensitivity to pain. They also demonstrate

measurable increases in pain catastrophization both related to experimentally induced pain and in comparison to controls, as well as problems with sexual function. These findings lend support to the idea that dyspareunia is in fact a serious pain disorder that with concomitant sexual deficits. Therefore, treatment for dyspareunia should be multidisciplinary and include a primary focus on alleviating the pain through physical therapy techniques, and on targeting the cognitive implications of the pain through the challenging and reframing of cognitive distortions related to pain catastrophization. Treatment efforts should also focus on directly targeting the sexual problems that arise as a result of the pain, by working with these women on increasing arousal, desire and satisfaction through the enjoyment of non-painful sexual activities.

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APPENDIX I - FSFI

These questions ask about your sexual feelings and responses during the past 4 weeks. Please answer the following questions as honestly and clearly as possible. Your responses will be kept completely confidential. In answering these questions, the following definitions apply:
Sexual activity can include caressing, foreplay, masturbation, and vaginal intercourse.
Sexual intercourse is defined as penile penetration (entry) of the vagina.
Sexual stimulation includes situations like foreplay with a partner, self-stimulation (masturbation), or sexual fantasy.

CHECK ONLY ONE BOX PER QUESTION.

Have you ever had sexual intercourse?
□ YES □ NO

Have you had sexual intercourse in the past 6 months?
YES □ NO

Sexual desire or interest is a feeling that includes wanting to have a sexual experience, feeling receptive to a partner's sexual initiation, and thinking or fantasizing about sex.

1. Over the past 4 weeks, how **often** did you feel sexual desire or interest?
   - □ Almost always or always
   - □ Most times (more than half the time)
   - □ Sometimes (about half the time)
   - □ A few times (less than half the time)
   - □ Almost never or never

2. Over the past 4 weeks, how would you rate your **level** (degree) or sexual desire or interest?
   - □ Very high
   - □ High
   - □ Moderate
   - □ Low
   - □ Very low or none at all

Sexual arousal is a feeling that includes both physical and mental aspects of sexual excitement. It may include feelings of warmth or tingling in the genitals, lubrication (wetness), or muscle contractions.

3. Over the past 4 weeks, how **often** did you feel sexually aroused ("turned on") during sexual activity or intercourse?
   - □ No sexual activity
   - □ Almost always or always\
   - □ Most times (more than half the time)
   - □ Sometimes (about half the time)
   - □ A few times (less than half the time)
   - □ Almost never or never

4. Over the past 4 weeks, how would you rate your **level** of sexual arousal ("turn on") during sexual activity or intercourse?

- No sexual activity
- Very high
- High
- Moderate
- Low
- Very low or none at all

5. Over the past 4 weeks, how **confident** were you about becoming sexually aroused during sexual activity or intercourse?

- No sexual activity
- Very high confidence
- High confidence
- Moderate confidence
- Low confidence
- Very low or no confidence

6. Over the past 4 weeks, how **often** have you been satisfied with your arousal (excitement) during sexual activity or intercourse?

- No sexual activity
- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

7. Over the past 4 weeks, how **often** did you become lubricated ("wet") during sexual activity or intercourse?

- No sexual activity
- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

8. Over the past 4 weeks, how **difficult** was it to become lubricated ("wet") during sexual activity or intercourse?

- No sexual activity
- Extremely difficult or impossible
- Very difficult
- Difficult
- Slightly difficult
- Not difficult

9. Over the past 4 weeks, how often did you **maintain** your lubrication ("wetness") until completion of sexual activity or intercourse?

- No sexual activity
- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

10. Over the past 4 weeks, how **difficult** was it to maintain your lubrication ("wetness") until completion of sexual activity or intercourse?

- No sexual activity
- Extremely difficult or impossible
- Very difficult
- Difficult
- Slightly difficult
- Not difficult

11. Over the past 4 weeks, when you had sexual stimulation or intercourse, how **often** did you reach orgasm (climax)?

- No sexual activity
- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

12. Over the past 4 weeks, when you had sexual stimulation or intercourse, how **difficult** was it for you to reach orgasm (climax)?

- No sexual activity
- Extremely difficult or impossible
- Very difficult
- Difficult
- Slightly difficult
- Not difficult

13. Over the past 4 weeks, how **satisfied** were you with your ability to reach orgasm (climax) during sexual activity or intercourse?

- No sexual activity
- Very satisfied
- Moderately satisfied
- About equally satisfied and dissatisfied
- Moderately dissatisfied
- Very dissatisfied

14. Over the past 4 weeks, how **satisfied** have you been with the amount of emotional closeness during sexual activity between you and your partner?

- No sexual activity
- Very satisfied
- Moderately satisfied
- About equally satisfied and dissatisfied
- Moderately dissatisfied
- Very dissatisfied

15. Over the past 4 weeks, how **satisfied** have you been with your sexual relationship with your partner?

- Very satisfied
- Moderately satisfied
- About equally satisfied and dissatisfied
- Moderately dissatisfied
- Very dissatisfied

16. Over the past 4 weeks, how **satisfied** have you been with your overall sexual life?
- Very satisfied
- Moderately satisfied
- About equally satisfied and dissatisfied
- Moderately dissatisfied
- Very dissatisfied

17. Over the past 4 weeks, how **often** did you experience discomfort or pain during vaginal penetration?
- Did not attempt intercourse
- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

18. Over the past 4 weeks, how **often** did you experience discomfort or pain following vaginal penetration?
- Did not attempt intercourse
- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

19. Over the past 4 weeks, how would you rate your **level** (degree) of discomfort or pain during or following vaginal penetration?
- Did not attempt intercourse
- Very high
- High
- Moderate
- Low
- Very low or none at all

Were your responses random, or did you answer truthfully (circle one)?

Answered truthfully OR Randomly

APPENDIX II

TELEPHONE SCREENING

"Thank you for calling to inquire about the cognitive processes in sexual pain study. This study examines cognitive processing in women who experience pain during sex. This study takes approximately one hour to complete and you will get 1.0 research credit for your participation. The study involves you filling out some questionnaires pertaining to sexual function and pain, looking at some pictures on a computer screen and then placing your hand in a bucket of cold water. Now that I have briefly described the study, are you still interested in participating?"

If participant says no, then thank them for their time and hang up.

If the participant says yes, then ask:

"Would it be ok if I asked you some questions to see whether you are eligible to participate?"

If yes, then proceed to ask the following questions:

How old are you? _____

What is your sexual orientation (optional)?

□ Heterosexual/straight

□ Homosexual/gay

□ Bisexual

1. Have you ever had penile-vaginal intercourse (i.e. penetration)?

Y N (If no, discontinue)

2. Have you attempted penetration in the past 6 months?

Y N (If no, discontinue)

a. If yes, approximately how many times (per week or per month)? _____

3. When you engage in sexual intercourse, what percentage of the time do you experience pain during or after?

Never Less than 25% of the time 25-50%

50-75% 75% or more of the time

4. When you experience pain during sex, how would you rate the intensity of the pain from 0-10, with 0 being no pain and 10 being the worst pain you can imagine? _____

5. How much distress does this pain cause on, on a scale from 0-10, with 0 being no distress and 10 being the worst distress you can imagine? _____

6. How would you categorize the pain you experience?

No Pain (0) Mild (1) Discomforting (2) Distressing (3)

Horrible (4) Excruciating (5)

For Controls only:

7. Do you experience any sexual problems? (e.g. low desire, lack of arousal, inability to achieve orgasm, etc.) _____

For everyone:

8. Do you suffer from any chronic pain condition other than pain during intercourse?

Y N

APPENDIX III – PCS

Everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures or surgery.

Please think of a pain that you experience on a regular basis (i.e. at least 1-2 times a month). Please write down this pain in the space below. For example, some respondents report experiencing things such as headaches, menstrual cramps, muscle pain, etc.

_____

_____

Instructions:
We are interested in the types of thoughts and feelings that you have when you are in pain. Listed below are thirteen statements describing different thoughts and feelings that may be associated with pain. Using the following scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.

RATING	**0**	**1**	**2**	**3**	**4**
MEANING	Not at all	To a slight degree	To a moderate degree	To a great degree	All the time

When I'm in pain …

Number	Statement	Rating
1	I worry all the time about whether the pain will end.	
2	I feel I can't go on.	
3	It's terrible and I think it's never going to get any better	
4	It's awful and I feel that it overwhelms me.	
5	I feel I can't stand it anymore	
6	I become afraid that the pain will get worse.	
7	I keep thinking of other painful events	
8	I anxiously want the pain to go away	
9	I can't seem to keep it out of my mind	
10	I keep thinking about how much it hurts.	
11	I keep thinking about how badly I want the pain to stop	
12	There's nothing I can do to reduce the intensity of the pain	
13	I wonder whether something serious may happen.	

APPENDIX IV – MHI-18

Instructions: Please read each of the following statements carefully and circle the answer that best describe your feelings **for the past month.**

1. **For this past month, has your daily life been full of things that were interesting to you?**
   - (1) All of the time
   - (2) Most of the time
   - (3) A good bit of the time
   - (4) Some of the time
   - (5) A little of the time
   - (6) None of the time
2. **Did you feel depressed during the past month?**
   - (1) All of the time
   - (2) Most of the time
   - (3) A good bit of the time
   - (4) Some of the time
   - (5) A little of the time
   - (6) None of the time
3. **During the past month, how much of the time have you felt loved and wanted?**
   - (1) All of the time
   - (2) Most of the time
   - (3) A good bit of the time
   - (4) Some of the time
   - (5) A little of the time
   - (6) None of the time
4. **How much of the time, during the past month, have you been a very nervous person?**
   - (1) All of the time
   - (2) Most of the time
   - (3) A good bit of the time
   - (4) Some of the time
   - (5) A little of the time
   - (6) None of the time

5. **During the past month, have you been in firm control of your behavior, thoughts, emotions, feelings?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
6. **During the past month, how much of the time have you felt tense or "high-strung"?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
7. **How much of the time, during the past month, have you felt calm and peaceful?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
8. **How much of the time, during the past month, have you felt emotionally stable?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time

9. **How much of the time, during the past month, have you felt downhearted and blue?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
10. **How much of the time, during the past month, were you able to relax without difficulty?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
11. **During the past month, how much of the time have you felt restless, fidgety, or impatient?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
12. **During the past month, how much of the time have you been moody or brooded about things?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time

13. **How much of the time, during the past month, have you felt cheerful, lighthearted?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
14. **During the past month, how much of the time have you been in a low or very low spirits?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
15. **During the past month, how much of the time were you a happy person?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
16. **During the past month, how often did you feel that you had nothing to look forward to?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time

17. **How often, during the past month, have you felt so down in the dumps that nothing could cheer you up?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time
18. **During the past month, have you been anxious or worried?**
    (1) All of the time
    (2) Most of the time
    (3) A good bit of the time
    (4) Some of the time
    (5) A little of the time
    (6) None of the time

APPENDIX V – SSAS

On this questionnaire are groups of statements. Please read each group of statements carefully. Then check off the one statement in each group which best describes YOU IN GENERAL.

1 = Not at all True 2 = A little Bit True 3 = Moderately True

4 = Quite a bit True 5 = Extremely True

	1	2	3	4	5
1. When someone else coughs, it makes me cough too					
2. I can't stand smoke, smog, or pollutants in the air					
3. I am often aware of various things happening within my body					
4. When I bruise myself, it stays noticeable for a long time					
5. I sometimes can feel the blood flowing in my body					
6. Sudden loud noises really bother me					
7. I can sometimes hear my pulse or my heartbeat throbbing in my ear					
8. I hate to be too hot or too cold					
9. I am quick to sense the hunger contractions in my stomach					
10. Even something minor, like an insect bite or a splinter, really bothers me					
11. I can't stand pain					

APPENDIX VI – DEMOGRAPHIC QUESTIONNAIRE

1. Age _____

2. What is your ethnicity?

   □ African-American □ Caucasian □ Native-American □ Other

   □ Asian □ Hispanic □ Pacific Islander

3. What is your religious affiliation?

   □ Catholic □ Jewish □ Muslim □ Other _____

   □ Christian □ Mormon □ None

4. What is your sexual orientation (optional)?

   □ Heterosexual/straight

   □ Homosexual/gay

   □ Bisexual

5. Are you left or right handed? L R

Table 1

Demographic Characteristics of Sample (N = 98)

Characteristic	Control		Dyspareunia	
	n	%	n	%
Ethnicity				
African American	5	8.3	10	26.3
Asian	6	10.0	0	0.0
Caucasian	32	53.3	21	55.3
Hispanic	9	15	4	10.5
Native American	1	1.7	0	0.0
Pacific Islander	4	6.7	0	0.0
Biracial	0	0.0	2	5.3
Other	3	5.0	1	2.6
Religion				
Catholic	12	20.0	6	15.8
Christian	17	28.3	16	42.1
Jewish	3	5.0	1	2.6
Mormon	1	1.7	3	7.9
None	19	31.7	8	21.1
Other	8	13.3	4	10.5

Table 2

Means and Standard Deviations: Pain Threshold and Pain Tolerance as a Function of Group and Condition

	Control Group				Dyspareunia Group				Combined Sample			
	Pain Threshold (in seconds)		Pain Tolerance (in seconds)		Pain Threshold (in seconds)		Pain Tolerance (in seconds)		Pain Threshold (in seconds)		Pain Tolerance (in seconds)	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pain	7.40	7.88	36.65	27.37	5.25	4.79	26.58	15.25	6.59	6.88	32.88	23.79
Sex	7.85	5.90	49.45	50.53	4.71	2.05	25.21	14.38	6.56	4.91	39.47	41.21
Neutral	7.75	6.27	36.70	39.26	4.50	4.07	19.25	8.475	6.53	5.71	30.16	32.30

Table 3

Summary of Two-Way Analysis of Variance on Pain Threshold as a Function of Group and Condition

Source	*df*	*F*	η^2	*p*
Group	1	5.61	.06	.02
Condition	2	.01	.00	.99
Group X Condition	2	.08	.00	.92
Residual	92			

Table 4

Summary of Two-Way Analysis of Variance on Pain Tolerance as a Function of Group and Condition

Source	*df*	*F*	η^2	*p*
Group	1	6.47	.07	.01
Condition	2	.66	.01	.52
Group X Condition	2	.37	.01	.69
Residual	92			

Table 5

Means and Standard Deviations for Sexual Function and Cognitive-Affective Measures

Measure	Dyspareunia		Control	
	M	SD	M	SD
FSFI Total	21.84	6.17	28.21	6.51
FSFI Pain	2.60	1.18	5.19	1.52
FSFI Total minus pain subscale	19.24	5.80	23.02	5.51
PCS Total	23.03	10.49	17.92	10.89
PCS Magnification	4.18	3.18	3.52	3.00
PCS Rumination	9.11	4.12	7.63	4.34
PCS Helplessness	9.74	5.11	6.77	5.13
SSAS Total	32.50	6.66	30.28	6.38
MHI Total	49.11	13.03	46.82	15.04
MHI Anxiety	12.89	4.01	11.72	4.08
MHI Depression	8.55	3.22	8.23	3.85

Table 6

Summary of Intercorrelations for scores on the Pain Threshold and Tolerance, Sexual Function and Cognitive-Affective Measures for the No-Dysfunction Sample

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1. Pain Threshold												
2. Pain Tolerance	.25											
3. PCS rumination	-.07	-.45**										
4. PCS helplessness	-.09	-.34**	.81**									
5. PCS magnification	.29*	-.05	.47**	.53**								
6. PCS total	.01	-.35**	.91**	.94**	.71**							
7. SSAS total	.00	-.17	.31*	.21	.28*	.30*						
8. MHI anxiety	.26*	.03	.16	.11	.24	.18	.16					
9. MHI depression	.15	.12	.09	.13	.14	.13	.06	.53**				
10. MHI total	.23	.10	.13	.16	.20	.18	.03	.76**	.90**			
11. FSFI minus pain	-.15	-.22	-.00	-.11	-.12	-.09	.08	-.39**	-.38**	-.43**		
12. FSFItotal	-.17	-.20	-.05	-.13	-.13	-.12	.06	-.39**	-.38**	-.42**	.98**	
13. Sex frequency	-.07	-.12	.06	.03	-.14	.00	.04	.04	.01	.03	.19	.16

Note: *$p < .05$. **$p < .01$.

Table 7

Summary of Multiple Regression Analysis for Variables Predicting Pain Threshold in No-Dysfunction Sample (N = 60)

Variable	*B*	*SE B*	*β*
FSFI Minus Pain	-.08	.18	-.07
PCS Total	-.02	.09	-.04
SSAS Total	.02	.14	.01
MHI Total	.09	.07	.21

Note: *$p < .05$. **$p < .01$.

Table 8

Summary of Multiple Regression Analysis for Variables Predicting Pain Tolerance in No-Dysfunction Sample (N = 60)

Variable	*B*	*SE B*	*β*
FSFI Minus Pain	-1.58	.98	-.22
PCS Total	-1.36	.47	-.37
SSAS Total	-.29	.80	-.05
MHI Total	.19	.36	.07

Note: *$p < .05$. **$p < .01$.

Table 9

Summary of Intercorrelations for scores on the Pain Threshold and Tolerance, Sexual Function and Cognitive-Affective Measures for the Dyspareunia Sample

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Sex frequency																
2. Pain intensity	.03															
3. Pain distress	-.15	.25														
4. Pain duration	.29	-.09	-.18													
5. Pain Threshold	-.00	-.05	-.07	-.13												
6. Pain Tolerance	.20	.11	.09	-.00	.38*											
7. PCS rumination	-.21	.18	.27	-.44**	-.22	-.13	—									
8. PCS helplessness	-.22	.25	.31	-.41*	-.12	-.01	.78**									
9. PCS magnification	-.06	.23	.25	-.48**	-.08	-.11	.35*	.46**								
10. PCS total	-.20	.26	.33*	-.51**	-.17	-.09	.88**	.93**	.66**							
11. SSAS total	-.25	.14	.46**	-.19	.02	-.06	.27	.40*	.31	.39*						
12. MHI anxiety	-.16	.10	.33*	-.23	-.26	-.19	.37*	.33*	.53**	.47*	.37*					
13. MHI depression	-.46**	-.07	.18	-.09	-.23	.03	.26	.31	.14	.30	.22	.48**				
14. MHI total	-.41*	-.05	.28	-.19	-.23	-.05	.38*	.43*	.39*	.48**	.37*	.79**	.86**			
15. FSFI pain	.16	-.52**	.15	-.09	.02	-.00	-.00	.08	-.10	.01	.07	.10	-.01	.09		
16. FSFI tot minus pain	.36*	.02	-.16	-.16	-.24	.02	.19	.06	-.04	.09	-.18	-.03	-.16	-.15	.23	
17. FSFI total	.37*	-.08	-.12	-.17	-.22	.02	.18	.07	-.06	.09	-.15	-.01	-.16	-.12	.40*	.98**

Note: *$p < .05$. **$p < .01$.

Table 10

Summary of Multiple Regression Analysis for Variables Predicting Pain Threshold in the Dyspareunia Sample (N=38)

Variable	*B*	*SE B*	*β*
FSFI Minus Pain	-.16	.11	-.26
PCS Total	-.02	.07	-.05
SSAS Total	.06	.10	.10
MHI Total	-.08	.05	-.28

Note: *$p < .05$. **$p < .01$.

Table 11

Summary of Multiple Regression Analysis for Variables Predicting Pain Tolerance in the Dyspareunia Sample (N=38)

Variable	*B*	*SE B*	*β*
FSFI Minus Pain	.05	.41	.02
PCS Total	-.10	.26	-.08
SSAS Total	-.05	.39	-.03
MHI Total	-.00	.21	-.00

Note: *$p < .05$. **$p < .01$.

Table 12

Summary of Two-Way Analysis of Variance for Dyspareunia Sample on Pain Threshold as a Function of Condition and Sexual Pain Frequency Group

Source	*df*	*F*	η^2	*p*
Condition	2	.13	.01	.88
Pain Frequency	1	.01	.00	.93
Condition X Pain Frequency	2	1.12	.07	.32
Residual	31			

Table 13

Summary of Two-Way Analysis of Variance for Dyspareunia Sample on Pain Tolerance as a Function of Condition and Sexual Pain Frequency Group

Source	*df*	*F*	η^2	*p*
Condition	2	1.10	.07	.35
Pain Frequency	1	.22	.01	.64
Condition X Pain Frequency	2	1.24	.07	.30
Residual	31			

Figure 1

Pain Threshold as a Function of Group and Prime Condition

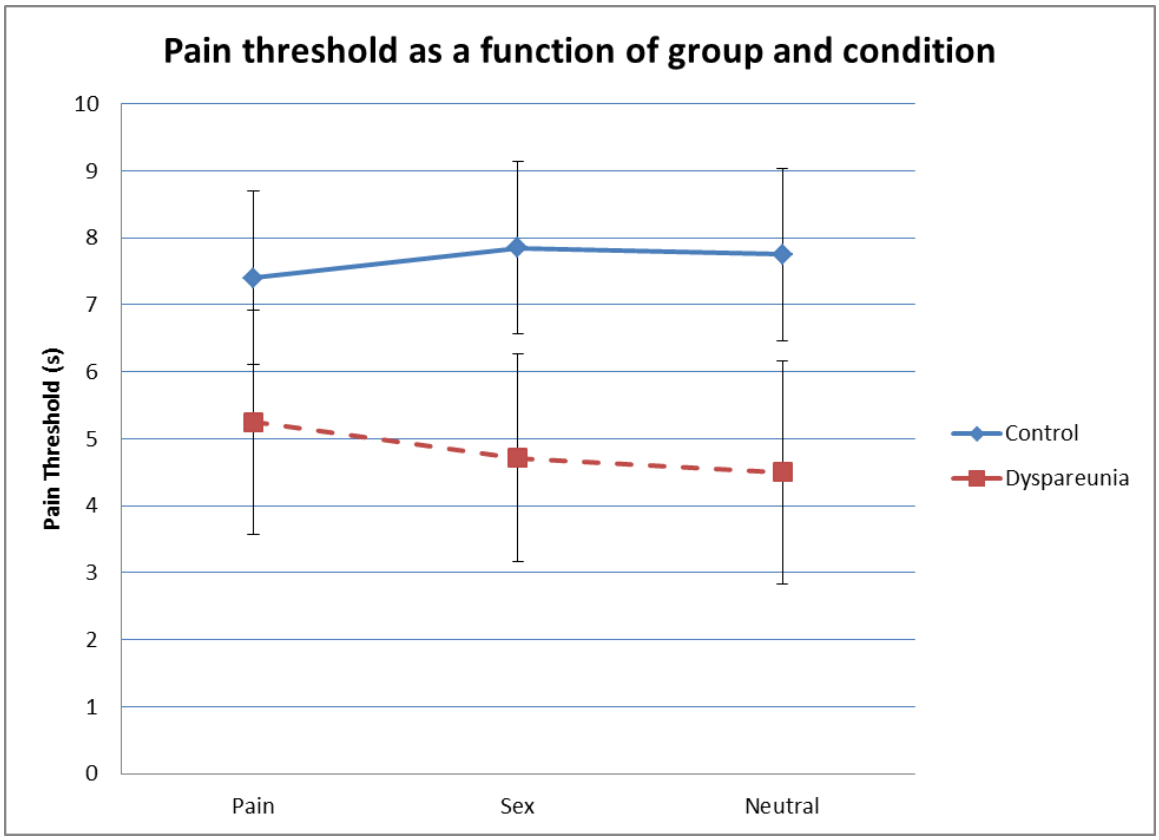
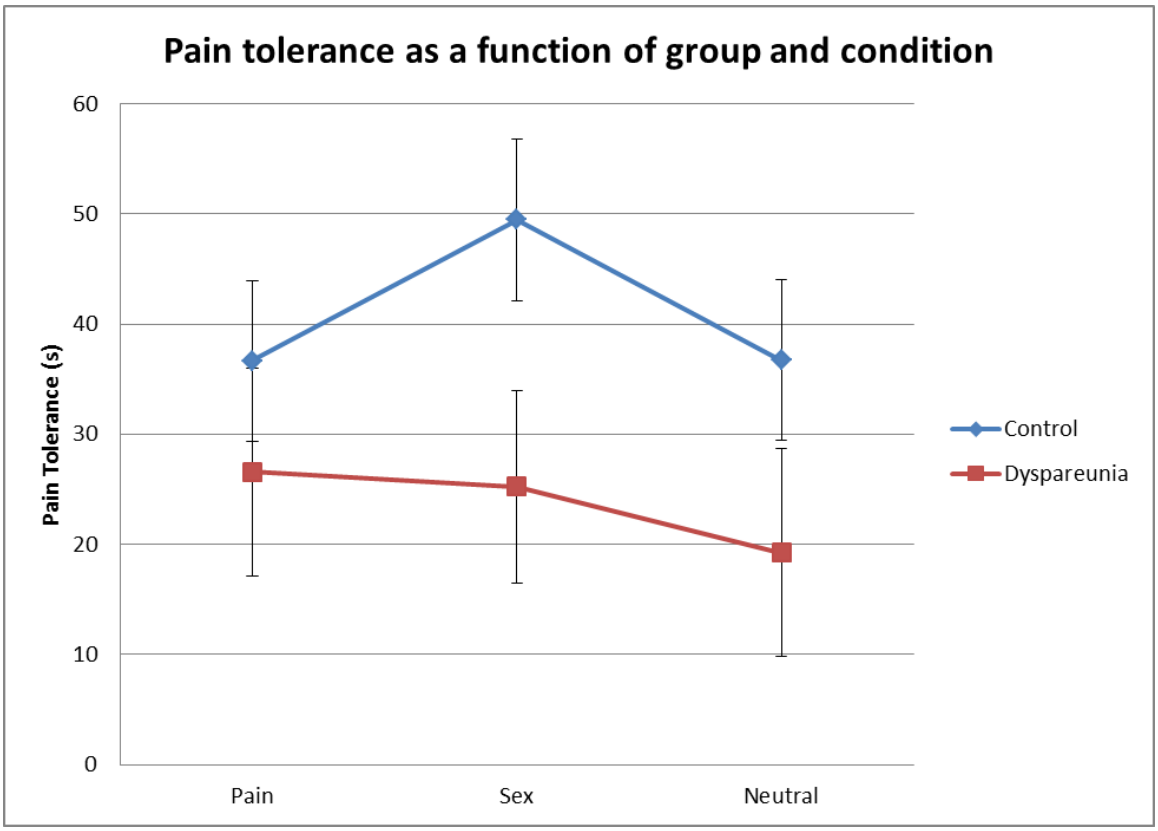


Figure 2

Pain Tolerance as a Function of Group and Prime Condition



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